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Ex-Post Critical Evaluations of Energy Policies in Malaysia from 1970 to 2010: A Historical Institutionalism Perspective

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Abstract: *Ex-post* evaluations of energy policies in Malaysia between 1970 and 2010 were conducted. The developments of energy policies in Malaysia were traced from the early 1970s with the introduction of the country's first energy-related policy all the way to 2010 with the country's first endeavour towards a biobased energy system. Analyses revealed that many of the policies were either: (1) directly responding to changes in global/domestic socioeconomic and political events, or (2) provided visions to guide developments of the energy sector in alignment with the country's growth agenda. Critical examinations of the country's actual energy consumptions during these 40 years were also conducted to evaluate the efficacy of these energy-related policies. Three noteworthy successes in Malaysia's energy landscape are: (1) the formation of PETRONAS as the national oil and gas company; (2) reduction of country's over-reliance on oil as a single source of energy by significantly growing the production and use of natural gas in a short span of time; and (3) creation of a thriving oil and gas value chain and ecosystem in the country. However, the country is still critically dependent on scarce petroleum resources, despite having an abundance of renewable reserves. Progress towards renewable energy has been too little and too slow.

Keywords: policy; energy; Malaysia; historical; biofuel

1. Introduction

The oil and gas industry is at the heart of Malaysia's economy and growth. Besides being a source of energy to fuel the rapidly growing domestic economy, the oil and gas industry is also a key source of revenue for the country in its capacity as a net petroleum exporter. The combined oil, gas and energy sector alone represented RM 127 billion, or 19%, of Malaysia's GDP [1], therefore making it the biggest single sector responsible for the growing Malaysian economy. The oil and gas industry in Malaysia began in 1910 when the first oil well was developed, and oil extracted, in Sarawak. Oil and gas has since been the backbone of Malaysia's economy and growth.

According to Gan and Li, Malaysia is one of the most developed nations amongst the Association of Southeast Asian (ASEAN) members: between 1990 and 2005, the gross domestic production (GDP) growth had averaged above 6%, and was well above 9% before the Asian Financial Crisis of 1997 [2]. There were numerous factors contributing towards Malaysia's economic performances of the past, such as favourable FDI inflows, technological innovations and good access to energy [3]. This is to a large extent driven by the strong policy initiatives that were introduced over the decades, and central to all of these is the range of energy policies that were formulated to shape and drive development of the oil, gas and energy sector in order support an emerging economy.

In this paper, we present an *ex-post* critical evaluation of the energy policies in Malaysia from 1970 to 2010 in order to understand: (1) the historical narratives that led to the introductions of these policies; (2) the shapes and forms the policies have taken; and (3) the efficacy of the policies in shaping Malaysia's actual energy mix in the covered 40 year period.

2. Methodology

2.1. Survey of Energy Policies

This study involves a look-back through historical lenses and has applied an *ex-post* critical analysis of the institutions—particularly the policies that were introduced—and the resulting effects they have on the country's actual energy balances in the 40 years period from 1970 to 2010. The approach, also referred to in literature as historical institutionalism [4–9] embraces a non-functionalist, more historical view of institutions [9]. The approach is concerned with tracing, historically, the emergence of different kinds of institutional measures that either promote or distort development [9]. Historical institutionalists argue that our present situation is to a large extent due to the way the institutions have evolved over the years, leading to a path-dependent development, and therefore taking a historical account of how the institutions have changed would provide valuable insights into our present situation. Historical institutionalist regard the period of institutional origins as crucial to the understanding of later developments. That is, the origins and developments of institutions are situated in time, and therefore to understand why Malaysia's energy scene is at its present state, it is important that we understand the context in which developments of the country's energy landscape had occurred in the past.

This study has adapted the critical juncture framework that was first proposed by Hogan and Doyle in 2007 [10]. Critical juncture is best defined as a particular event, or conjunction of events, that trigger processes of institutional or policy change into motion and providing the opportunity for the nation to alter significantly their development strategies and preferences. The three steps of a critical juncture consist of: (1) the emergence of crises that pose a threat to the *status quo*; (2) ideational change; and (3) radical change in policy. A crisis presents new problems as previous policies are discredited due to their implications in, or inability to correct, the situation. A new window of opportunity appears to allow existing paradigms to be contested and for new ideas to emerge as alternatives to the *status quo*. It is important to note that although loyalty to *status quo* is usually weak at critical junctures, it does not always lead to new development paths as policy actors may choose to maintain the existing strategies and preferences.

In this study we investigate key critical junctures in Malaysia's energy development journey from 1970 to 2010 in order to identify endogenous and exogenous crises that had led to these critical junctures and the effects they had on contemporary ideas, and whether they engender a new paradigm to underpin the country's subsequent energy developments. Content analysis is an essential tool that is consistent with a historical institutionalist approach towards critical energy policy analyses. For this, official policy documents, legal texts, scientific publications from various sources and in different fields, books and documents from official governmental and non-governmental websites locally, and globally were critically analysed. Amongst which are key legislative texts [11,12], official transcripts from the upper and lower houses of the Malaysian parliament [13–17], authorised governmental policy documents [18,19] and the official national developmental agendas issued by the government's Economic Planning Unit (EPU) every five years since the year 1990 [20–23]. Critical analyses of these time-series documents provide a framework for understanding the changes in national philosophy towards the role of energy in Malaysia's economic developments. The qualitative analyses presented here are then followed by quantitative assessments of the actual energy balance reported for the country from 1970 to 2010.

2.2. Analysis of National Energy Mix

Energy balance refers to the production and consumption of the various primary energy sources, whereby primary energies are energy sources that are derived directly from nature without going through any transformation. Examples of primary energies are crude oil, natural gas, coal, geothermal, nuclear, hydroelectric and others. Data from BP's 2011 Statistical Review [24] were used since it covers many countries globally from before the 1970s to the year 2010, data broken into production and consumption, and for the various types of energy sources (coal, natural gas, oil and renewables). The statistics in the BP Statistical Review, which are updated annually, are taken from government sources and published data. Such extensive coverage allows for consistent representation of the energy consumption in various countries globally, for the various types of energy sources and over a period of time. See Owen *et al.* for a review of the types of published energy data available and their sources of ambiguity [25].

3. Development of Energy Policies between 1970 and 2010

Formal energy-related policies have only been introduced in Malaysia in the last three decades, but the petroleum industry came into existence more than a century ago. The following section provides a brief narrative of the petroleum industry landscape in Malaysia prior to the establishment of any energy policy in Malaysia.

3.1. Pre-1970s: The First Oil Well

The first oil discovery can be traced back to the 1870s in what was known back then as the Borneo territories, but it was not until the beginning of the twentieth century that appreciable amounts were found [26]. Malaysia's first oil well was developed and oil extracted by Royal Dutch Shell on Canada Hill in Miri, in the state of Sarawak in 1910 [27], but the oil fields subsequently deteriorated as a result of World War II. The petroleum activities in Malaysia, however, expanded markedly in the 1960s with the discovery and developments of offshore fields in Sabah and Sarawak, initially by Shell [26]. In subsequent years, Shell and Esso had dominated both, the upstream production as well as the downstream oil refining and sales in the country. By the end of the 1960s, several exploration companies had started to expand the exploration activities to the offshore of Peninsular Malaysia.

For more than 50 years the petroleum industry in Malaysia were dominated by foreign companies. The lucrative concessions made Malaysian oil and gas fields an attractive investment for foreign investors. It was only in the early 1970s that formal policies and legislations were drawn to better control and regulate the petroleum industry.

3.2. 1973–1975: Establishing Malaysia's Energy Foundation

The first form of a formal government intervention in the petroleum industry in Malaysia can be traced back to as early as 1974 with the initial formation of a national oil company known as Petroliam Nasional Berhad (PETRONAS). There were a number of internal and external socio-political factors that had driven the government to establish PETRONAS as a national company. The early 1970s was a time where the world was faced with a major oil crisis that had led to significant increases in oil prices in a very short spell of time. The infamous 1973 oil embargo by several Arab oil exporting nations and Iran had dramatically led to oil prices surging by 200% in just 6 months (Figure 1). There were increasing interests from members of parliaments on the issues of global oil price hike and the impacts on Malaysia as an oil producer [13,14]. The sudden oil price hike, and the volatility and susceptibility of oil prices to the mounting tensions between Israel and the Arab nations, had motivated the country leadership to find ways of reducing reliance on imported oil as well as to gain a bigger share of profit from its indigenous resources as means to fund its growing economy. This came at a time when Malaysia was producing almost 100,000 barrels of oil per day, whilst daily domestic consumption was only 85,000 barrels [13,14]. Moreover, at this time, only 20% of Malaysia's crude oils were refined locally, while the remaining 80% were exported to refineries outside of the country [17], reflecting a possible loss in a more profitable trade opportunity. With the ratification of the Petroleum Development Act of 1974 [11], PETRONAS was corporatized under the 1965 Companies Act [28].

However, the motivation for the formation of PETRONAS in 1974 can also be attributed to the internal socio-political dynamics of the country at that point in time. In the late 1960s and early 1970s, multiracial Malaysia was experiencing growing ethnic tensions between the two major races, namely the Malays and the Chinese, which culminated in a violent riot on the 13th of May 1969. This was largely due to the feelings of discontent because of the widening economic disparity between the two ethnic groups [29,30]. As a consequent, the early 1970s saw the emergence of economic nationalism in Malaysia which eventually led to the ratification of the National Economic Policy (NEP) of 1973 [29].

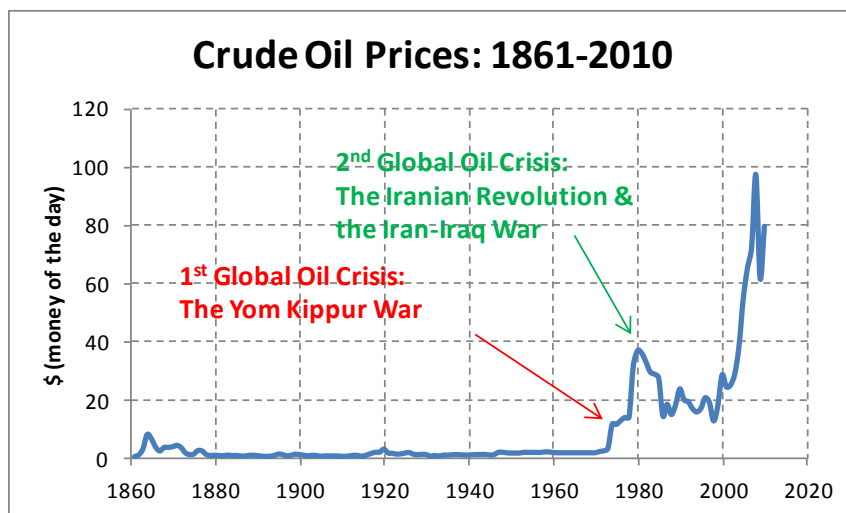


Figure 1. The prices of crude oil from 1861 to 2010 based on the actual \$ at the time. Prices not corrected for inflation. Data were obtained from the BP Statistical Review of World Energy [24] and plotted by the authors.

The objectives of the NEP were predominantly to eradicate poverty among the entire population through export-oriented industrialisation and the restructuring of society with a view of eliminating the identification of race with economic functions [29,30]. The objectives were introduced as means to induce more Malaysian control over the modern private sector and to provide the Bumiputeras (literally translated as the “sons of the soil”—Primarily the Malay Muslims) greater access to businesses, educations and the economy, as a form of affirmative action [26,30]. Long-term targets were established to increase the Malay ownership of share capital in limited companies from 2% in 1970 to 30% in 1990, and to grow the proportion of Malays employed in manufacturing and installed in managerial positions to be reflective of the racial composition of the country [30]. From an economic perspective, there was a clear shift from planning and policymaking based purely on economic considerations towards an affirmative action policy based on ethnicity [30]. Therefore, the formation of PETRONAS in 1974, a year after the introduction of the 1973 National Economic Policy, as a commercial entity with exclusive rights over a lucrative indigenous resource, and which was headed and managed by the Malays at a time when many Malaysian-led businesses were controlled by the non-Malays, is believed to be non-coincidental. It is highly likely that this is a strategic initiative under Malaysia’s affirmative action in trying to correct the social and economic imbalances between the major ethnic groups of its plural society.

The Petroleum Development Act was mainly championed in parliament by the Primary Industries Minister in 1974, in which according to the facts presented to the members of senate, the discoveries of oil in Malaysia had to be made the basis for expediting the country's economic growth, including to act as a catalyst for industrial development, through the adoption of an integrated approach [14]. There were overwhelming supports by members of parliament for the proposed Petroleum Development Act given that this came at a moment in time when the country was faced with severe shortages in meeting domestic demand for diesel and kerosene, and in which many senators saw this as an opportunity for the country to get more involved in activities further downstream of oil extraction, and provide solutions to these acute, and recurring, supply shortages [14].

The adoption of this act is a historical milestone for the nation as it marks a clear shift in the country's paradigm towards petroleum resource developments. Prior to the formation of PETRONAS, oil fields were developed by foreign companies through a concession system, in which these companies were given complete control over the exploration and extraction of oil resources in the country, with absolute freedom to sell or export these oils given that the companies have full ownership of the resources once they were extracted from the ground. The country only gained through small payments derived from annual fees, payments of royalties and through a Petroleum income tax. The Petroleum Development Act, however, is based on a Production Sharing System (PSS), which upholds the sovereignty of a nation to have full control and ownership over all riches within the country's territory and jurisdiction. Although oil field exploration and extraction may still be performed by contractor companies, all of which were foreign entities at that time, the ultimate responsibility however is towards the Malaysian government through PETRONAS. The proposed PSS was developed after careful consideration of other systems in use by various other oil producing countries, but it was eventually modelled after the system that has been successfully adopted in Indonesia since 1966 [14]. As a result of the Petroleum Development Act, these resources now belong to the government and managed by PETRONAS.

The Petroleum Development Act of 1974 is a law that was introduced largely for the corporatization of PETRONAS [11]. According to the act, PETRONAS is given entire ownership and exclusive rights, power, liberties and privileges for the exploration and exploitation of onshore and offshore petroleum resources in the country. In addition to that, the law also stipulates that PETRONAS, which is under the direct purview of the Prime Minister, has control over activities further downstream of petroleum exploration. And so the tremendous growth and expansion of the petroleum industry in Malaysia to its present level of being the biggest source of income for the country [31] can be attributed to a large extent to PETRONAS. The success of PETRONAS is further exemplified by the fact that in 2010 PETRONAS, which had employed more than 40,000 employees, was listed as the eleventh most profitable company in the list of Fortune Global 500 companies [32]. It can be argued that the Petroleum Development Act of 1974 has been hugely successful in laying the seed for a giant Malaysian-based multinational to thrive.

Currently PETRONAS continues to play a major role in driving the industry's growth through its development of oil and gas resources as well as the creation of opportunities for local companies to build up their capacity and capability across the value chain. For example, the Oil Field Services and Equipment (OFSE) sector, which primarily provides the oil and gas support services for the upstream sector, now accounts for about RM 1–2 billion of the country's GDP annually [1]. More importantly,

PETRONAS has played a key role in nurturing local companies such as Scomi, SK Petro, Petra Perdana and others into global players that now compete locally and globally with international players, like Schlumberger, Technip and Baker Hughes, that had historically dominated the OFSE sector in Malaysia [1] (Table 1).

Whilst the Petroleum Development Act of 1974 had created PETRONAS as the national machinery to run and manage the indigenous petroleum resource, there was a need for specific new legislation to regulate the industry to ensure that whatever activities associated with it must be consistent and supportive of the national development agenda; hence the introduction of the National Petroleum Policy in 1975 [14,33].

Table 1. Summary of some of PETRONAS's key roles in the oil, gas and energy landscape in Malaysia.

Sectors	PETRONAS's Roles	Contribution to GDP (RM Billion)
Upstream Oil & Gas	PETRONAS Petroleum Management Unit	Regulates upstream activities
	PETRONAS Carigali	Participates in Production Sharing Contracts (PSC) with contractors such as Shell, ExxonMobil, Murphy Oil, Talisman, Petrofac, Newfield and others
	Oil Field Services and Equipments (OFSE)	Nurture domestic companies to be competitive in providing support services primarily to the upstream sector
Midstream & Downstream Oil & Gas	Pipeline, transportation and other logistic assets	3.2
	Refining, petrochemicals and marketing and trading of end products	20.8
Energy	Supply of subsidized fuel for power generation, transmission and distribution	16

The National Petroleum Policy of 1975 was established as means to regulate the oil and gas industry to achieve Malaysia's economic development needs. The policy was aimed at making available adequate supplies of petroleum at reasonable prices for the nation's economic development as top priority. The policy was also aimed at promoting a greater Malaysian representation and providing a favourable investment climate which includes the creation of opportunities for downstream industries. The policy acknowledged the fact that petroleum is an exhaustible resource and therefore there is a need for conserving these assets and protecting the environment when deciding the optimal pace of resource exploitation for socio-economic gains.

The policy however, was solely focused on petroleum as an energy source and had not sought to diversify the energy base of the country. Furthermore, the environmental aspect of the policy was more concerned with the environmental impacts associated with the exploration and production of petroleum and had not looked at the effects arising from the energy-use phase further downstream of petroleum exploration and production. These shortcomings were later rectified in subsequent policy frameworks.

3.3. 1979–1981: Defining Malaysia's Core Energy Policy

In 1979 and 1980, events in Iran and Iraq led to another round of global oil crisis. The Iranian revolution in 1979 and the invasion of Iran by Iraq had resulted in a dramatic drop in oil production (Figure 2) from both countries. These had resulted in a global shortage of oil supplies which had caused the prices of oil to more than double during that period (Figure 1). The occurrences of two major oil crises in less than a decade highlighted the extreme sensitivity of oil prices to supply shortages, and the influential role that OPEC countries play in determining the availability of oil supply in the global market. The fact that many of these OPEC countries are politically unstable is a threat to the oil security of others.



Figure 2. The global oil production between 1965 and 2010. The 1979/1980 Iranian Revolution had resulted in a drop in oil production that had spurred another round of oil crisis. Data were obtained from [24] and plotted by the authors.

As a reaction to this, Malaysia in 1979 defined its core energy policies through the formulation of the National Energy Policy, which was instrumental in guiding the formulation of the nation's five-year development plans [18]. The National Energy Policy of 1979 had three key objectives which revolved around supply, utilization and environmental aspects, as summarized below:

- I. **Supply Aspect:** The supply objective of the policy was meant to ensure the provision of adequate, secure and cost-effective energy supply through developing indigenous energy resources, both non-renewable and renewable energy sources using least-cost options. The supply objective also advocates for the diversification of supply sources both from within and outside the economy in order to address energy security issues in the event of supply disruptions.
- II. **Utilization Aspect:** The utilisation objective, however, was aimed at promoting the efficient use of energy and the elimination of wasteful and non-productive patterns of energy consumption.
- III. **Environmental Aspect:** The environmental aspect of the policy objective was to minimise the negative impacts of energy production, transportation, conversion and consumption on the environment.

The three core aspects of the National Energy Policy made it a well-rounded and robust energy aspiration for the country. It was sufficiently broad to cover a wide range of issues relating to the energy sector and therefore making it relevant irrespective of time. These three aspects of the policy are relevant now just as much as they were in 1979. This is consistent with the concept of sustainable development, which requires sufficient foresight to ensure that developments now take into consideration the needs of the future.

Given the supply objective of the 1979 National Energy Policy, the Malaysian government was conscious of the importance of extending the life of domestic depleteable energy reserves as well as the need for alternative energy options to sustain a future that is self-sufficient for energy. Consistent with these two goals, two policy initiatives were adopted. The National Depletion Policy of 1980 was a policy framework designed to safeguard the depletion of oil reserves by controlling the rate of crude oil production to avoid over-exploitation [16]. The underlying motivation for introducing the National Depletion Policy was largely to do with the predictions at that point in time that Malaysia would run out of oil in about 12 years' time [16] given the average 200,000 barrels of oil production a day [34]. This has now been proven to be unfounded with more oil discoveries over the years as well as with the technological advancements in enhanced oil recovery techniques which improves the amount of oil that can be viably extracted. To complement the National Depletion Policy, the Four-Fuel Diversification Policy of 1981 was established to ensure reliability and security of energy supply by reducing over-dependency on crude oil by ways of diversifying supply to include coal, natural gas and hydroelectric [18,35]. Although at that point in time the focus was to broaden the national energy base for reasons of security of supply, the policy can be seen as a pioneering government intervention to establish the need for renewable energy in the form of hydroelectric, but possibly due to a lack of awareness, hydroelectric was not promoted as renewable energy back then.

The Malaysian parliament had deliberated the use of nuclear energy for electricity generation in Malaysia [15]. However, the Minister of Energy was very wary of the possible safety and environmental implications associated with a nuclear power plant, especially since this was only a few months after the nuclear disaster incident in Pennsylvania on the 28th of March 1979 [15,36]. Therefore, nuclear technology was considered lower priority until such time when there is adequate confidence that the risks can be effectively mitigated.

3.4. 1981–1990: Ramping-up Production

It is important to have a robust policy design however, it is equally crucial to ensure adequate time and resources are allocated for executing the policy on the ground. In general there is a long time lead for energy projects to come on-stream [37]. Whereas the energy policy landscape in Malaysia may appear idle during the 1981–1990 era, the fact is that energy production in Malaysia had increased by about 150% (on a tonnage basis) and it was also during this period that Malaysia's position as a net energy exporter was further enhanced and reached its peak (Figure 3). The years between 1981 and 1990 saw resources actually directed towards improving the production capacity incrementally and so, what might initially appear to be a lack in proactive policy introduction, was actually an era of intensive on-the-ground policy execution.

3.5. 1990–2000: Gasifying Malaysia's Energy Mix

The 1981 Four-Fuel Diversification Policy had envisioned a future where the country's energy needs are met from a variety of sources as opposed to being solely dependent on oil. In line with this, the highlight of the Sixth Malaysia Plan (1990–1995) and the Seventh Malaysia Plan (1996–2000) for the energy sector was primarily to increase the role of natural gas in the country's energy mix [22,23]. Concerted measures were introduced to ensure that the use of gas as an energy source, particularly for electricity generation, was significantly increased. Apart from this, efforts were undertaken to increase the use of gas as industrial feedstock. Correspondingly, the percent energy share of natural gas in the total primary energy demand for the country increased from 16% in 1990 to close to 40% in the year 2000 [20,22]. From the supply side, Malaysia's total gas production between 1990 and 2000 had increased by about 120% whilst the production of oil had only increased by a mere 8.2% in the same period.

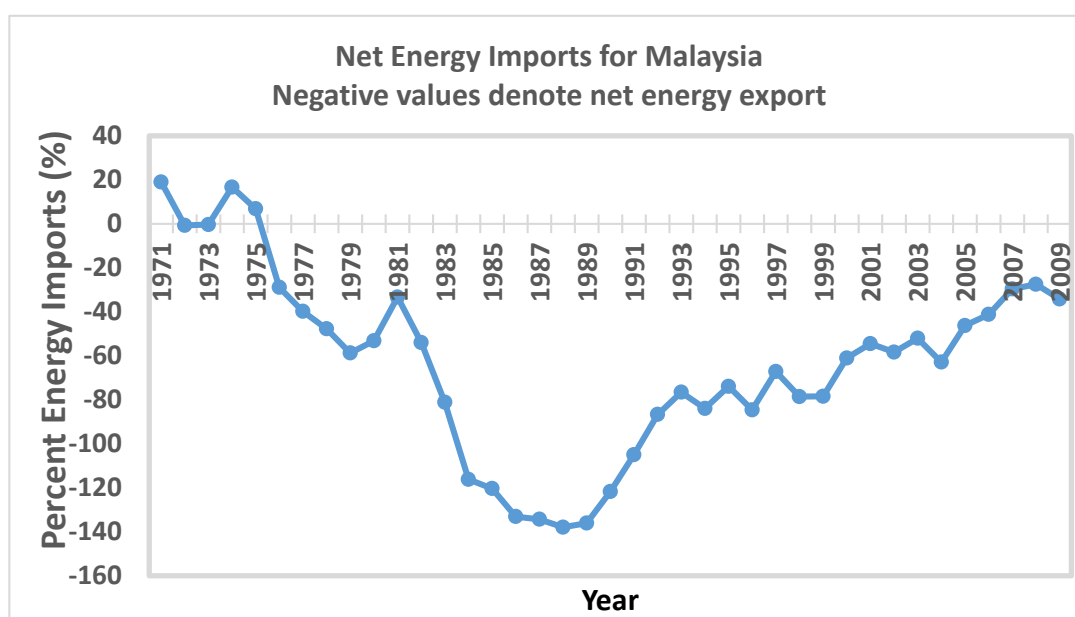


Figure 3. Net energy imports of Malaysia as a percentage of energy use. Negative percentage denotes that Malaysia is a net energy exporter. Data were obtained from [38] and plotted by the authors.

The expansion in gas utilization was contributed largely by the power sector for electricity generation which was supported by the installations of combined cycle gas turbines (CCGT) technology in Peninsular Malaysia [20]. In addition to that, the non-power sector that had substantially increased their gas consumption is the petrochemicals industry. Furthermore, it was also during this period that the Natural Gas for Vehicles (NGV) program was launched, however this still remains a niche application until today due to a combination of factors such as the requirement for a new network of distribution infrastructures as well as the need for vehicle conversion.

3.6. 2001–2010: Towards a Greener Pasture

The energy goals during the Sixth and Seventh Malaysia Plan periods were mostly to ensure sustainable development of exhaustible resources as well as the diversification of the country's energy

base. The focus of the latter had been largely to increase the uptake of natural gas. In the Eighth Malaysia Plan period (2001–2005) these goals were pursued further. However, the wider aim of the Eighth Malaysia Plan was to transform the country into a knowledge-based economy in order to enhance its resilience and competitiveness [20]. From an energy perspective, renewable energy is still an emerging area which is knowledge intensive. On top of that, Malaysia is a country that has been blessed with an abundance of natural biomass resources. Hence the Eighth Malaysia Plan had underlined the niche, but high potential, role of renewable energy in the development of alternative energy sources to complement the Four-Fuel Diversification Policy of 1981 [20]. Towards this end, Malaysia's first National Biofuel Policy was formulated on the 21st of March 2006. The National Biofuel Policy (NBP) was formulated under the direct purview of the Ministry of Plantation Industries and Commodities Malaysia (MPIC) [19], which had envisioned the following [19]:

- I. Use of environmentally friendly, sustainable and viable sources of energy to reduce the dependency on depleting fossil fuels;
- II. Enhanced prosperity and wellbeing of all the stakeholders in the agriculture and commodity based industries through stable and remunerative prices.

The biofuel policy was largely championed by MPIC in the initial stages, and later the ministry itself was entrusted with the main responsibility to develop and implement the policy [39]. The policy was developed following stakeholder consultations and on the basis of earlier research findings by the Malaysian Palm Oil Board (MPOB) [40]. When the policy was first being formulated, the motivation was quite simply to stabilize the prices of crude palm oil (CPO) whilst at the same time exploit a new and emerging market opportunity especially with the rapid increase in biofuel mandates and demand globally [40].

The Malaysian Palm Oil Board (MPOB) had successfully pioneered the R&D activities of palm-based biofuel in diesel engines since 1982 [39]. Palm oil has been the leading edible oil traded in the world market in which Malaysia alone accounts for about 48% of the total production and 58% of the total world trade [41]. Hence, the biofuel policy in Malaysia is primarily aimed towards the use of palm products as feedstock for the manufacturing of biofuel [19]. Basically, the policy is underpinned by five key strategic thrusts [39] as summarized below:

a) Thrust 1: Biofuel for Transport

As this sector is the main consumer of subsidized diesel, it has been given priority. Commercial diesel fuel in the country is currently composed of a blend of 5% palm-derived fatty-acid methyl ester and 95% petroleum diesel. This has been made available in the Klang Valley central region only, but will later be expanded nation-wide in stages. There are currently ongoing discussions to increase the blend concentration from the existing 5% to 10% in 2015. However, the challenges associated with a much a wider roll-out include high CPO prices and the requirements for costly upgrades to the existing infrastructures at the terminals nationwide. A key point to note is that fuels in Malaysia are still heavily subsidized, and therefore the use of biodiesel, which are more expensive, will only increase the country's spending on subsidies at a time when the country is trying to gradually remove these subsidies.

b) Thrust 2: Biofuel for Industry

The policy aims for the use of biodiesel blends in industrial sectors, particularly as fuel for boilers in manufacturing plants, construction machines and generator sets. However, the main problem is still the high price for palm commodities.

c) Thrust 3: Biofuel Technologies

The research, development and commercialization (R&DC) of biofuel technologies will be a key enabler for the successful implementation of the biofuels mandate, especially if larger roll-outs are anticipated. Increasingly more funding is being made available by the government and private sectors, in which the MPOB has played a leading role in various biofuels technology R&DC activities domestically and internationally.

d) Thrust 4: Biofuel for Export

A key aspect of the national biofuel policy is to encourage the production of palm based biofuel for global export markets in order to meet the increasing demands for renewable fuels. The EU currently represents the largest export market for Malaysian palm biodiesel, accounting for about 50% of the total biodiesel export, followed by the U.S. with a share of about 17% [42]. It has been estimated that by 2020 about 2.6–2.7 million tonnes of palm oil will be consumed by the European transport sector alone [43]. However, the EU has strict sustainability requirements that biofuels have to comply with and therefore it is equally important that whatever developments that are planned ought to take into consideration of the effects it has on the sustainability performances of the palm biodiesels.

e) Thrust 5: Biofuel for Cleaner Environment

The policy states that the increased use of biodiesel will improve the quality of the environment through reduced fossil fuel use and thus lower GHG emissions. However, as will be further elaborated in the latter part of this paper, this is not necessarily the case especially when the policy fails to incentivise sustainable oil palm productions. This has been discussed extensively in [39].

It is interesting to note that the five strategic thrusts are solely focused on the downstream aspects on the biofuel industry. It is deemed necessary that the policy also contains strategy focusing on the upstream sector in order to disseminate and further improve on best plantation management practices so that sustainable palm oil production in Malaysia becomes the industry norm. Currently the use of palm biodiesel by the transport sector is highly contentious given that oil palm plantations are often linked to environmental degradations such as deforestations and destructions of peat lands [39,44]. Therefore, it is critical that the policy provides greater assurances that only sustainably-produced biofuels are used as substitute for fossil transport fuels. The fact is that not all biofuels are better than fossil fuels for the environment. Conversely, not all palm oils are bad. The policy should provide a framework that separates the good from the bad, while incentivising the good so that it becomes the industry norm.

Following the development of the biofuel policy, the Malaysian parliament had ratified the Malaysian Biofuel Industry Act 2007 (Act 666) in order to regulate and provide a guiding framework for the implementation of this policy [12]. According to this law, biofuel is defined as any fuel,

whether solid, liquid or gaseous, that is derived from biomass. In principle, the law does not specify the types of biomass that can be used as well as the sector that is applicable, whether for marine, aviation, automotive or industrial, which therefore provides more room for future innovation. However the law empowers the Ministry charged with the responsibility for biofuel to prescribe the exact chemical structure and the volume percentage to be blended into any fuel. At present only palm derived fatty-acid methyl esters (FAMES) are endorsed for use as blending components into regular diesel as transport fuel, where at the moment the mandate limits it to a maximum of 5% by volume, or also referred to as B5 [45].

The successful implementation of the biofuel mandate by the transport sector is an important milestone for the nation. The country is heavily dependent on petroleum resources and a significant portion of the demand for oil is by the transport sector. In 2005 for example, the transport sector alone accounts for almost 41% of the total energy demand representing the largest share compared to all other sectors [21]. Besides, it is also anticipated that the largest growth in energy demand will be by the transport sector [21]. As Malaysia moves up the economic ladder, car ownership potential and total average distance travelled are expected to increase in tandem. Given that the automotive industry is also crucial to the Malaysian economy, it is reasonable to expect this growth trend to continue for the foreseeable future. Therefore, it is important to embark on strategies that can lessen the transport sector's growing dependence on conventional oil. Biofuel is definitely one of the many avenues worth pursuing.

However, the absence of a sustainability element within Act 666, especially when one of the five strategic thrusts of the biofuel policy is to improve the quality of the environment, can be seen as incomplete. The policy makes the mistake of assuming that all biofuels are necessarily sustainable and are therefore better for the environment. This is in contrast to what many studies have shown [46–51]. The absence of a sustainability definition within Act 666 is seen here as a gap which, if left unaddressed, may compromise the ability of the policy to meet the goals of ensuring the use of environmentally friendly and sustainable sources of energy. Moreover, a possible unintended adverse effect is the worsening of the environmental performances of the transport sector, particularly from a global warming perspective, due to the mandatory substitution of transport fossil fuels by a possible inferior alternative [39].

During the Eighth Malaysia Plan Period (2001–2005), the development of the energy sector was primarily aimed at ensuring a secure, reliable and cost-effective supply of energy sources with the aspiration of enhancing the competitiveness and resilience of the economy by encouraging greater use of renewable energy and efficient utilization of energy [20]. The subsequent developmental plan period, the Ninth Malaysia Plan (2006–2010), highlighted the key role of the energy sector as an enabler towards strengthening economic growth of the nation [21]. The developmental agenda reaffirms Malaysia's aspiration to reduce dependency on petroleum resources through the greater use of alternative fuels and efficiency improvements in the various sectors. Here the development of palm biodiesel was again given emphasis in an effort to make Malaysia the world leader and the hub for palm oil. Figure 4 summarizes the developments of energy policies in Malaysia between 1970 and 2010.

The Journey towards a National Biofuel Policy

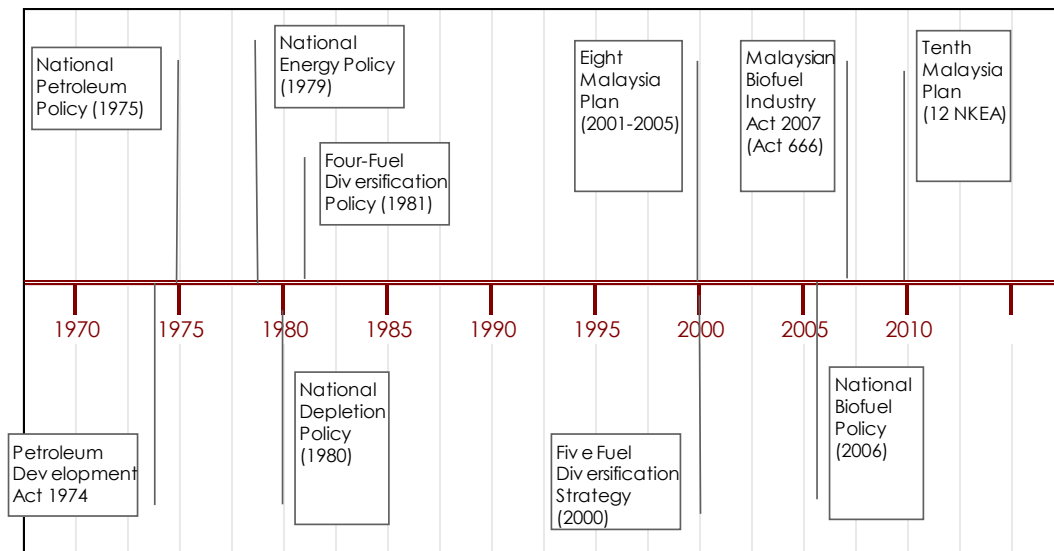


Figure 4. The timeline is a summary of the relevant initiatives in Malaysia leading to the National Biofuel Policy. The illustration here is the work of the authors.

3.7. Outlook: National Renewable Energy Policy

In 2011, the parliament of Malaysia ratified a new law to allow for the establishment and implementation of a special electricity tariff system in order to catalyse development and deployment of renewable electricity [52]. The law was developed in support of the National Renewable Energy Policy that aims to enhance the utilisation of indigenous renewable energy resources to contribute towards national electricity supply security and sustainable socio-economic development [53]. The principal focus of this policy is to increase the contribution of Renewable Energy (RE) in the domestic production and supply of electricity by facilitating the growth of the sector through the provision of appropriate regulatory frameworks and fiscal measures until grid parity is achieved. The principal objectives of the National Renewable Energy Policy and Action Plan are:

- (1) To increase RE contribution in the national power generation mix;
- (2) To facilitate the growth of the RE industry;
- (3) To ensure reasonable RE generation costs;
- (4) To conserve the environment for future generation; and
- (5) To enhance awareness on the role and importance of RE.

Accordingly this is planned to be achieved through the following strategic thrusts:

- (1) Introduce appropriate regulatory framework;
- (2) Provide conducive environments for RE businesses;
- (3) Intensify human capital development;
- (4) Enhance RE research and development; and
- (5) Design and implement a RE advocacy program.

Currently the actual capacity for RE generation is very low in the country due to the fact that the economics of renewable electricity is unfavourable but also because of the lack in infrastructure for grid connectivity and the absence of appropriate regulatory and institutional measures, such as poor governance, technological constraints and low awareness levels [53]. The policy envisions that the contribution of RE in the overall power generation mix will reach 9%, 10% and 13% by 2020, 2030 and 2050 respectively. These will be achieved through a combination of solar photovoltaics (PV), solid waste, mini-hydro, biogas and biomass power generation capacities.

It is anticipated that the introduction of these measures would enable large GHG (greenhouse gas) emissions reduction potential from the power generation sector, which currently accounts for about 33% of the total GHG emissions by the country [53]. However, similar to the National Biofuels Policy, the National Renewable Energy Policy again makes the assumption that all renewable energy will result in lower GHG emissions simply because they are renewable and bio-derived. This may not necessarily be the case given that the production of the biomass may lead to higher emissions. It is recommended that sustainability criteria are defined to ensure that only sustainable biomass, such as waste residues, are used for power generation, otherwise risking the policy's objective relating to the conservation of the environment.

4. Effects of Government Policies on National Energy Balance

Figure 5 depicts the trend in the types of energy consumed in Malaysia for the duration of 45 years. It is worth mentioning that prior to the 1980s, the key source of energy was oil. The Four-Fuel Diversification Policy that was introduced in 1981 highlighted the need to increase the role of gas, coal and hydroelectric in order to diversify the national energy base. Following this, the share of gas in the national energy balance had more than tripled in a matter of only five years since the policy was introduced (from 12% in 1981 to 41% in 1986); and from the year 2000, gas overtook oil as the largest share of energy consumed. The large availability of gas resources and the effective measures that were put in place have been successful in bringing gas into mainstream at such rapid pace, when globally it is more common to expect major energy projects to take up to 30 years to reach materiality [54]. However, the policy had not been equally successful in increasing the role of coal and especially hydroelectric; both of which are also part of the Four-Fuel Diversification strategy. Malaysia has domestic coal reserves, but the development has not been actively pursued because most of the deposits are located in interior areas which lack the proper infrastructure, therefore making their exploitation uneconomical [20]. The slight increase in the consumption of coal in the national energy balance at the beginning of the year 2000 is attributable to the commissioning of several new coal-fired power plants as part of the developmental agenda underlined by the Seventh and Eighth Malaysia Plan Periods (1996–2005). This was made possible with the introduction of the New Mineral Policy that had liberalized the sector to induce more private sector involvement in the exploration, development and production activities [22]. Unbeknown to many, Malaysia actually has huge untapped coal reserves amounting to approximately 1.72 billion tonnes, and with such huge reserves in the backyard, it is unfortunate that Malaysia is still importing a substantial amount of coal from China, Indonesia and Australia [55].

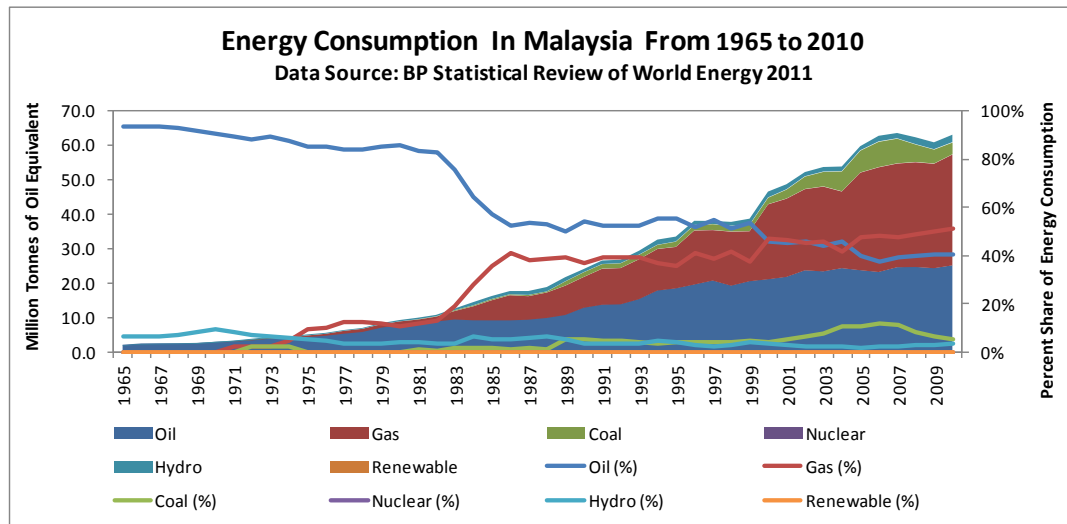


Figure 5. The chart depicts the energy consumption trend in Malaysia from 1965 to 2010. The line graphs are the percent energy share while the shaded areas represent the absolute energy consumption in Million Tonnes of Oil Equivalent. Over the years gas has become a prominent source of energy and successfully reducing the country's dependence on oil. Petroleum are the major sources of energy consumed in Malaysia for the last 45 years without any significant advances in the area of renewable energy. The above trend is not sustainable from an environmental and resource availability perspective. Data were obtained from [24] and plotted by the authors.

It is also regrettable that the introduction of the Five-Fuel Diversification Policy in the year 2000 had not been as successful in increasing the use of renewable energy. Malaysia is a country bestowed with an abundance of natural and renewable resources, ranging from solar to hydro and biomasses, yet a decade has gone by with no major progress achieved. As at end of 2010, Malaysia has yet to fully diversify its energy base as per the supply strategy stipulated in the National Energy Policy and is still heavily reliant on petroleum sources. It is a matter of urgency that Malaysia undertakes a review of current renewable energy development mechanisms to identify gaps and barriers to the implementation of these projects. The introduction of the National Renewable Energy Policy and Action Plan in 2009 could potentially be the game changer especially with the ratification of the Renewable Energy Act [53] that would enable the introduction of the feed-in-tariffs for renewable electricity.

As a net petroleum exporter, the oil and gas industry is at the heart of Malaysia's economy and growth, not just as a source of revenue for the country but also to support and propel the growth of domestic economy. It is a well-known fact that energy consumption and GDP growth is closely related (Figure 6), however the direction of causation is still controversial, that is, whether economic growth leads to energy consumption or that energy consumption is the engine of economic growth [56]. What is important to note from Figure 6 though is that there are many pathways to achieve GDP growth. Development in the U.S., for example, has indeed resulted in high GDP *per capita*, but this has been achieved at the expense of high total energy consumption. It is possible to still achieve high GDP *per capita* but with a more moderate increment in energy use, as exemplified in the case of Japan and some of the European countries. For example, to achieve a GDP *per capita* (at PPP) of 20,000 USD, the *per capita* energy consumption of Japan was only a third of that of the U.S.

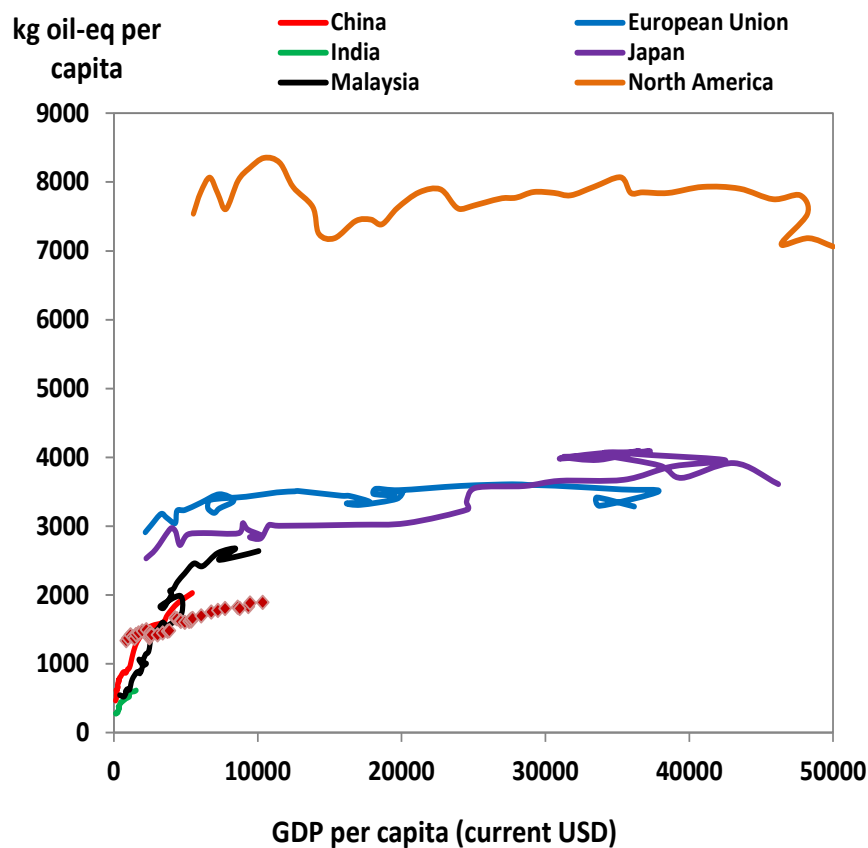


Figure 6. Chart depicts annual *per capita* primary energy consumption as a function of GDP (at current USD) per capita, from 1971 to 2011. The graph illustrates that although the link between GDP growth and energy use is strong, there are developmental pathways that lead to GDP growth but with a more modest increase in rate of energy consumption. Data were obtained from the World Bank [38] and plotted by the authors.

It is unreasonable to expect Malaysia, or any other developing country, to limit growth in order to reduce the country's petroleum consumption trends, instead what is more reasonable and relevant here is for Malaysia to continuously improve the efficiency of resource use for economic growth, or in other words the eventual decoupling between the rate of petroleum consumption increase and the rate of GDP growth.

Figure 7 depicts the Compound Annual Growth Rate (CAGR) of the *per capita* energy consumed and GDP increment between 1971 and 2008 broken into four different periods. Between 1971 and 1980, an 8% annual growth rate in energy consumption *per capita* was required for Malaysia to sustain a *per capita* GDP growth rate of 12% annually, denoting that every 1% growth in *per capita* energy consumption was related to about 1.6% growth in GDP *per capita*. In the subsequent period (1981–1990) however, the rate of *per capita* GDP growth is less responsive to the growth in the energy being consumed, where a 1% growth in *per capita* energy consumption had only resulted in 0.7% growth in GDP. This is very likely due to external economic factors that have been unfavourable for the Malaysian economy to grow. It was during this period that many countries were struck by the economic recessions triggered by the 1978/1979 oil crisis. It was in 1985 when Malaysia's economy was severely hit and contracted by about 10% [57].

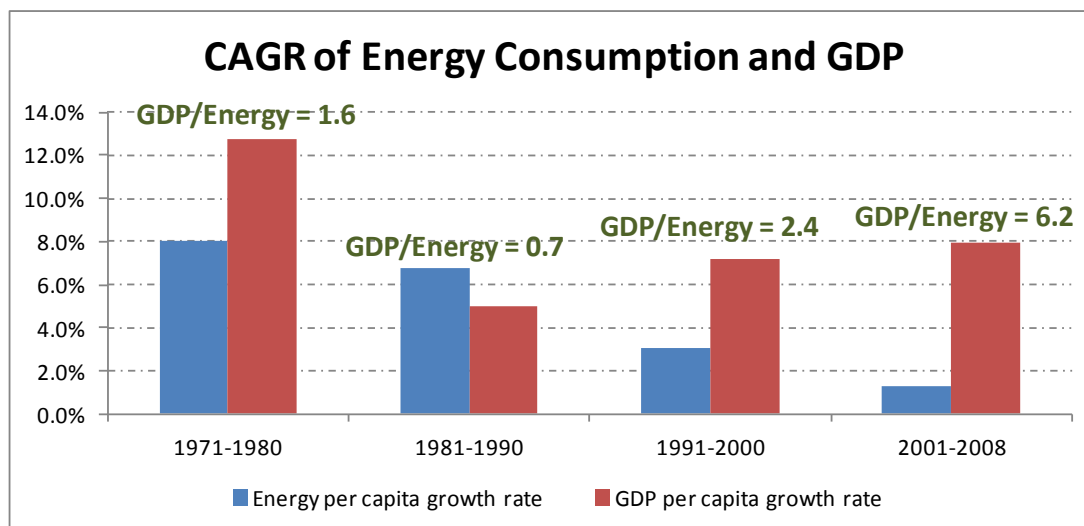


Figure 7. The Compound Annual Growth Rate (CAGR) of energy *per capita* and GDP *per capita* for Malaysia between the years of 1971 and 2008 are presented above. The growth rate in energy consumption *per capita* is less than the growth rate in *per capita* GDP for all the different eras except for the period between 1981 and 1990 when the world was faced with several crises. The GDP to Energy ratio signifies the percent annual GDP growth rate *per capita* for every 1% growth in *per capita* energy consumption. Data for energy consumption and GDP were obtained from [24,58], respectively. The chart was plotted by the authors.

In later years however, there have been a marked improvement in materializing a larger growth in GDP with every 1% increment in *per capita* energy consumption, therefore indicating a more effective role of energy in the GDP-energy relationship. In the last two periods (1991–2000 and 2001–2008) shown in Figure 7, there have been a substantial decoupling between the growth rate of energy consumption and GDP in Malaysia. For instance, between 2001 and 2008, a 1% increment in *per capita* energy consumption had correlated to a 6% growth in *per capita* GDP, signifying a large improvement in the efficiency of natural resource use for economic growth in the country.

5. Conclusions & Policy Implications

This study has identified key critical junctures throughout the 40 years history of Malaysia's energy developments from 1970 to 2010. Conjunctions of events in the Middle East, in particular in 1973 and 1979, coupled with security of energy supply for domestic economic growths, were major crises that had threaten prevailing paradigms in the period between 1970s and 1980s, which eventually culminated in a shift in the national philosophy towards petroleum resource exploitation. The oil and gas sector has since evolved profoundly leading to the creation of a thriving industry throughout the entire value chain, from upstream production all the way to downstream retail business. The rapid developments of Malaysia's energy landscape were made possible with the introductions of various policies to enable and drive the growth of the industry. Energy policies in the later years had resulted in a more diversified energy base. Natural gas is now a critical component of the nation's energy mix and the country's dependence solely on oil as energy source has been substantially reduced.

The country's enhanced position as a net oil and gas exporter has practically shielded the country from major external and internal shocks since the late 1980s, and therefore the country has continued on its gradual trajectory towards further locking-in fossil-fuels in the Malaysian economy, in spite of having an abundance of renewable energy resources. The continued exploitation of these resources will inevitably lead to dangerous and irreversible changes to the global climate, which eventually will impact developing countries like Malaysia (amongst others) the most [59]. A decade has gone by since the Five-Fuel Diversification Policy highlighted the need for renewable energy sources but with little progress that has been made to date. Malaysia is still heavily drawing from its natural capital. Unfortunately this is not easy to change.

Firstly, energy prices in Malaysia are kept artificially low due to government subsidy, therefore creating a perverse incentive against efficient utilization. Secondly, on top of the subsidy, the energy prices in Malaysia, as well as in most other countries globally, fail to internalize the cost of environmental externality. The prices of energy that is paid by consumers do not take into account the social cost associated with the environmental degradation resulting from the production and use of the energy. And thirdly, technological and institutional systems in Malaysia have all revolved around the petroleum industry for a very long time making it extremely difficult and costly to cause transition to a new and more sustainable energy system. Because of these, there is a clear need for Malaysia to transform its energy landscape. Since experiences in other countries have shown that an energy project can take up to 30 years before it reaches a material level in a country's total energy mix [54], it is obvious that the transition has to start now. Waiting for the incremental evolution towards cleaner energy system will naturally be too slow.

Malaysia is now slowly beginning to realise the importance of further energy diversification away from fossil-based fuels, especially since the country is fast becoming a net importer of oil given the increase in domestic energy consumption, against a rapid depletion in local oil reserves. What the country needs is a policy to revolutionize the energy industry, an intervention by the government to provide incentives for a swifter transition. The National Renewable Energy Policy is expected to be the game changer, at least for the power generation sector. However, a similar push is required for other sectors.

Author Contributions

All authors have made substantial contributions to conception and design, and/or acquisition of data, and/or analysis and interpretation of data and participated in drafting the article or revising it critically for important intellectual content. All authors have also given their final approval of the version of manuscript to be submitted and any revised version of manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Performance Management Delivery Unit (PEMANDU). Economic Transformation Programme. In *A Road Map for Malaysia*; PEMANDU: Kuala Lumpur, Malaysia, 2010; Chapter 6.

2. Gan, P.Y.; Li, Z. An econometric study on long-term energy outlook and the implication of renewable energy utilization in Malaysia. *Energy Policy* **2008**, *36*, 890–899.
3. Ahmed, E. Are the FDI inflow spillover effects on Malaysia's economic growth input driven? *Econ. Model.* **2012**, *29*, 1498–1504.
4. Thelen, K.; Steinmo, S. Historical institutionalism in comparative politics. In *Structuring Politics. Historical Institutionalism in Comparative Analysis*; Cambridge University Press: Cambridge, UK, 1992; pp. 1–32.
5. Pierson, P. The path to European integration: A historical institutionalist analysis. *Comp. Polit. Stud.* **1996**, *29*, 123–163.
6. Peters, B.G.; Pierre, J.; King, D. The politics of path dependency: Political conflict in historical institutionalism. *J. Polit.* **2005**, *67*, 1275–1300.
7. Laird, F.; Stefes, C. The diverging paths of German and United States policies for renewable energy: Sources of difference. *Energy Policy* **2009**, *37*, 2619–2629.
8. Eriksson, R. The European energy policy. In *Framing of Energy Security in the European Union*; Lund University Publications: Lund, Sweden, 2011.
9. Thelen, K. Historical institutionalism in comparative politics. *Annu. Rev. Polit. Sci.* **1999**, *2*, 369–404.
10. Hogan, J.; Doyle, D. The importance of ideas: An a priori critical juncture framework. *Can. J. Polit. Sci.* **2007**, *40*, 883–910.
11. *Petroleum Development Act 1974*; Act 144; Percetakan Nasional Malaysia: Kuala Lumpur, Malaysia, 1 January 2006.
12. *Malaysian Biofuel Industry Act 2007*; Act 666; Percetakan Nasional Malaysia Berhad: Kuala Lumpur, Malaysia, 2007.
13. Parliament. *Official Report. House of Representatives. Third Parliament. Third Session. Jilid III. Bil. 2. 4 December 1973*; Parliament: Kuala Lumpur, Malaysia, 1973.
14. Parliament. *Official Report. Senate. Third Parliament. Fourth Session. Jilid IV. Bil. 9. 26th July 1974*; Parliament: Kuala Lumpur, Malaysia, 1974.
15. Parliament. *Parliamentary Debates. House of Representatives. Fifth Parliament. First Session. Jilid 1, Bil. 58. 13hb Jun 1979*; Parliament: Kuala Lumpur, Malaysia, 1979.
16. Parliament. *Parliamentary Debates. House of Representatives. Fifth Parliament. First Session. Jilid I, Bil. 84. 26hb October 1979*; Parliament: Kuala Lumpur, Malaysia, 1979.
17. Parliament. *Parliamentary Debates. House of Representatives. Fourth Parliament. First Session. Jilid I, Bil. 9. 18th November 1974*; Parliament: Kuala Lumpur, Malaysia, 1974.
18. Energy Commission. National Energy Policy. 12 March 2007. Available online: http://www.st.gov.my/index.php?Itemid=1236&id=538&option=com_content&task=view (accessed on 2 July 2010).
19. Ministry of Plantation Industries and Commodities Malaysia (MPIC). *The National Biofuel Policy*; MPIC: Kuala Lumpur, Malaysia, 2006.
20. Economic Planning Unit (EPU). *Eight Malaysia Plan 2001–2005*; Percetakan Nasional Malaysia Berhad: Kuala Lumpur, Malaysia, 2001.
21. Economic Planning Unit (EPU). *Ninth Malaysia Plan (2006–2010)*; Percetakan Nasional Malaysia Berhad: Kuala Lumpur, Malaysia, 2006.
22. Economic Planning Unit (EPU). *Seventh Malaysia Plan 1996–2000*; Percetakan Nasional Malaysia Berhad: Kuala Lumpur, Malaysia, 1996.

23. Economic Planning Unit (EPU). *Sixth Malaysia Plan 1990–1995*; Percetakan Nasional Malaysia Berhad: Kuala Lumpur, Malaysia, 1990.
24. BP. *BP Statistical Review of World Energy*. Available online: <http://www.bp.com/en/global/corporate/about-bp/energy-economics/statistical-review-of-world-energy.html> (accessed on 2 July 2011).
25. Owen, N.; Inderwildi, O.; King, D. The status of conventional world oil reserves—Hype or cause for concern? *Energy Policy* **2010**, *38*, 4743–4749.
26. Von Der Mehden, F.; Troner, A. *Petronas: A National Oil Company With An International Vision*; The James A. Baker III Institute for Public Policy of Rice University: Houston, TX, USA, 2007.
27. Shell Malaysia. The History of Shell in Malaysia. Available online: http://www.shell.com.my/home/content/mys/aboutshell/who_we_are/history/malaysia/ (accessed on 8 September 2011).
28. *Companies Act 1965 (Incorporating all amendments up to 1 January 2006)*; Act 125; Percetakan Nasional Malaysia: Kuala Lumpur, Malaysia, 1 January 2006.
29. Abdullah, F. Affirmative Action Policy in Malaysia: To Restructure Society, To Eradicate Poverty. *Ethnic Stud. Rep.* **1997**, *XV*, 189–221.
30. Brown, G. Making ethnic citizens: The politics and practice of education in Malaysia. *Int. J. Educ. Dev.* **2007**, *27*, 318–330.
31. Performance Management Delivery Unit (PEMANDU). *Building a National Consensus on National Key Economic Areas (NKEAs) for Malaysia, Presentation Slides by Dato Sri Idris Jala*; PEMANDU: Kuala Lumpur, Malaysia, 2010.
32. CNNMoney. Global 500 2011: Top Performers—Most Profitable. 25 July 2011. Available Online: <http://money.cnn.com/magazines/fortune/global500/2011/performers/companies/profits/> (accessed on 19 August 2011).
33. Jalal, T.S. National energy policies and the electricity sector in Malaysia. In Proceedings of the ICEE 2009 3rd International Conference on Energy and Environment, Malacca, Malaysia, 7–8 December 2009.
34. The Straits Times. Energy Policy to Conserve Oil Reserves. *The Strait Times* 24 October 1979, p. 11.
35. Pusat Tenaga Malaysia. Energy Sector Embracing Climate Change. In Proceedings of the Presentation by Pusat Tenaga Malaysia at National Conference on Climate Change, Kuala Lumpur, Malaysia, 11 September 2007; Preparedness towards Policy Changes: 2007.
36. World Nuclear Association. Three Mile Island Accident. Available online: <http://www.world-nuclear.org/info/safety-and-security/safety-of-plants/three-mile-island-accident> (accessed on 8 February 2015).
37. Kramer, G.J.; Haigh, M. No quick switch to low carbon energy. *Nature* **2009**, *462*, 568–569.
38. World Bank. *The World Bank Data. Energy & Mining*; Available online: <http://data.worldbank.org/> (accessed on 11 February 2011).
39. Abdul-Manan, A.F.; Baharuddin, A.; Chang, L.W. A detailed survey of the palm and biodiesel industry landscape in Malaysia. *Energy* **2014**, *76*, 931–941.
40. Chin, M. *Biofuels in Malaysia. An analysis of the legal and institutional framework*; Working Paper 64; Center for International Forestry Research (CIFOR): Bogor, Indonesia, 2011.
41. Simeh, M.K.M. An overview of Malaysian palm oil market share in selected markets. *Oil Palm. Ind. Econ. J.* **2009**, *9*, 29–36.

42. Malaysian Palm Oil Board (MPOB). Overview of the Malaysian Palm Oil Industry 2009. Available online: http://econ.mpob.gov.my/economy/Overview_2009.pdf (accessed on 14 February 2012).
43. Gerasimchuk, I. *Biofuel Policies and Feedstock in the EU*; Chatham House: London, UK, 2013.
44. Evans, S. The rocky road towards palm oil sustainability. *Ends Rep.* **2011**, *443*, 34–39.
45. U.S. Department of Agriculture (USDA). *Malaysia Biofuels Annual Report 2009*; USDA Foreign Agricultural Services: Kuala Lumpur, Malaysia, 2009.
46. Pimentel, D.; Patzek, T. Ethanol production using corn, switchgrass and wood; Biodiesel production using soybean and sunflower. *Nat. Resour. Res.* **2005**, *14*, 65–76.
47. CONCAWE; EUCAR; Joint Research Centre (JRC). *Well-to-Wheels Analysis of Future Automotive Fuels and Powertrains in the European Context*; Well-to-Wheels Report Version 2c; JRC: Luxembourg, 2007.
48. Wicke, B.; Dornburg, V.; Junginger, M.; Faaji, A. Different palm oil production systems for energy purposes and their greenhouse gas implications. *Biomass Bioenergy* **2008**, *32*, 1322–1337.
49. Cherubini, F.; Bird, N.; Cowie, A.; Jungmeier, G.; Schlamadinger, B.; Woess-Gallasch, S. Energy-and greenhouse gas-based LCA of biofuel and bioenergy systems: Key issues, ranges and recommendations. *Resour. Conserv. Recycl.* **2009**, *53*, 434–447.
50. Lange, M. *The GHG Balance of Biofuels Taking into Account of Land Use Change*; Kiel Working Paper No. 1619; Kiel Institute for the World Economy (IfW): Kiel, Germany, 2010.
51. US Environmental Protection Agency. *EPA Issues Notice of Data Availability Concerning Renewable Fuels Produced from Palm Oil Under the RFS Program*; EPA: Washington, DC, USA, 2011.
52. *Renewable Energy Act 2011*; Act 725; Percetakan Nasional Malaysia Berhad: Kuala Lumpur, Malaysia, 2011.
53. Kementerian Tenaga, Teknologi Hijau dan Air (KeTTHA). *National Renewable Energy & Action Plan*; KeTTHA: Kuala Lumpur, Malaysia, 2009.
54. Kramer, G.; Haigh, M. No quick switch to low-carbon energy. *Nature* **2009**, *462*, 568–569.
55. Adnan, H. Malaysia Has Huge Untapped Mineral Resources. Available online: <http://biz.thestar.com.my/news/story.asp?file=/2009/2/3/business/3177846&sec=business> (accessed on 3 February 2009).
56. Aqeel, A.; Butt, M. The relationship between energy consumption and economic growth in Pakistan. *Asia Pac. Dev. J.* **2001**, *8*, 101–110.
57. Tahir, M.N.H.; Mohd Sam, M.F.; Abu Bakar, K.; Abdul Aziz, N.A.; Roni, M. Buffering the economic downturn: Malaysia against the rest of the world. Proceedings of the 2nd International Conference on Business and Economic Research (ICBER), Langkawi, Malaysia, 2011.
58. DOSM. Department of Statistics Malaysia, Time Series Data. Available online: http://www.statistics.gov.my/portal/download_Economics/files/DATA_SERIES/2009/Bab_1Akaun_Negara.pdf (accessed on 31 December 2011).
59. Stern, N. *The Economics of Climate Change: The Stern Review*; Cambridge University Press: Cambridge, UK, 2007.

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