

Global Energy Security and Malaysian Perspective: A Review

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ABSTRACT

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This paper serves to review the status of energy security in Malaysia and the strategic planning that was taken to enhance the future energy security. Since the early stage of industrial revolution in 2002, Malaysia enjoyed a continuous development in the sector due to the prosperous in natural resources such as oil, gas and coal. However, due to the excessive development without proper planning, Malaysia is now facing a problem of energy insecurity as ample of resources are needed to sustain the domestic development. With issues of price volatility and the reduction in oil production, the oil business become unstable. It leads to the thriving of natural gas and coal which enable energy generation. Nonetheless, these resources are finite and could be run out one day in the future. Hence, the government of Malaysia has been doing strategic planning for the development of Malaysia to ensure its energy security. These plannings include the management of current reservoir and the energy policy, which enhance the effectiveness of energy usage within Malaysia to ensure energy security in Malaysia.

Keywords:

Malaysia energy security, Malaysian perspective, Energy security

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1. Introduction

The industrial revolution in the year 2002 has made Malaysia in a fast-developing nation for the past few years. While it is blessed with a lot of resources such as oil, gas and coal supply, these resources are hydrocarbon fuel which could be used to supply energy and power the economy of a nation [1]. However, they are depletable and could be run out one day in the future. Hence, it is imperative that the government of Malaysia has some strategic planning to utilize these resources efficiently to make sure that the nation's development is not affected to the energy insecurity. In this case, the current trends of the energy utilization, usage including the export and import of resources are discussed. The strategic planning of Malaysia government in ensuring the energy security to maintain or boost the nation's economy is also reviewed [2–4].

Malaysia has been involved in the international business of export and import with the neighboring countries for the past few decades. Although Malaysia is well-known as the major oil exporters in the region of ASEAN, she would eventually becomes a net oil importer in the future with the declination of oil production [5–7]. As for natural gas, Malaysia has achieved the status for being the second-largest liquified Natural Gas (LNG) exporter in 2014 with the help of the development of a petrochemical complex situated in Pengerang, Johor [8]. Coal on the other hand are vastly used for the

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energy generation in Malaysia. Due to the slump in 2013, Malaysia GDP is still in the recovering phase which force its demand on energy to increase. In this case, Malaysia has been one of the major importers of coals due to the demand rise while most of its coal supply were obtained from either Indonesia or Australia [9,10].

As of international organization in the context of regionalisation, Malaysia has planned its energy security for long-term benefits by being proactive in joining various efforts as one of the ASEAN member states. For example, Malaysia has devoted itself in building the ASEAN Power Grid (APG) which aims to help ASEAN member states to meet the rising energy demand [11–22]. This strategy will establish Electricity Open Market among ASEAN countries for optimizing resource utilization [11, 14, 23–27]. The construction of this power grid is estimated to be completed by 2020 [14, 28–30]. By promoting efficient usage and sharing of resources among ASEAN countries, the waste of energy can be avoided, and a new potential market will be formed to aid the development of the relevant infrastructure. Besides that, Trans-ASEAN Gas Pipeline (TAGP) is also conceived as another major part of the ASEAN Vision 2020 [29, 31–37]. This infrastructure will interconnect the existing and planned gas pipelines within ASEAN, transporting natural gas across borders in parallel to secure the optimum gas supply [31, 33, 38, 39]. The proposed energy project is believed to be able to cover the rapid economic growth and population increase which has created huge challenges to the energy security aspect.

For the energy security of Malaysia, the recent instability in global economy and crude oil market has leads to the price fluctuation of fossil fuels. In addition, the severity of global warming has boosted Malaysia to adopt an energy mix strategy in parallel to fulfil the surging energy demand in the country [40–47]. The objective of diversification of fuel sources is to achieve a sustainable energy supply which is crucial for its development for Malaysia as they are working towards achieving the Vision 2020 which makes Malaysia a developed nation [3, 4, 48–55]. For instances, dependency of current energy mixes on coal has made the government to plan in reliance on coal while diversifying on other sources. According to Fig. 1, it is shown that starting from 2001 to 2020, coal has been the first choice in generating electricity for our nation due to its low fuel cost. However, its usage is expected to be decreased in 2030 in consideration to the environmental health problem of coal combustion towards the global climate change issue [55, 56].

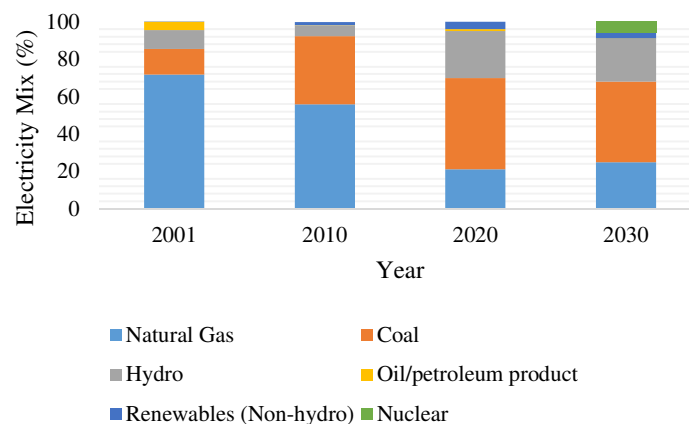


Fig. 1. Fuel Mix for Power Generation in Malaysia [55, 56]

According to the data of energy usage within Malaysia given by Energy Commission [19], total electricity generation in 2015 is 12710 ktoe. It can be noticed that a big portion of electricity has been allocated to the industrial sector as Malaysia is transforming into an industrial-based developing country [48, 57–62] which requires plenty of energy sources. The sources for the electricity generation could be generated from natural gas, coal, hydro, oil and renewables [55, 56, 63] even though Malaysia

focused on using coal and natural gas as their main energy source. In that regards, Malaysia has been putting much efforts to transform its economy framework by changing the main income source to other potential segments which could provide the energy security for the development of the nation.

Furthermore, the handling of these resources in Malaysia are also of concern of this paper as the hydrocarbon resources in Malaysia is likely to yield production in the future which are the lifeblood of any integrated oil and gas company that consist of upstream and downstream operations. Thus, proper management of these resources can ensure the sustainability of business as well as energy security of this country [64]. In this case, Malaysia have implemented numerous energy policies past this four decades in order to cope with energy security issues and implement efficient and effective energy usage [65, 66]. The management of old and new reserve for hydrocarbon resources (oil, gas and coal) can be referred to those policies that had been implemented by Government such as National Petroleum Policy 1975, National Depletion Policy 1980 and Four-fuel Policy 1981. Other than that, the initiatives taken by integrated oil and gas company are able to provide reliable supply production by exploration, development and refining of those hydrocarbon supply have somehow resolve energy security for quite a long period of time [67–69].

All in all, the surge of population growth and economic development over the years has led to the increase of energy usage within Malaysia. Hence, comprehensive strategic planning is needed to ensure the future energy security of Malaysia. In this case, the government has consistently amends the energy policy in parallel to the needs of development. The paradigm shift impacts greatly on energy development as it outline measures taken to manage scarce sources of the oil, gas and coal sector [70]. In addition, the policy also introduces the prospect of considering renewable energy such as nuclear energy [70].

This paper aims to review the resources utilization of Malaysia outside and within the nation itself. It covers the involvement of Malaysia in the international stage in securing the energy security of their own nation. The current energy mix, its limitation and the energy usage within Malaysia along with the strategy planning of the government are also within the scope of the review paper.

2. Malaysia Export and Import of Energy Sources

For the past, Malaysia is known for being the influential oil exporter in the ASEAN region [71]. However, it is noticed that it started to follow the footsteps of Indonesia due to the declination of oil production which would eventually lead the country into becoming a net importer.

The energy industry in Malaysia is crucial in propelling the country's economy especially the oil and gas field acting as one of the major contributors in generating revenue, but according to statistics in the year 2012, the largest contributor was in fact the gas industry in comparison to the oil industry [5]. According to the statistics, the value of oil exports has accounted for approximately 10% of Malaysia's GDP in the last five years. However Malaysia's oil reserves are maturing and oil production within the country is declining at a steady rate, with the addition of the country's oil consumption that is rising significantly [5]. This is due to the strong economic development and Fig. 2 illustrates the annual consumption of oil in Malaysia from the year 2006 until 2016, depicted from the statistics of various sources [72].

There has been a debate between the economists and the market analysts on the issue of Malaysia becoming a net importer of oil. This debate is indeed the impact of the significant rise of oil consumption and the maturing oil wells in terms of declining oil production within the country. It means that Malaysia has turned into a net oil importer in January throughout August during the year 2014 due to a larger import of petroleum products while crude oil exports shrank [6]. According to RHB Research, "Malaysia has imported a net amount of RM3 billion in the first eight months compared with a net export of RM2.1 billion in 2013". Whereas the Malaysian Prime Minister Datuk Seri Najib Razak in 2015 stated that the Malaysian oil exports amounted to RM7.7 billion while RM8.9 billion was imported from January to November the previous year [7]. In Fig. 3, the statistics of crude

oil and other petroleum products shows that there is fluctuations of the import and export trends throughout the year 2005 until 2015.

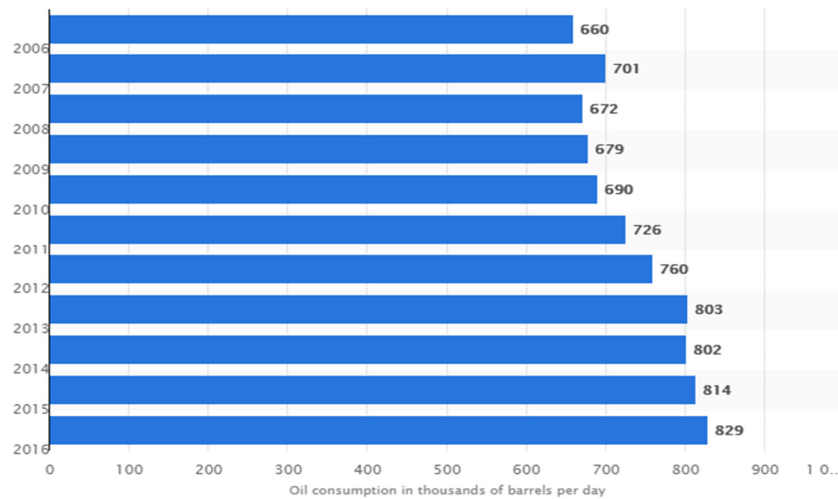


Fig. 2. Annual oil consumptions in Malaysia from the year 2006 to 2016 [72]

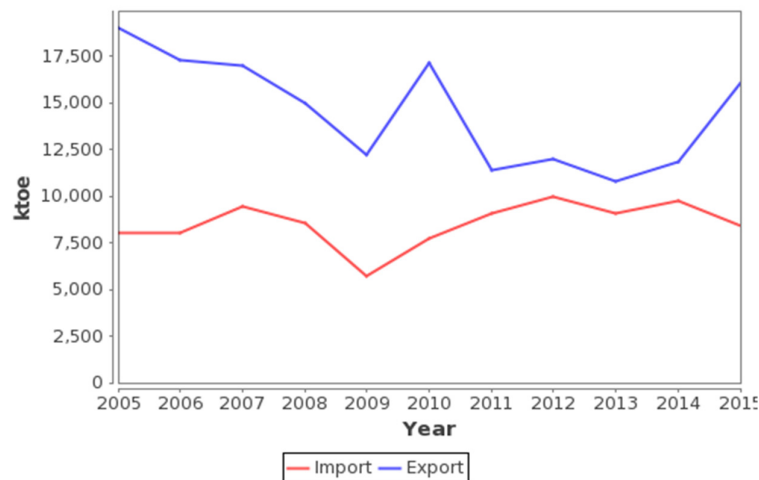


Fig. 3. Annual import and export for crude oil and condensates from 2005 until 2015 [73]

Despite of that, statements from chief economist of MIDF Amanah Investment Bank to FocusM. AllianceDBS, Maslynnawati Ahmad was contradicted to this hypothesis where she said, “If it is just crude oil, we would not become a net oil importer. But if we add on trade for petroleum products, yes we are a net oil importer” [6]. If the Liquefied Natural Gas (LNG) product is included in the mix, the results will be the opposite; net oil exporter. This is because Malaysia has achieved the status for being the second-largest LNG exporter in 2014 due to the development of the petrochemical complex situated in Pengerang, Johor [8]. In the year 2017, the LNG sales which contributes approximately 4.8% of total exports had doubled from RM2 billion to RM4 billion due to the strong increase in both export volume (+57.4%) and an average unit value (+28.2%) [74].

Malaysia's energy security strategy has been set to export its premium Tapis sweet crude oil and import low-grade oil to refined in its downstream facilities [75]. On the other hand, coal is also one of the beneficiary within Malaysia's energy security context. It is said the Malaysian GDP is still in the recovering phase since the 2013 slump, forcing the energy demand to increase. Therefore the share of coal in the energy generation mix has been on the rise and it is expected to grow from 47% to 63% by 2020, according to Noor Asihin Surani, Senior Manager at Fuel Strategic Planning of TNB Fuels [9].

3. Ways to improve Malaysia Energy Security in the International Stage

In the international stage, Malaysia is a member state of the Association of Southeast Asian Nations (ASEAN) which consists of 10 member countries including Thailand, Vietnam, Laos, Indonesia, Philippines, Myanmar, Brunei, Malaysia, Singapore, and Cambodia [22]. For the last couple of years, the ASEAN region experiences significant increase in energy demand increases due to their fast economic growth, compared to other regions of Asia [23]. It has been reported that, the primary energy consumption of the ASEAN region would increase from 556.28 (Million ton of oil equivalent) Mtoe, to 1414 Mtoe within the period of 2012–2030 [14].

Since then, the ASEAN power grid (APG) is being implemented among ASEAN countries through ASEAN Heads of States/Governments, under the ASEAN Vision 2020 in order to meet the growing demand for electricity [14]. It is a plan to connect the transmission networks between the ASEAN countries to optimize the use of energy resources in order to operate the power network in an efficient, economical, and reliable manner and to strengthen the relation among the member countries by electric power interconnection [11]. The primary aim of APG is to ensure regional energy security by promoting the effective utilization and sharing of resources for common regional benefit by sharing of surplus generated electricity for improving system security through the reduction of system cost amongst member countries [19]. It can contribute to the creation of the provision for future energy trade and together exploit the large energy resources within ASEAN and reduce the need of fuel imports from other regions [25].

It has been reported that the oil reserves in ASEAN region is 27.96 billion barrels. Indonesia is the largest oil producer, equivalent to its control of the largest oil reserve in the region [25]. Brunei has the second largest oil reserve, followed by Vietnam, Malaysia, and Myanmar. However, Brunei and Malaysia are the only net oil exporter of the region [19]. Indonesia, Malaysia and Brunei stand as the top three of natural gas reserves where natural gas reserves of 350.29 trillion cubic feet are reported for ASEAN region. Thailand and Singapore are the net liquefied natural gas (LNG) importer in this region, while Brunei, Malaysia, and Indonesia are net exporters of LNG [31]. In addition, coal is also found abundance within this region with 80 years of reserve to production ratio and its topmost amount being 45,710.5 million tons (MMT) [30,36]. Among these nations, Indonesia, Thailand, Malaysia, and Vietnam have the highest amount of coal reserves [20]. Despite of it, Malaysia's coal production is considerably low which makes it a net importers of steam coal as it used amply amount of coal for domestic development [26]. In this case, most of the coal supplies are obtained from either Indonesia or Vietnam as they are the largest coal producer in ASEAN region.

While APG that links the energy resource-rich and the energy resource-poor countries could conceivably play an important role in aiding Malaysia to attain the status of energy security nation through decreasing the overall cost of region to meet its growing electricity demand [13,17], it is extremely challenging to meet these high growing demand. It is indeed an "industry wisdom" as it takes two years to connect energy resources within an Asian country, ten years to connect resources within two countries, and "a miracle" to create a multi-cross-country network of distribution involving more than two countries [12,31].

As for natural gas and its associated transportation infrastructure in Southeast Asia, it provides an excellent ways through which to explore the dynamics of regional energy policy and a host of energy-related issues [14]. Relationships between cross-border suppliers, economic development, trade flows,

and regional security, all revolve around the basic allocation of energy resources [22,28]. Furthermore, the production of natural gas is closely related social and political conditions, such as human health and safety, protection of the environment, and pertaining to society development more generally [11,24]. In this case, Malaysia as the net exporter of natural gas enables it to attain good relationships with its neighbouring country. With this Malaysia is able to obtain various resources from them and aid in ensuring the energy security for Malaysia.

Table 1 Summary of type energy used in ASEAN [32]

Country	Oil (BBI)	Gas (TCF)	Coal (MMT)	Hydro (MW)	Biomass (MW)	Geothermal (MW)	Solar (MW)	Onshore	Offshore
								Wind (MW)	Wind (2030) (TW h)
Brunei	6.0	34.8	–	–	–	–	10	–	–
Cambodia	–	9.89	–	15,000	1712	–	875	1300	–
Indonesia	10	169.5	38,000	75,625	49,810	29,000	551	9300	21.34
Lao PDR	–	3.60	600	26,500	730	–	33	24,000	–
Malaysia	3.42	84.4	1024.5	29,500	29,000	–	1412	2,599	13.39
Myanmar	3.1	12.1	–	108,000	6849	–	12,967	1600	–
Philippines	0.285	4.6	346	13,107	20	2047	350	7400 –76,000	6.96
Singapore	–	–	–	–	–	–	–	–	0.22
Thailand	0.156	12.2	1240	16,655	22,831	–	3000	190,000	19.42
Vietnam	5	19.2	4500	68,500	9688	–	3111	642,000	15
Total	27.961	350.29	45,710.5	352,887	120,640	21,705	22,309	946,799	76.33

4. Current Energy Mix, Usage and Trends

The energy mix of Malaysia at 2015 is unbalanced such that about 46.3% of natural gas is used to cater the domestic demand while coal makes up of 41% of the total installed capacity. On the other hand, the hydroelectric accounted for a 10.7% of electricity generation while other renewables energy such as solar and biomass could only take up to 1-2% in the energy mix. This situation is very much different from the year 1995 as the reduction in oil for power generation is replaced by the dependency on coal to power the domestic development as shown in Fig. 4 [10].

Fig. 5 shows the statistics on final electricity consumption in 2015 conducted by the Malaysian Energy Commission [76] where the allocation of energy in each sector within Malaysia. According to the figure, the total energy produced has a capacity of 12710 ktoe while the majority of the energy goes to industrial sector which needs 45.9% of total demand, 32.2% for commercial, 21.4% for residential, 0.4% for agriculture and 0.2% for transportation [77]. The primary reason for the current trend of energy usage is due to the focus of the Malaysian government on industrial development which contribute the most to the national revenue or the GDP of the nation in achieving the status of developed country.

As for the trends of energy usage, these large-scale development on industrial sector such as electronics and construction industries [78] has threatened the environmental health which has also gradually become the concern among public [48,79–87]. The utilization of fossil fuels, particularly coal resulting in the high emission of harmful pollutants and carbon dioxide into the open air, has ultimately contributed to the issues of climate change [88–98]. Facing with the problem of climate change as well as diminishing of crude oil, Malaysia has introduced the energy sustainability concept into its government policy which is under the Energy Sustainability Policy [3,53,55,99–102]. One of

them is the fuel mix policy in accordance to achieve more secure, efficient and sustainable energy utilization [3]. Fuel Diversification Strategy which covered for both renewable energy and alternatives sources is expected to attain the goal of reducing 40% of CO₂ emission intensity per unit of GDP with the absolute implementation of fuel mix strategy in Malaysia to secure the future power demands [55, 101, 103–105].

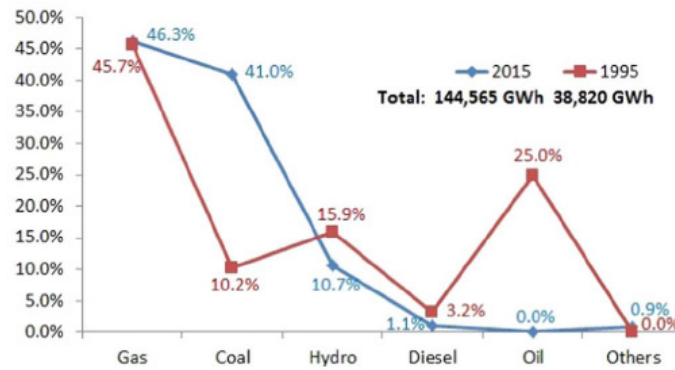


Fig. 4. Electricity Generation Mix in Peninsular Malaysia in 1995 and 2015 [10]

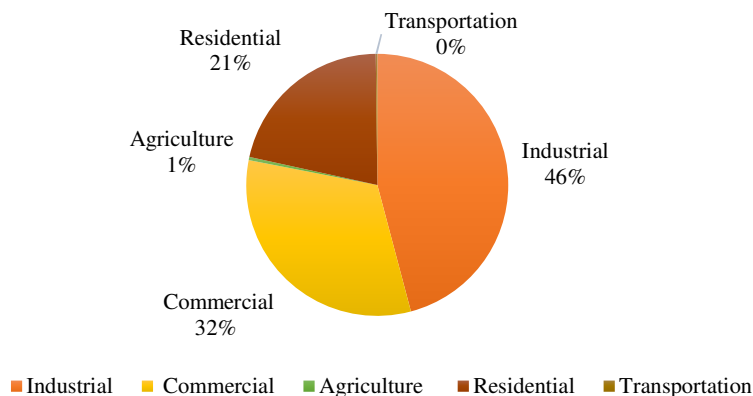


Fig. 5. Malaysia Energy Demand for 2015 [76]

5. Resources Management within Malaysia

The first global oil crisis that occur in the 1973 had attracted people’s attention to energy security issues due to the energy supply shocks. This crisis had led to huge economic losses for many oil importing economies and generated political instability for many countries [106]. This major event had highlights importance of energy security in the global scale. Energy security can be defined as the ability to meet demand of energy service needs in reliable circumstances through great period of time and been regarded as an important aspect towards sustainable development of modern society [107,108].

The spikes in the fossil fuel prices in the past several years had caused many challenges in energy access of many countries, generating impacts towards inconsistency of power supply, distortion progress of development, affecting economies inflation and increasing the price of raw materials [107].

All these phenomenon are due to the energy insecurity. Therefore, energy security is important in Malaysia for sustainable development. The Malaysia government plays an important role in moving forward activities in a number of areas which will enhance energy security further while also delivering wider energy goals [108].

Malaysia is constantly tries to meet the huge demands of domestic and international energy sector as it is known as one of the supplier of oil and natural gas in the world. However, Malaysia government also have setback when their oil reserves have declined from 771 billion barrels/day in 2000 to 703.92 billion barrels/day in 2007. As energy costs remain to increase from year to year whilst fossil fuels depleting, the issues regarding nation hydrocarbon resources needs to be properly identified. Table 2 remarks concerning issues of Malaysia three major hydrocarbon resources.

Table 2 Issues of Conventional Malaysia Electricity Resources[107]

TYPES OF RESOURCES	ISSUES ARISES
CRUDE OIL	Prices of fossil fuel are not stable and are always increasing due to increasing demand and depletion issues. Republic of China has core interest in oil in South China Sea which making oil issue more crucial for Malaysia.
GAS	Malaysia owns extensive natural gas pipeline networks in Asia, under the multi-phased Peninsular Gas Utilization (PGU) project. Need to be considered in environmental cost impact towards CO ₂ gas emission.
COAL	Coal production has been decreasingly slowly, due to mine closure as well as lower demand. Have high carbon price that will contrasting the Kyoto Protocol which strictly aim towards CO ₂ gas emissions

Thus, it is important for the government to establish energy security in the most economic manner to address these issues and moves towards ensuring sustainability in development. The government had established numerous policies and programs to cater the energy demand in the country. The policy taken can be referred in Fig. 6.

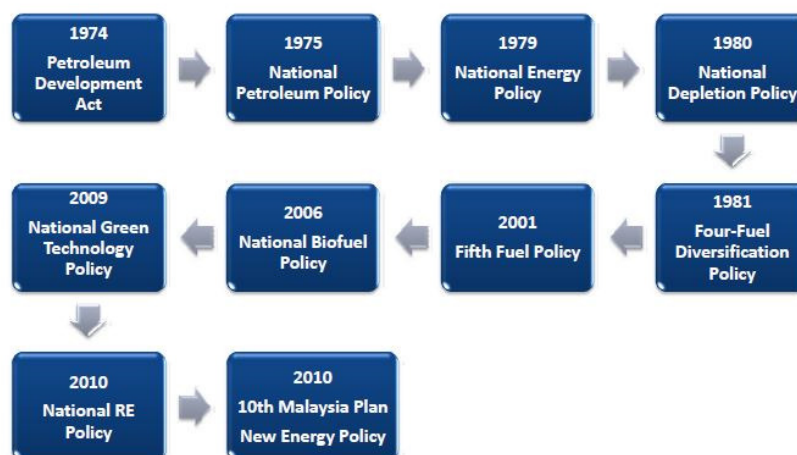


Fig. 6. Transition of Malaysia Energy Policies [65]

In this paper, only several policies that implemented by the Malaysian Government will be discussed as it relates to secure major hydrocarbon resources and reserve which is oil, gas and coal. National Petroleum Policy 1975, National Depletion Policy 1980 and Four-fuel Diversification Policy 1981 will be the highlighted policies in this section.

To begin with, National Petroleum Policy 1975 was formulated in the Third Malaysia Plan which started from 1976 up to 1980. The objective of bringing about efficient utilization of the resource for industrial development as well as to ensure that the nation exercises majority control in the management and operation of the industry. The major aims of this policies were to guide and regulate the fast-growing petroleum industry in Malaysia. It is because the massive production encountered an average growth rate of about 40.5% per annum between 1970 and 1975 [109]. These policies affect the way the fuel resources are supplied to the electricity sector where the local resources are utilized as much as possible for power generation to support the local petroleum industry. This majorly enables the facilitation of rapid growth of Malaysia oil industry [110].

The National Depletion Policy 1980 was introduced to safeguard the exploitation of natural oil reserves due to the rapid increase in the production of crude oil. Basically, the implementation of production control on major oil fields was executed. The major oil fields of over 400 million barrels of oil initially in place (OIIP) restricted their production to 1.75 per cent of OIIP. However, the ceiling was revised to 3 per cent in view of the fact that 1.75 per cent was on the conservative side in the year of 1985 [109]. Because of this policy, the total production of crude oil is currently limited to about 650,000 barrels per day and the proven oil reserves are expected to last another 16 years based on that particular production rate at that time.

As a complement for National Depletion Policy 1980, the Four Fuel Diversification Policy 1981 was then designed to prevent over-dependence on oil as the main energy resource. It was to ensure reliability and security of the energy supply by focusing on four primary energy resources which is oil, gas, hydropower and coal. The strategy implemented by the Government by using this policy was to utilize non-oil domestic energy resources as well as to increase the country's self-reliance with respect to energy supply and savings in foreign exchange [65,109]. It aimed for a supply mix of oil, gas, hydropower and coal in energy mix usage for this nation. Consequently, the energy security of the national supply was enhanced by utilizing other local resources. The greatest achievement of this policy was the dependence upon fuel oil has been reduced which high dependence on oil in 1985 has been significantly reduced throughout the years, substituted by natural gas which is found in abundance in Malaysia. It can be observed from the electricity generation fuel mix trends from 1985 to 2005 as in Fig. 7. The summary of major energy polices mention can be refer in Table 3.

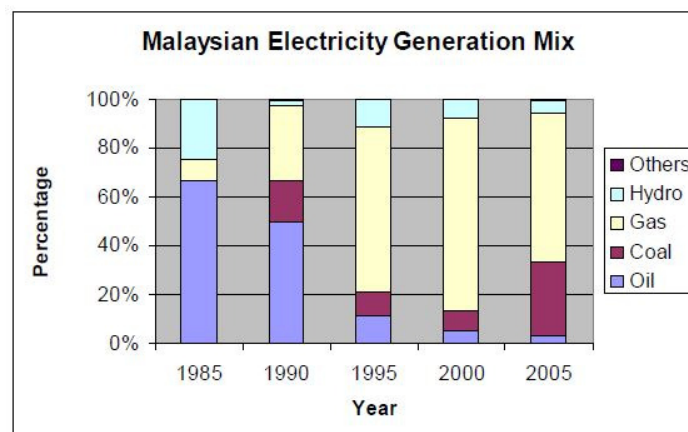


Fig. 7. Malaysia Electricity Generation Mix from 1985 to 2005[109]

Other than the government initiatives and policies, the role of integrated oil and gas company in providing reliable supply production could also ensure energy security of Malaysia. The focus area in oil and gas production will be mainly emphasized on the upstream, midstream and downstream activities as well as the action taken to secure and utilizing current and future hydrocarbon reserves.

As known, Malaysia has the 25th largest reserves and the 14 largest gas reserve in the world [69]. Thus, the proper management of this resources need to be performed effectively and efficiently to ensure the availability and sustainability of this reserve. The oil and gas industry are generally divided into upstream, midstream and downstream activities. Upstream activities consist of exploration, development and production of oil and gas resources [111]. Midstream and downstream activities range from the transportation of oil and gas, to refining and processing through to marketing and trading of end products [67].

Table 3 Summary of energy policies implemented to secure Malaysia hydrocarbon resources [66]

ENERGY POLICIES	OBJECTIVES
National Petroleum Policy 1975	Efficient utilization of petroleum resources Ensuring the nation exercises majority control in the management and operation of the industry
National Depletion Policy 1980	To prolong the life span of the nation's oil and gas reserves
Four Fuel Diversification Policy 1981	Aimed at ensuring reliability and security of supply through diversification of fuel (oil, gas, hydro and coal)

Table 4 Comprehensive plan and action implemented to optimize usage of the hydrocarbon reserve [111,112]

ENHANCING DOWNSTREAM GROWTH	
tapping two sources of growth in the downstream sub-sector to take advantage of growth opportunities and improve the supply of oil and gas to end users	
PLAN	ACTION
Building a regional oil storage and trading hub	Development of new technology base that capable supplying demand for national and international usage. This storage and trading hub able to increase economic growth of the nation.
Unlocking premium gas demand in peninsular Malaysia	Expanding additional investment to enhance facilities and infrastructure for gas industry. The prevention of current industrial diesel and LPG users to conventional natural gas able to increase gas demand in Malaysia
SUSTAINING OIL AND GAS PRODUCTION	
involves extending the lifecycle of existing resources by optimising exploration, development and production activities	
PLAN	ACTION
Rejuvenating existing fields through enhanced oil recovery	Implement Enhanced oil recovery (EOR) which uses external energy to improve oil recovery from mature oil fields. The amount of oil recovered from the underground reservoirs can be increased from a range of 20 to 35 percent (industry norms) to 30 to 50 percent.
Developing small fields through innovative solutions	Developing significant proportion of Malaysia's remaining resources lay in fields with less than 30 million barrels of recoverable oil. It able to produce smaller amount of revenue fur to the smaller scale.
Intensifying exploration activities	Conduct exploration to discover and develop the remaining resources in a timely and prudent manner. Enable the utilization of new reserve

The availability of domestic hydrocarbon resources gave Malaysia a natural impetus to develop the oil and gas sector. The national oil corporation, PETRONAS plays a major role in the creation of opportunities for local companies to build up their capacity and capability across the value chain as well as driving the industry's growth through its development of oil and gas resources. For instances, PETRONAS' Petroleum Management Unit regulates upstream activities, while PETRONAS subsidiary Petronas Carigali participates in production sharing contracts (PSC) with other PSC contractors such as Shell, ExxonMobil, Murphy Oil, Talisman, Petrofac, Newfield and others [111].

To properly exploit the hydrocarbon reserve and resources, the government and integrated oil and gas companies have focused on enhancing downstream growth as well as sustaining oil and gas production. This can be achieved by the implementation of plans with comprehensive actions which has been summarized in Table 4.

These initiatives allow the current reserve to be utilized optimally by using the new exploration technology which open the new window of possibilities to have new reserves. The expansion in the downstream activities enable Malaysia to exploit the further use of gas supplies. The key personnel for all of the initiatives need to work collaboratively between each other in order to achieve the national energy security. The key player of this plan is in Table 5.

Table 5 Overview of the agencies in charge of the various initiatives [111]

EPP	Lead Initiative Owner	Other Key Agency, Company and Organization
Rejuvenating existing fields through enhanced oil recovery	PETRONAS	Production sharing contracts (PSC), Contractors
Developing small field through innovative solutions	PETRONAS	Production sharing contracts (PSC), Contractors
Intensifying exploration activities	PETRONAS	Production sharing contracts (PSC), Contractors
Building a regional of storage and trading hub	Malaysia Industrial Development Authority (MIDA)	Project Owners, Ministry of Transport, Ministry of Natural Resource and the Environment, Ministry of Finance
Unlocking premium gas demand in Peninsular Malaysia	Malaysia Industrial Development Authority (MIDA)	PETRONAS, Relevant state government, Ministry of Energy, Green Technology and water (KETTHA), Gas Malaysia, Economic Planning Unit, Energy Commission

6. Malaysia’s Strategic Planning in Ensuring the Future Energy Security

In the preceding years, Malaysia’s economy expansion is highly reliant on the fossil fuels to drive its rapid advancement. Nonetheless, the surge of population growth and economic development over the years lead to the increase of energy consumption and consequently pressured the scarce natural sources market. In 2017, Peninsular Malaysia’s electricity generation capacity are at 22,919 MW whereas the peak demand are at 17788 MW with only 29% for reserve margin [113]. The situation is aggravated when the oil industries took a major downturn when the U.S oil prices crashes below \$27 dollars a barrel for the first time since 2003 [113]. Hence, issues such as the volatility of oil market and fossil fuel depletion crisis had enlightened the government on the vitality of strategic planning in ensuring the future energy security [114].

Energy security can be defined as the ability to meet demand of energy service needs in reliable circumstances through a period of time. There are several threats that can jeopardize the energy security such as political instability, warfare and natural disasters [114]. These predicaments can gravely impact the energy security as it will contribute to the discrepancy of power supply, escalation of raw material’s prices & unemployment rate and increase economies inflation[114]. Thus, the energy security in Malaysia is fundamental in sustaining the development and prevents the nation’s trade and economic system to plunge into an avalanche.

6.1 Energy Policy's Paradigm Shift

In the recent decades, the government had established several energy-related policies that can be traced back to 1979 during the implementation of National Energy Policy in ensuring adequate, cost effective, secure and environmentally sustainable supplies of energy [115]. Later in 1980, the National Depletion Policy was manifested due to the commendable acknowledgement of the nation towards global energy depletion with the objectives of prolonging the lifespan of the nation's oil and gas reserves [115]. After that, in 1981 the Four-fuel Policy that aimed in ensuring the reliability and security of supply via diversification of fuel (oil, gas, hydro and coal) was introduced [116]. This policy was later rejuvenated in 2001 into Five-fuel Policy that include the utilization of renewable resources [116]. Last but not least, on 2010 the New Energy Policy was implemented which outlines the major strategic to promote renewable energy in the country [116].

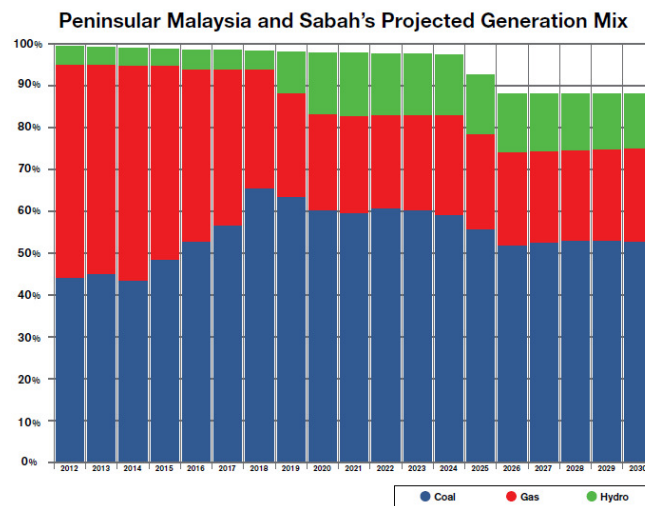


Fig. 8. Malaysia's Energy Mix [116]

6.2 The New Energy Policy 2010

The New Energy Policy 2010 addresses the economic efficiency, security of supply & social and environmental objectives. It consisted of five main pillars which are the energy pricing, supply, efficiency, governance and change management [117]. The New Energy Policy 2010 is designed to as a solution for Malaysia's Key Challenges which is the availability of resources & infrastructure, accessibility to fuel and supplier diversity, the affordability of the user & economy's reliance and acceptability [117].

6.3 Initiatives to Address Challenges

In the gas and oil sector, the government had planned to enhance supply through Regasification Terminals in Melaka and Johor and develop the refinery and petrochemical in Johor [118]. Apart from that, the government also decided to institute new gas pricing framework where the gas prices are to increase by RM3/mmbtu every 6 month and itemizing the subsidy amount in consumer utility bills [118]. They also promote competition and transparent pricing through Open Access to Peninsular Gas Network and reviewed the Gas Supply Agreements. In addition they also invested on the study of stockpiling infrastructure and alternative energy sources [118].

As for the coal sector, the government diversified the coal supplier countries to Australia, Russia and South Africa in ensuring the security of coal supply [119]. Furthermore, they also encourage the

usage of latest technology such as supercritical boiler to achieve higher plant efficiency. Moreover, the government also invested on the study of coal storage and finances the exploration of possible resource ownership in supplier countries [119]. On the other hand, for the hydro field, the government restart a review in the potential of power importation from Sarawak as a long term option since it possess hydro power potential of more than 20,000MW [119].

As of late, Renewable Energy (RE) has increased more consideration in Malaysia for number of reasons due to numerous issues regarding global warming, exhausted source of fossil fuels and drastic climate changes. In the meantime, various of study investigate the mechanism related with Renewable Energy, for example the kinds of energy that can be renewed, the significance of supporting parties, the execution of policies and financial basics for this procedure [120].

In the 9th Malaysia Plan, Small Renewable Energy Program (SREP) had been acquainted to execute RE action plan with the approach for both residential and industrial sector [120]. On the off chance that electricity produce by renewable energy is to develop in Malaysia, the investment ought not to be constructed only with respect to the cost of the establishments but also consideration through the whole externalities and life cycle-cost [120]. This can give useful effect towards society and Malaysia improvement later on.

6.4 Nuclear Energy Scenario and Strategy

Nuclear energy has always been viewed as a clear-cut solution in ensuring the energy security in Malaysia. The motivation to implement nuclear energy arises due to several factors mainly as a long term and reliable energy security plan [120]. Apart from that, Malaysia is considering nuclear energy as one of the viable option in order to diversify the energy sources thus reducing the economic reliance towards fossil fuels. This is express in 10th Malaysia Plan when the government stated their initial desire to explore the usage of nuclear power and to conduct feasibility studies and public awareness campaign [121]. In addition, the government also announces their intention to deploy nuclear energy in the Economic Transformation Programme (ETP) as they include the nuclear power as one of Entry Point Project (EPP) under oil, gas and energy sector and initially targeted to commission the first unit of the 2GW nuclear capacity by 2021 before it is later postponed to 2030 [121].

The ETP had specified four enablers in order to deploy nuclear energy in Malaysia which are public acceptance, international governance, regulatory context and site acquisition[122]. In term of public acceptance, a qualitative & quantitative research on the nation-wide public opinion will be conducted and a ten-years Comprehensive Communication Plan & Strategies on Nuclear Energy will be formulated [122]. Apart from that, a new comprehensive nuclear law & regulation will be drafted and reviewed by IAEA.

5. Conclusion

As conclusion, the energy demand within Malaysia would continue to surge due to the exponential growth of population and industrial development. Hence, to ensure a continuous development within Malaysia, accessibility to reliable and affordable energy is utmost important. It shows the importance of strategic planning of Malaysia government in securing the future status of energy security. Nevertheless, all parties including the people of Malaysia need to recognize the urgency of these policies and implement to increase the efficiency and effectiveness of energy usage within Malaysia

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