Energy 76 (2014) 931–941

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

A detailed survey of the palm and biodiesel industry landscape in Malaysia

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ARTICLE INFO

Article history:
Received 27 May 2014
Received in revised form
11 August 2014
Accepted 3 September 2014
Available online 27 September 2014

Keywords:
Sustainable energy
Renewable energy
Biofuels
Malaysia
Palm oil

ABSTRACT

This paper provides a critical review of the palm biodiesel landscape in Malaysia. The palm industry is a key source of revenue for the country, where in 2009 the industry was responsible for generating 8% of the gross national income per capita. The interest in palm-based biodiesel can be traced back to the early 1980s however it was only in 2006 that Malaysia officially formulated its first National Biofuel Policy as a strategic government intervention to drive development and implementation of palm biodiesel as substitute to regular fossil-based diesel. As at January 2013, the implementation of the biodiesel mandate (at 5% concentration) has been limited to the Klang Valley central region only. But there are plans for a much wider roll-out and at higher concentration blends in 2014. The policy in its current form assumes that all biofuels are sustainable and therefore fails to provide assurances that the fossil diesel will be replaced by a more sustainable energy source. Here it has been argued that a market-based policy approach would be better than a technology-forcing mechanism.

1. Background

The oil and gas industry is at the heart of Malaysia's economy and growth, not just as a key source of revenue for the country but also to support and propel the growth of the domestic economy. Like many other countries globally, Malaysia too is very dependent on fossil energy sources. That is, an energy source that is depleteable and one that leads to the worsening of the climate. It is a well established fact that a country's persistent reliance on petroleum is not a good thing from many fronts. But unfortunately, weaning the country off fossil energy is not easy and requires a lot of willpower.

The transport sector in Malaysia has been the largest consumer of energy for some years now [1] and because of this, the transport sector is the largest contributor of GHG (greenhouse gasses) emitted in the country, accounting for more than 40% of the country's total GHG emissions [2]. This is not expected to change anytime soon, in fact the trend is expected to get worse. This is especially the case as Malaysia moves up the income ladder, where affluence, like everywhere else, is characterized by, amongst others, increased vehicle ownership potential and personal mobility.

With increasing concerns on climate change, crude oil price volatility and security of energy supply, many countries globally have started formulating policies to promote the use of biofuels as substitute to fossil fuel for the transport sector, either by providing fiscal incentives in the form of tax credits [3,4] or through obligatory volume targets [5]. Likewise, Malaysia too has developed and introduced a NBP (National Biofuel Policy) in 2006. This is a first major step that the country has proactively taken to introduce alternative forms of energy to complement and partially substitute petroleum. As of now, the implementation of the policy has been limited to the central Klang Valley region only, however discussion surrounding a nation-wide roll out is already underway, where in fact there is now desire to increase the concentration of the palm-biodiesel blend from the current 5% level to 10% in 2014 [6].

A lot of studies focussing on the palm oil and biodiesel industry in Malaysia have been done in the past by various researchers, some of which are works by Refs. [7–10]. However, many of these studies, though detailed and robust, tended to focus on particular aspects of the oil palm or biodiesel complex through specific

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http://dx.doi.org/10.1016/j.energy.2014.09.007
0360-5442/

viewpoints. Darshini et al., for example, has provided an excellent insight into the perspectives of key stakeholders within the industry, and as will be shown later is consistent with the argument presented here.

In this paper we present a critical review of the Malaysian biofuel landscape. Detailed overviews of the palm and biofuels industries are presented by tracing its historical developments up to its current state. A critical discourse on the biofuel policy is also provided with a special emphasis on sustainability and innovation. Ensuing this, we present an overview of some of the recent developments in Malaysia that may have an impact, directly or indirectly, on the biofuels landscape in Malaysia. Throughout this paper, we offer constructive suggestions for how the competitiveness of Malaysian biofuels can be improved. This paper builds on previous works by others and is a timely review of the biodiesel initiative in Malaysia before the policy is implemented on a much wider scale.

2. An overview of the industry

2.1. Oil palm cultivation in Malaysia

Oil palm was first introduced to Malaysia, back then known as Malaya, in the 1870s as ornamental crops, but later in the 1917s was commercialized, initially in Selangor, but have eventually spread throughout the country and now has become the number one plantation crop in Malaysia, contributing about 5–6% of Malaysia's GDP [11], and is currently the fourth largest contributor to the national economy accounting for about 8% of the country's GNI (gross national income) per capita [12].

According to the Department of Statistics Malaysia, oil palm plantations currently occupy 14% of the total land area of the country [13]. Looking back through history, it was the government land settlement schemes, in particular the FELDA (federal land development authority) that was mainly responsible for promoting and expanding the oil palm plantations in Malaysia as part of their socio-economic responsibilities towards the rural poor and landless [14]. However, from the Sixth Malaysia Plan (1991–1995) onwards, there was a concerted effort by the government to privatize the developments of large oil palm estates, in which now large private entities own about 60% of the total area cultivated for oil palm, with the balance being managed by independent and organized smallholders, where the latter include FELDA [13,15]. Although there is a strong push for private sector-led oil palm developments, the Malaysian government is still heavily involved in the palm oil sector from multiple fronts. On the one hand the Malaysian government plays the role of a regulator, policy maker and law enforcer, but on the other hand the government is also the indirect shareholder for some of the large private entities involved in the palm oil business [14,16], thus making them the indirect owner and beneficiary of the growing industry. There is therefore also a strong incentive for the government to promote and expand the industry domestically and internationally.

At present, the Malaysian based Sime Darby Plantation is a key player of the oil palm industry, whose position was enhanced through the merger of Sime Darby Berhad, Golden Hope Plantations Berhad and Kumpulan Guthrie Berhad. These three separate entities were founded almost 200 years ago by pioneering English planters who had established rubber plantations in Malaya, but later were converted into oil palm estates. This combined heritage of more than 400 years has made Sime Darby Plantation now as one of the world's largest palm oil producers responsible for about 6% of the world's CPO (crude palm oil) output annually [17]. The Group has operations in over 20 countries and employing more than 100,000 people [18]. The conglomerate, as at June 2010, was one of the largest listed companies on the local stock market, Bursa Malaysia, with a market capitalization of RM 48.1 billion, where the three largest shareholders as at September 2010, are AmanahRaya Trustees Berhad (i.e. Skim Amanah Saham Bumiputera), the EPF (employees provident fund)Board and PNB (permodalan nasional berhad), which accounts for a total of more than 60% of the issued capital [18].

Today, 4.56 million hectares of land in Malaysia is cultivated with oil palm, producing 17.57 million tonnes of palm oil and 0.66 million tonnes of palm kernel oil, thus making Malaysia one of the largest producers and exporters of palm oil worldwide, accounting for about 11% of the world's oils and fats production and 26% of export trade of oils and fats [19]. It is important to note that oil palm is the most efficient oilseed crop in the world, where a hectare of oil palm plantation is able to produce up to 10 times more oil than other leading oilseed crops globally which therefore provides great utility for a piece of land especially in areas that are land-scarce. Because of the aforementioned efficiency in oil palm cultivation, in 2009 oil palm was the largest source of oils and fats globally whilst at the same time occupying the smallest (~5%) total land area cultivated for oilseeds. With the extraordinarily high yield inherent to oil palm, it should be possible to mitigate a further deforestation of land for new oil palm establishments through better management practices of existing plantations and replanting schemes and via international cooperation.

2.2. Biofuels development in Malaysia

2.2.1. Historical perspective

In many countries, a biofuels mandate or policy tends to incentivize the development and deployment of substitutes for both types of fuels, gasoline and diesel, for use in spark-ignition and compression-ignition vehicles respectively [5,4]. These policies typically aim to replace fossil fuels with non-fossil alternatives. However, the situation in Malaysia is a little different given that more emphasis has been given for substituting diesel fuels, whilst the development of alternatives for gasoline has been rather slow, if not nonexistent. To some extent this is likely to be due to the proactive development, demonstration and effective lobbying by the oil palm industry associations.

The commercial interest in biodiesel can be traced back to the early 1980s when there was a realization that the country has large potential to become a pioneer of the biodiesel industry given Malaysia's status as world's largest producer and exporter of palm oil [15]. The initial research and development were spearheaded by the Malaysian Palm Oil Board (MPOB, then known as PORIM) which had led to the construction of a palm biodiesel pilot plant and subsequently a series of laboratory, engine and road evaluations were carried out successfully and this include a large fleet trial that was conducted and had ascertained its fitness for purpose [15,16]. In 1992, MPOB managed to develop a winter-grade palm biodiesel technology [15] that is especially crucial for palm biodiesel to enter markets with temperate climates. However, despite these successes, the biodiesel industry had failed to take off and was relatively dormant for many years in the 1990s. It is not entirely clear the reasons behind this, but it can be hypothesized that the relatively low and stable oil price as well as the country's growing strength as a net oil exporter during this period had overshadowed the biodiesel industry, and moreover it wasn't until the mid 21st century that global demand for biofuels really took off (Fig. 1) as a result of mandatory blending targets that were introduced in many countries, particularly within the OECD nations [20].

2.2.2. Revitalizing the biofuels industry

The biofuel industry in Malaysia was given a new lease of life when the Eight Malaysia Plan underlined the niche, but high

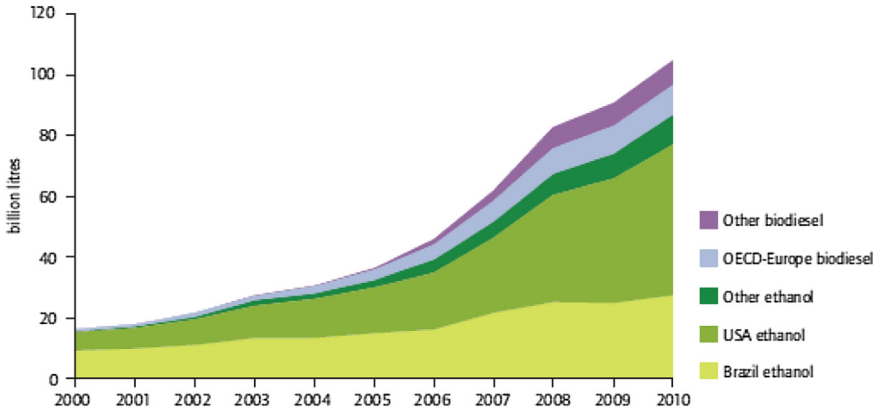

Fig. 1. Global biofuels production between 2000 and 2010 [20].

potential role of renewable energy in developing an alternative energy source to complement the Four-Fuel Diversification Policy of 1981 [21]. Amongst the so-called fifth fuels, the Eight Malaysia Plan had highlighted biomass, biogas, municipal waste, solar and mini-hydro as the renewable resources that will receive priority during the plan period. This was further enhanced in the Ninth Malaysia Plan.

The Ninth Malaysia Plan (2006–2010) highlighted the key role of the energy sector as an enabler towards strengthening economic growth of the nation. 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 given an emphasis in an effort to make Malaysia a world leader and the hub for palm oil. The Ninth Malaysia Plan also underlined that efforts will be taken to promote the export of palm biodiesel. Consistently, the Ninth Malaysian Plan also stated that during this period, the agricultural industry will be revitalized to become the third engine of growth for the economy, with emphasis on New Agriculture, which is characterized by, amongst others, the use of modern technologies and production of value-added products. The palm industry, specifically, was expected to benefit from greater downstream diversification. To accelerate the development of the palm oil downstream industry, several POIC (palm oil industrial clusters) were established throughout the country to act as catalyst in creating a value chain for the palm oil industry as well as the development of related supporting industries.

Pursuant to these, in 2006 the Malaysian government adopted the National Biofuel Policy and had pledged to set aside 6 million tonnes of CPO specifically for biodiesel production [15]. The implementation was planned to commence originally in 2010 and rolled-out in phases, initially for use by selected government vehicles before a nation-wide execution can be done.

It is believed that in the initial stages the biofuel policy was largely championed by the MPIC (ministry of plantation industries and commodities) Malaysia, in which the motivations were quite simply to stabilize the prices of CPO (crude palm oil) whilst at the same time exploit a new and emerging market opportunity especially with the rapid increase in biofuel mandates and demand globally [15]. The ministry itself was later entrusted with the main responsibility to develop and implement the policy. Although the policy was developed following stakeholder consultations and on the basis of earlier research findings by MPOB [15], it is still unclear which stakeholders were directly involved in and the nature of the consultation process. Regardless of its original intent, the ultimate objectives of the National Biofuel Policy that was agreed upon and officially published are as follows:

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

By the end of 2007, the government had approved 92 licenses for individual biodiesel projects, amounting to a total production capacity of about 10.2 million tonnes [16], but by October 2008 only 16% on these were realized [15] largely because a lot of these projects were either delayed or abandoned since the economic viability of biodiesel projects were less attractive with the rising CPO prices. In 2009, there were a total of 25 biodiesel plants in the country, mostly located in the Peninsula Malaysia. These had a total production capacity of 2.6 million tonnes, of which only a mere 228,000 tonnes were produced where most of it were for the export markets [22]. However, the Malaysian government is presently looking at increasing domestic consumption of palm biodiesel through obligatory use as diesel blends nationwide and at higher concentrations. This is expected to provide a significant rise in the use of palm oil in the domestic transport sector (Fig. 2) [23].

3. Strategies of the National Biofuel Policy

The National Biofuel Policy briefly outlines its execution plan. The policy is underpinned by five strategic thrusts with implementation strategies divided into short, medium and long-term plans. These are explored further in the following section.

3.1. Five strategic thrusts of the NBP

3.1.1. Biofuel for transport

The policy acknowledges that diesel use by the transport sector is highly subsidized and therefore this sector will receive the highest priority under Malaysia's biofuel agenda. The plan was to blend 5% palm biodiesel into regular diesel (producing B5) and make it available country wide for use by land and sea transports. However, as at December 2012, this has yet to be fully achieved due to the high CPO prices. Implementation has instead been limited to road transport applications and within the Klang Valley region only. Under existing circumstances, a wider nationwide roll out is not foreseen to be straightforward given the costly and complex infrastructural needs and high CPO prices, however, the MPIC is optimistic that this will happen earliest in 2013 [24].

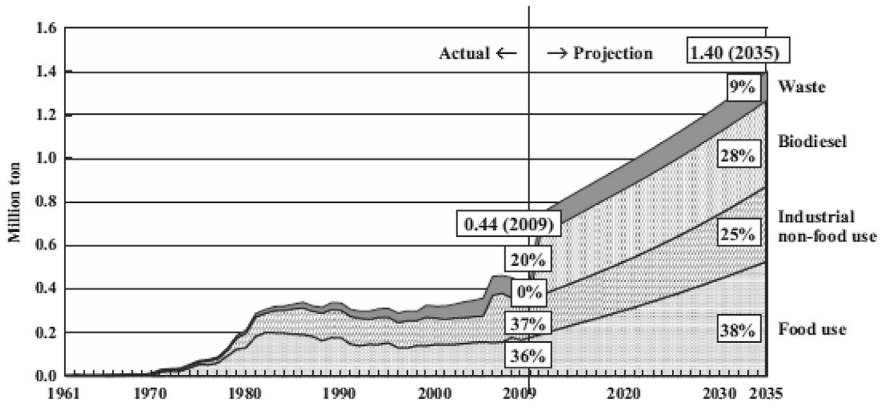

Fig. 2. Actual and projected domestic demand for palm oil between 1961 and 2035 by various sectors [23].

3.1.2. Biofuel for industry

The policy also aims for the use of B5 by the industrial sector, particularly as fuel for boilers in manufacturing plants, construction machineries and generator sets, but as noted earlier, the main obstacle is still the high price for palm commodities.

3.1.3. Biofuel technologies

It is envisioned that technology will be a key enabler for the successful implementation of the biofuel mandate, particularly if greater biofuel use is anticipated. Because of this the policy stipulates that funding will be made available via government and public sector to assist in research, development and commercialization of biofuel technologies. In fact MPOB has been a key player in this arena where they have successfully developed and commercialized palm biodiesel technologies over the last decades. Domestically several commercial plants were built using MPOB's technology with industrial partners such as Carotino and Golden Hope, and impressively these technologies have also been adopted internationally, for example in Thailand and South Korea [25]. This will increasingly become an important area for palm biodiesel in the future for it to be more competitive economically and technologically.

Industrial R&D activities will play a pivotal role by continuously improving the existing biofuels technology and creating a technology-push for new inventions through the S-shaped innovation development curve with possible occasional discontinuities brought about by chasms of radical breakthroughs. It is a well-known fact that technologies in its early stages of development typically have significantly higher unit costs than the established alternatives, but with improved market adoption comes the benefits associated with increasing returns through economy of scales and learning effects [26]. Hence innovation will be crucial for identifying, developing and commercializing advanced lower cost technology alternative, which is absolutely necessary in order for Malaysia to establish itself as the leading hub for biofuels technologies to serve a growing bio-based economy globally.

However, from an innovation systems perspective, the role of demand-pull is as important as technology-push, and there must be a feedback loop to match between the supply of technologies and the demand for it, which can be thought of as matching technical possibilities to market opportunities. There is now, and increasingly so in the future, opportunities for meeting the growing demand for sustainable biofuels driven by stringent renewable energy mandates globally. Technology solutions must suit market problems. Innovation in biofuels technology will have to take these emerging needs of the markets into account otherwise there is a risk that these new inventions will face major obstacles in penetrating the market place. Sufficient foresight is therefore required in the management of R&D activities to ensure technological innovations now take into consideration of the needs of the future. Sustainable energy is indeed an emerging and pressing need.

3.1.4. Biofuel for export

An important driver for the biofuel industry in Malaysia is to serve the growing demand for biofuels internationally. Therefore the establishments of plants for producing biofuel for export will be encouraged and facilitated. At the moment, most of the biodiesel produced locally are for the export market. In contrast to other competing bioenergy crops, palm oil is already quite competitive from an economic and supply availability angle given its lowest per unit production cost and highest oil productivity per hectare [27,28]. However, to remain competitive in the near future, the industry has to demonstrate greater sustainability standards, in particular from a GHG emissions reduction potential, in order to meet the stringent sustainability needs of biofuels regulations worldwide especially in the U.S. and Europe. A very recent regulatory notice issued by the EPA (environmental protection agency) concerning the GHG performances of palm biodiesel has indicated that biodiesel produced from palm oil fails to meet the minimum GHG savings threshold required for a biofuel to qualify as a renewable fuel under the RFS2 (renewable fuels standard 2) program in the US [29]. If this becomes final, the competitiveness of palm biodiesel in the US will be severely compromised as there is no incentive for the use of palm biodiesel to meet the obligatory volume targets, whilst competing biofuels that qualify under the RFS2 program would have a relative advantage. Likewise, the European Union has their version of renewable energy requirements which is made progressively more stringent. It is important to note that in 2009 the EU represents the largest export market for Malaysian palm biodiesel accounting for more than 50% of the total biodiesel exports, followed by the US with a share of about 17% [30]. Therefore for palm oil to be competitive in these key export markets there must be a concerted effort to transform the domestic industry towards greater sustainability standards and proactively inform decision makers globally about these continuous betterments. Unless this is taken seriously, these emerging biofuels mandate can be a threat to the Malaysian palm biofuel industry.

Whilst these advanced renewable energy regulations provide incentives for the industry to change, the reality on the ground is that changes will take time. This is especially applicable in the case of perennial crops such as oil palm where one plantation cycle is about 20–30 years, and in which a significant share of the GHG emissions attributable to palm biodiesel are due to the conversion

of forest and/or peat lands during the initial oil palm plantation establishment many years ago. These land conversion decisions were made historically before the regulations were enforced. Furthermore, regulatory designs such as the RFS2 in the U.S. have imposed GHG performances by crop-types based on industry averages and therefore deny compliance opportunities for companies with above average performances. It is strongly believed that regulations should avoid penalizing renewable fuels based on crop-types. Instead, renewable energy regulations should as far as possible be performance-based while remaining crop-neutrality. Not all palm biodiesel are bad, just as much as not all biofuels are good.

It has to be recognized that for Malaysian palm biodiesel to compete successfully in the international arena, it is not only critical for the industry to continuously improve their sustainability performances, it is equally important to correct this negative perception that has been formed over the decades.

3.1.5. Biofuel for a cleaner environment

The policy states that the increased use of biofuels will enhance the quality of the environment as it reduces the use of fossil fuels, minimize emissions of GHGs and other forms of pollutants. As will be argued later in this paper, here the policy makes the mistake of assuming that all biofuels, and all palm biodiesels, are inherently better for the environment. This is, however, not necessarily the case and as will be elaborated further in the following sections of this paper, there is a very strong need for a sustainability standard to govern and regulate what is considered as sustainable biofuels, or else there is a risk of substituting fossil fuels with an inferior alternative. Therefore it is strongly believed that this policy thrust should primarily aim to further enhance the sustainability performances of palm biofuels in order to create a positive image for palm oil to improve its market competitiveness.

Looking at the strategic thrusts of the policy summarized above, all five of it seek to expand and strengthen the biofuel industry in Malaysia from a downstream perspective. Here downstream is defined as elements and processes succeeding the plantation phase in the palm oil to biofuels supply chain. The policy fails to recognize the importance of the plantation or upstream stage in the overall biofuels industry. For a start, a lot of the sustainability requirements imbedded within the biofuels regulatory directives, such as the US RFS2 and the EU RED, are related to the characteristics of the plantation operations. For example, topical sustainability issues that are typically linked to palm biofuels are deforestation, plantation on peat land and destruction of high conservation areas [28], all of which has to do with the plantation sector. Improvements in these areas will create a positive outcome for the industry particularly for regulatory compliance, but also indirectly improving the palm oil brand image. Both of these can have material contribution to the industry's bottom line.

Moreover, the plantation sector still has a lot of room for betterment especially amongst the independent smallholders who account for about 13% of the total Malaysian oil palm plantation areas [22]. The average oil palm yield in Malaysia is about 20 tonnes per hectare per annum (Fig. 2) [31]. For the independent smallholders in Malaysia, the average oil palm yield is only 17 tonnes per hectare in 2010 [22] which is about 15% lower than the national average, whilst at the same time some large plantation companies have reported yields much higher than the national average, for example in 2008, IOI Corporation Berhad announced that they have achieved an annual yield of more than 28 tonnes per hectare [32]. Because of the lack in expertise and financial strengths, the oil palm yields of these smallholders suffer. With proper guidance on best management practices and support by giving access to funding and best planting materials, it is possible to enhance the yield of the smallholders which will create a win–win situation for all; the smallholders will benefit from higher revenue streams, the country would have more oil palm fruits to exploit and importantly, with a higher productivity, the demand for additional land to be converted into oil palm plantations can be controlled and indirectly reducing the pressure for more deforestation.

To summarize, the national biofuel policy in Malaysia has identified five strategic thrusts that has the potential to propel the palm biofuel industry in Malaysia. Some of the thrusts have met with obstacles that may slow down the expansion and growth of the industry, namely the prohibitive palm oil prices and sustainability compliance with regulations in export markets. It has also been argued that widening of the thrusts to include upstream operations is as pertinent to the growth of the industry as the expansion and improvement in the downstream operations are. One key point that keeps cropping up in this section is that there are strong incentives for making sustainable palm oil the industry norm. The incentives here extend beyond ecological conservation and are very tightly linked to the industry's economic bottom line by enabling easier access to key export markets. (Fig. 3)

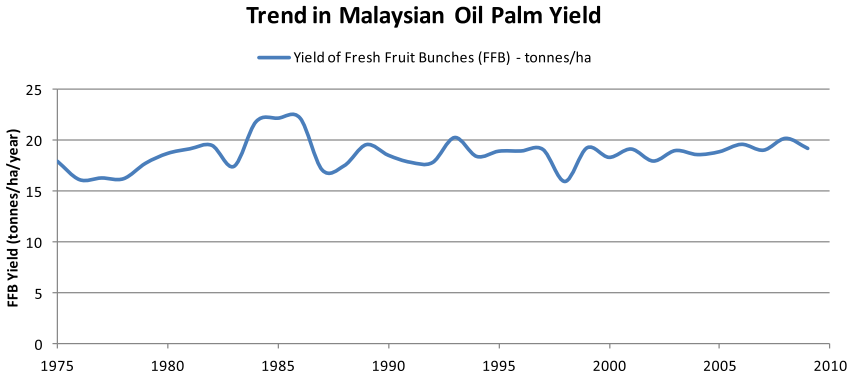

Fig. 3. The national average oil palm yield in Malaysia for the last 34 years. Data were obtained from Ref. [31] and plotted by the author.

3.2. Three steps implementation plan

Whereas the five strategic thrusts summarized above are meant to drive the Malaysian biofuels agenda, the policy has also highlighted a three-phase approach known as the short, medium and long term plans in order to assist with the implementation of the biofuel mandate. These are steps to be taken in stages towards

making the biofuel industry a success domestically, whilst aspiring to increase greater uptake of biofuel technologies by foreign companies. The strategies are summarized in Fig. 4 below.

One of the key steps highlighted in the implementation strategy above is the ratification of a legislation to provide for the mandatory use of biofuel in Malaysia. This was achieved in 2007 when the Malaysian parliament had sanctioned the Malaysian Biofuel Industry Act of 2007. This is deemed as an extremely crucial step to stimulate the demand-pull for biofuels locally.

4. Malaysian biofuel industry act 2007 (act 666)

The Malaysian Biofuel Industry Act of 2007, or also known as Act 666, is a law that provides for the mandatory use of biofuel, licensing of activities relating to biofuel and for matters connected therewith and incidental thereto [33]. According to this Act, biofuel is defined as any fuel, whether solid, liquid or gaseous, that is derived from biomass, where in biomass refers to any biodegradable fraction of products, waste and residues from agriculture (including plant and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste [33]. The Act 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 Act empowers the Minister charged with the responsibility for biofuel to prescribe the type of biofuel and the volume percentage to be blended into any fuel.

Initially the mandate only allowed for two types of biofuels to be blended into mineral diesel for transport application, those were palm olein and methyl esters of palm-derived fatty acids, or also known as fatty acid methyl ester (FAME) [33,34]. The former (i.e. blend of palm olein into regular diesel), also known as *Envo Diesel*, was later in 2008 revoked from the mandate despite the positive outcomes from vehicle trials by the MPOB (Malaysian palm oil board) due to the fact that vehicle manufacturers argue that the use of such chemistry as biofuels would not be fully compatible with the existing diesel engines in the market [34–36]. Therefore at present only palm derived 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 [36]. However, the implementation of B5 had been delayed several times due to issues concerning logistics, infrastructure cost and blending facilities [36]. According to the then director-general of MPOB, Datuk Dr Mohd Basri Wahid, the Malaysian government at that time was still keen on promoting the use of palm-based FAME domestically, but had considered reducing the concentration to 3% (i.e. B3) instead of 5% since the B5 mandate would cost the government about RM250 million per year in subsidy due to the high price of crude palm oil as well as the extra cost associated with blending and distribution [37]. However, in 2011, the biofuel mandate was successfully rolled out in the Klang Valley region as a blend of 5% into regular diesel.

5. A critique of the National Biofuel Policy

A policy is a form of strategic government intervention. The general role of policy is to provide direction and guide decisions and actions in a particular area [38]. Public policies provide a strategic vision to align supporting functional institutions such as laws, regulations, funding priorities, resource allocations and others in order to advance the policy goals. The formal objectives of the NBP are twofold, those are:

a) Use of environmentally friendly, sustainable and viable sources of energy to reduce the dependency on depleting fossil fuels;
   - ➢ This objective has two distinct features. On the one hand it clearly states that the purpose of the policy intervention is to reduce our dependency on fossil fuels. The second aspect of this objective is that it spells out the characteristics of the fossil substitute. The fossil substitute has to have the attributes of being environmentally friendly, sustainable and viable.

b) Enhanced prosperity and well being of all the stakeholders in the agriculture and commodity based industries through stable and remunerative prices.
   - ➢ This policy is also meant to stabilize the price of agricultural commodities at a remunerative level, which is likely to be achieved by creating a new market and a higher demand for it. The purpose for this is to enhance the economic well-being and the welfare of all stakeholders in the agricultural and commodity-based industry. In other words this is targeted

Short-Term Plan	Medium-Term Plan
•Establish Malaysian standard specifications for the B5 biodiesel. •Participate in B5 biodiesel trials by selected government departments with their fleets of diesel vehicles •Establish B5 biodiesel pumps for the public at selected stations •Voluntary trials on B5 biodiesel by the Malaysian Palm Oil Board (MPOB) for selected users in the industrial sector. •Promote awareness to educate the public on the use of B5 biodiesel.	•Establish Malaysian standard specifications for palm oil-based methyl ester for domestic use and export •Engage engine manufacturers to extend warranties to include the use of B5 diesel. Conduct extensive B5 testing to facilitate granting of such engine warranties. •Pass and enforce legislation to mandate use of B5 diesel. •Encourage establishment of commercial methyl ester plants. The MPOB will act as catalyst by pioneering the establishment of palm biodiesel plants in Malaysia in collaboration with the private sector.
Long-Term Plan •Gradually increase the proportion of palm oil in the diesel blend. •Promote greater uptake of biofuels technology by Malaysian companies and foreign companies abroad.	

Fig. 4. A summary of the short, medium and long term plans of the National Biofuels Policy.

towards improving the socio-economic statuses of all stakeholders involved in the biofuel economy.

From an overall perspective, it is explicit that the underlying motivation for the NBP is to substitute fossil fuel with an agricultural commodity-based alternative. The policy is a government instrument that tries to correct market failures associated with our continued dependency on fossil fuels, which is necessary under present circumstances given the techno-institutional impasse the country, and the world, has gotten into [39]. The introduction of the NBP has been envisioned to lead to an improvement in the socio-economic well-being of all stakeholders in the biofuel supply-chain. The policy aims for fossil fuel replacements that are environmentally friendly, sustainable and viable, where viability encompasses technical and economical practicability. The policy has taken a fairly holistic approach in its objectives in trying to balance between environmental quality, social equity and economic prosperity, consistent with the concept of sustainable development [40]. It is believed, therefore, that the goals of the NBP are satisfactorily sound and appropriate.

Malaysian Biofuel Industry Act of 2007, or Act 666, which contained detailed provisions of the mandate, was passed by the parliament as means to direct the industry towards achieving the policy goals. The following section, therefore, is a critical assessment of Act 666 as means to evaluate its ability to advance the goals of the policy. Here we limit our appraisals of Act 666 from the aspects of sustainability, innovation developments and risks of future techno-institutional lock-ins.

5.1. Issues on sustainability and environmental–friendliness

The National Biofuel Policy clearly envisions the use of sustainable sources of energy to reduce the country's dependency on fossil fuels however the legislated Act 666 does not have a provision specifying the minimum sustainability criteria that a biofuel has to meet in order to ensure that it is sustainable. Although the Act allows for the Ministry responsible for biofuels to specify the types of biomass feedstock, no guidelines have been adopted to date to provide for the definition of environmental-friendliness and sustainability. This is in contrast with other biofuels related regulations worldwide, such as the European Union RED (renewable energy directives), the U.S. Renewable Fuels Standard and the California Low Carbon Fuels Standard, which provides a clear definition and guidelines on the minimum irreducible sustainability criteria that a biofuel has to comply with. This is vital to ensure that the policy goals can be met, otherwise governments risk encouraging the substitution of fossil fuels with alternatives that can potentially have inferior sustainability performances.

The biofuel policy in Malaysia 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. Many scientific studies have concluded that not all biofuels are the same [41,42]; where in fact:

i. two palm-based biodiesels from different plantations and mills can have significantly different environmental performances [43,44]; and in some cases
ii. The GHG emissions intensity of biofuel may even be worse than fossil fuel [29,45]

Hence, the absence of a sustainability element within the Malaysian Biofuel Industry Act 2007, especially when one of the five strategic thrusts of the NBP is to improve the quality of the environment, can be seen as incomplete. 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.

As of June 2014, more than 40% of the oil palm plantations certified by the Roundtable on Sustainable Palm Oil (RSPO) are in Malaysia [46]. The RSPO provides a clear set of sustainability guidelines that were developed through multi-stakeholder consensus to define the practices for sustainable palm oil production. The RSPO standard is quite holistic from a sustainability definition given that the 8 core principles within the standard addresses the legal, economic, environmental and social aspects of the palm oil industry, from oil palm plantation through to the finished palm oil [47]. However, an area of discontent according to critics of RSPO is that the existing standard is relatively loose on GHG emissions [48]. The standard fails to provide clarity on the role of GHG emissions and global warming on palm oil sustainability [48]. This is particularly relevant for biofuels since a biofuel policy is often touted as a possible mechanism to reduce the carbon footprint of the transport sector. Moreover, the RSPO still remains a voluntary standard mainly to serve external markets where there is a stronger pull for sustainable palm oil, and unless a similar pull is created domestically, it is not unreasonable to suggest that non-certified palm oils will end up being consumed locally and therefore creating a perverse outlet for possible irresponsible practices.

5.2. Loss in opportunity for Induced–innovation

The official objectives of the NBP neither specify the exact feedstock-type and biofuel chemistry that can be used, nor the sector that this policy will apply to. The policy however does mention that it is formulated primarily for the promotion of palm-based biodiesel and therefore the entire biofuel policy in Malaysia has been planned around the palm industry. On top of that, Act 666, which is the main policy instrument that is meant to support and advance the policy goals, stipulate that only FAME (fatty-acid methyl ester) derived from palm oil is approved for use at 5% blend into regular diesel. The biodiesel mandate in Malaysia regulates the specific feedstock-source (i.e. palm oil), chemistry-type (i.e. FAME) and the applicable sector (i.e. for diesel use), and therefore provide less freedom for innovative actions by competing firms.

The policy in its existing form is a conventional way of regulating the environment by prescribing mandatory corrective actions, which is often referred to in literature as a “command-and-control” regulation since they allow very limited flexibility in the means of achieving goals [49,50]. A “command-and-control” regulation tends to be “technology forcing”, which is effectively making the adoption of a particular technological solution mandatory, and therefore they tend to slow-down the development of competing and alternative technologies that may be more superior and effective in meeting the policy goals. In the absence of a market-pull for newer technologies, there is no fiscal incentive for firms to pursue alternative technological innovations. Furthermore, the “command-and-control” policy framework does not provide an incentive for competing firms to outdo each other by offering advantages that are above and beyond the mandatory targets and therefore the policy loses out on the opportunity of bringing about greater benefits.

In contrast to the “command-and-control” policy concept is the market-based approach [49,50], or also sometimes referred to as the economic-incentive approach [51]. The market-based approach encourages behaviour through market signals rather than through

explicit directives, and these employs policy instruments such as pollution charges, subsidies, or some target setting which then allows for individual firms to decide based on best available low-cost technologies [50,51]. Such policy instruments would harness market forces and induce innovations resulting in diverse technological solutions that compete on technical and cost viabilities.

The fact is that competing multinational firms are already investing in R&D in a race to diversify their technology portfolios and commercialize modern and more cost-effective solutions. By adopting a command-and-control policy approach that has specifically prescribed the mandatory use of palm-derived FAME, Malaysia is closing its doors to the possible inflows of modern alternative technologies and knowledge that are, in a globalised world, intrinsically and internationally mobile [52]. The transfer of knowledge and technologies from other countries into Malaysia can be facilitated by the NBP if it provides incentives for multinational firms to adopt best available low-cost technology from these developed economies and apply it in Malaysia. The NBP in its current closed form, however, is biased against the entry of novel and modern technologies.

5.3. Risk of future techno–institutional lock–in

In preparation of the nationwide roll-out of palm-based biodiesel as per the NBP, a lot of the logistic issues are being resolved. Existing infrastructures such as blending facilities will need to be upgraded so that it can cope with this new mandate and often this will require intensive capital investment. A total of RM200 million has been allocated by the government for the set-up of blending facilities nationwide [53]. Once major capital investments are made and logistical arrangements are specifically organized to support the commercial introduction of palm-based biodiesel, there is a risk that the entire system will gradually evolve through continuous improvement to cater specifically for a palm-based biofuel system and therefore making it difficult for the future replacement of palm biodiesel with other alternatives. In fact the worldwide dependency on fossil fuel has been a result of similar techno-institutional complex which is now hard to unlock due to the massive interlocking between the various technologies, socio-economic systems, legal frameworks and other institutional conditions that were specifically designed to support a fossil-based economy [39,54]. As Malaysia prescribes the mandatory use of palm-derived FAME in the B5 mandate, with time, the industry will go through the learning curve and similarly there will be other sources leading to increasing returns to scale thereby exacerbating the technology lock-in. It is possible that as the government encourages the diffusion of a particular technology, it eventually becomes so entrenched in the market place that it is hard to be displaced in the future. Hence it is important for policies to be as technology neutral as possible [51].

6. Tenth Malaysia plan (2011–2015) and the ETP

Subsequent to the passing of the Malaysian Biofuel Industry Act in 2007, several other initiatives were introduced as part of the Malaysian economic development scene which is directly, and indirectly, relevant to the palm oil industry given its key position in the national economy. Two initiatives in particular are the Tenth Malaysia Plan and the ETP (economic transformation program).

In the newly announced Tenth Malaysia Plan (2011–2015), twelve national key economic areas were identified as drivers of economic activity that has the potential to directly and materially contribute a quantifiable amount of economic growth to the Malaysian economy [55]. These imperatives are required in order to achieve a high income nation by 2020. One of the key areas of focus is the palm industry which has been marked as potentially a significant contributor towards the projected 2020 gross national income per capita that is required for Malaysia to be a high income nation [55].

It can be expected, therefore that a lot more public and private funding and effort will be directed towards further developing and expanding this industry in the context of Malaysia's ETP (economic transformation plan). Thus far, eight EPP (entry point projects) relating to the palm industry have been identified to provide an incremental GNI growth of RM 47.1 billion as part of the ETP. These are split into upstream and downstream activities and have incorporated elements of productivity increase, industry expansion and sustainability improvements.

Traditionally plantation companies view upstream activities as the core of their business. This represents a share of more than 80% of the total palm oil export value. The downstream non-food segment however accounts for 14.5% while the food and health-based industry accounts for only 4%. Malaysia's ETP has underlined 8 key areas to drive the growth of the industry through upstream and downstream activities as means to in-sector diversification. For the upstream sector, the focus is primarily on productivity and sustainability improvements. Upstream expansion will be limited by land availability and so productivity here refers to plantation intensification as opposed to extensification as means to efficiency gains. The downstream sector at present is still a niche area but with a large growth potential. Therefore the theme for the downstream sector is more focused on industry expansion and the creation of a new industry such as the commercialization of second generation biofuels. Details of these eight elements of the palm oil transformation plan are summarized below.

6.1. Upstream productivity and sustainability

6.1.1. Acceleration of oil palm replanting

Oil palm trees typically mature after about 25 years, following which the yield will gradually decrease and serve as an impetus for oil palm operators to replant. However, new oil palm plantations will take about 3 years before the first harvest can be exploited and thus represents a period of no economic gains. The focus on short-term economic gains has been a deterrent for many plantations to replace existing crops with newer ones. This is especially the case with the smallholders and particularly during high CPO prices. As a consequent of this delay in replanting, a large area of oil palm cultivations in Malaysia are in the stage of declining yield. If the backlog in oil palm replanting is not addressed sufficiently quickly, it can lead to a lower national productivity especially in the future when more plantations reach the maturity age. This EPP is a three prong approach involving the implementation of a binding replanting policy for all plantations, the provision of financial support targeted to independent smallholders and to make available quality planting materials (e.g. seeds). MPOB has the duty of managing all these whilst at same time monitoring the age profile of plantations in the country.

6.1.2. Improving FFB (fresh fruit bunch) yield

It was highlighted earlier that the average oil palm yield in Malaysia is not optimized especially amongst the smallholders. This lower yield achieved signifies a loss in possible revenue for the plantation operators and the nation. Hence, this EPP aims to boost the average yield to 22 tonnes per hectare for independent smallholders, 26 tonnes per hectare for organized smallholders and 28 tonnes per hectare for the plantation sector by 2020. This represents a 25% increment in the national average yield to 26.2 tonnes per hectare. This will be achieved through a series of initiatives such as to group neighbouring smallholders into cooperatives to ease sharing of industry best practices which will be made

mandatory nationwide and to enable greater administrative and trade ability. In addition, MPOB will expand their counselling and guidance services by recruiting more counsellors (known as Tunas officers) and assigning them to the various smallholder clusters as advisors.

6.1.3. Improving worker productivity

A common issue facing the plantation industry is the shortage of skilled and unskilled workers and their over-reliance on foreign workers. The fact is that the industry itself is very labour intensive, for example it has been estimated that Malaysia relies on manual labour for 75% of its FFB (fresh fruit bunches) collection process, which represents approximately one worker for every 15 ha. This EPP will increase mechanization as much as possible by promoting the increased adoption of a motorized harvesting pole (known as Cantas™), the use of diamond sharpening tool and the switch from manual collection to buffalo-assisted collection system. These would lead to improved harvesting efficiency.

6.1.4. Increasing OER (oil extraction rate)

The objective of this EPP is to increase the OER (oil extraction rate) from the oil palm fruits to 23% by 2020 from the present OER of 20.5%. This significant growth potential was derived from the fact that currently there exist large variations between mills due to inconsistency in input FFB quality and inefficiency of older milling machines particularly those owned by the independent millers. Here MPOB will again play a critical role by deploying their officers to underperforming or deteriorating mills to get their process rectified. One of the rectification plans include to ensure robust FFB acceptance screening process so that fruit bunches that are rejected by one mill are not accepted by another. However, this will need to be carefully managed alongside the EPP relating to the improvement in FFB yield highlighted in point "II" above so that the oil palm produce itself is of utmost quality. A mechanism will have to be put in place to ensure the there are outlets for the lower quality FFBs otherwise possibly creating a supply glut that may lower the price of these "rejected" FFBs substantially to make it economically more attractive for use by the mills at the expense of the national OER target. An important point to note is that the national OER level is resultant of the average mill conditions and fruit quality in the country. Whilst it is good to have a target for future OER level, it is equally important to ensure that the pursue of the target is done by placing more emphasis on raising the overall performance of the industry and not by discriminating against plantations that produce lower quality fruits, which are mostly the disadvantaged smallholders. Initiatives must therefore focus on improving the quality of the fruits and increasing the efficiency of the mills, thence OER enhancements will naturally follow.

6.1.5. Developing biogas at palm oil mills

This is an important area for the palm oil industry which is heavily linked to global warming. Conventionally, the processing of FFBs produce effluents, also known as POME (palm oil mill effluents), that upon treatment and prior to discharge leads to the production and release of methane gases due to the anaerobic decay of organic matters. Methane gas is approximately 25 times worse than carbon dioxide in trapping heat in the atmosphere which is responsible for global warming. This has given the industry a negative image over the years, and at present only 17 out of more than 450 mills in Malaysia are equipped with methane capture (also referred to as biogas capture) technology. The captured methane gases can then be used to produce bio-electricity or renewable electricity to complement the national energy balance. The success of this initiative will lead to several favourable outcomes for the industry and nation, such as additional income stream for the mill operators from the sale of electricity, lower global warming impact associated with palm oils hence better brand image and easier access to export markets with strict GHG requirements, and finally diversification of Malaysia's energy mix and a shift to renewable sources.

6.2. Downstream expansion and sustainability

6.2.1. Developing Oleo Derivatives

Currently Malaysia's downstream non-food segment is focused on the manufacturing of basic oleochemical products which are consumed by a variety of industries. However, the capacity for production of these basic oleochemicals is higher than there is demand globally for it. Based on demand projections, the situation is not expected to change substantially in the coming years. Given that these products also have low profit margins, it is desirable to expand the industry by growth in the higher value-added sector, which at present represents a small 1% of the total palm oil non-food downstream segment. These higher value oleo derivatives have much higher profit margins too. Initiatives here will include encouraging foreign investments, incentivize domestic companies to establish plants through joint ventures and exploit synergies with petrochemical companies. The EPP, through MPOB, will also provide support to existing local players in this arena to expand their production.

6.2.2. Commercializing second generation biofuels

This element is of particular interest as it is very germane to the discussion in this paper. The EPP here aims to accelerate the production of new generation biofuels derived from waste residues from the oil palm plantations. This is a high potential area for Malaysia since the industry is known to produce large quantities of wastes and residual biomass that can be exploited for the production of bioenergy, but which currently are not optimally utilized [56]. The industry in 2009, for example, had generated over 60 million tonnes of biomass in the form of empty fruit bunches, tree fronds and trunks, which under contemporary practices, are used as composts and mulches. These biomasses are sources for renewable energy and since they are produced from wastes and residues, they typically offer significantly higher GHG emissions savings over conventional resources, and on top of that they do not compete with the food industry and therefore avoid the food versus fuel debate. These renewable energies can be used for electricity generation or if processed further can be a good substitute for the transport fuels sector, not just for domestic use but also for the export market. The country's leading global position in the oil palm agricultural sector has given the nation a relative advantage over other countries. However, experiences in other countries have shown that the sluggish commercialization rate of such technology is due to a lack in economic feasibility, especially in the absence of any government support and incentives. This is also the case in Malaysia [56]. Looking at the scenario in Malaysia, there need to be some form of incentives to attract investments into this area. The lack of a demand pull for such technology can slow down the pace of technology development and deployment. Government policy will have to provide the initial support for the industry to take off where through economy of scale and learning curves the cost can be brought down to a more manageable level. The existing National Biofuel Policy, as has been argued above, is very prescriptive in nature which is a bane for inducing innovation. A market oriented policy is needed to stimulate technological development and deployment.

6.2.3. Expediting growth in food and health-based downstream segment

Whilst the EPP "Developing Oleo Derivatives" highlighted above will focus on growing the high value non-food segment of the

industry, this project entails the acceleration in growth of the downstream food and health based sector which currently constitutes only 4% of the total palm oil export value. There is untapped growth potential in this given that most home-grown players in this industry are either large companies who play the role of silent joint venture partners or small and medium enterprises with limited expertise. Two approaches will be taken for this. One is to grow the industry through acquisition of established foreign companies which will be promoted through tax incentives. The second approach is to encourage major plantation companies to grow organically while simultaneously outsource certain aspects of their manufacturing processes to local small and medium enterprises. This will initially be led by Sime Darby and Felda.

It is believed that the Economic Transformation Programme has created a neat strategy for growing the industry. The program clearly creates a distinction between the needs of the upstream and downstream segments and identifies the key drivers for the respective sectors. The link between the ETP and the National Biofuel Policy is mainly through the projects identified for increasing the upstream productivity and sustainability. The successes of these upstream enhancements will lead towards more palm oil commodity being made available. The impact on domestic biofuels market is uncertain. However, with the ever increasing awareness and global pressure for greater sustainability standards, it can be argued that oil palm developments that do not take into account of improved sustainability practices could potentially lead to the global market to shun away from unsustainable palm oils and therefore forcing the domestic markets to absorb the commodity surpluses, if any, for use as biofuels amongst others. Since an oil palm plantation cycle is typically about 25 years, it is very important that replanting and new plantation schemes now take into account of the possible needs of the future in an effort to make sustainable palm oil the norm. This is consistent with the Brundtland's concept of sustainability which requires sufficient foresight. The proposed projects under the ETP could lead to overall gains in sustainability, in particular the initiative relating to upstream productivity enhancement that could reduce the pressure for more land and thus control plantation expansion into forests and peat lands.

7. Final thoughts

In the Tenth Malaysia Plan (2011–2015) the government of Malaysia announced the New Energy Policy which is aimed at strengthening the energy supply by means of creating a more competitive market and a gradual reduction in energy subsidy. These will be driven by the five strategic pillars that have been identified as follows:

a. Rationalising energy pricing gradually to match market price, taking into account current economic condition and affordability of the people;
b. Undertaking a more strategic development of energy supply by diversifying energy resources, including renewable energy resources. Nuclear energy will also be considered as an alternative source of energy;
c.Accelerating the implementation of energy efficiency initiatives in the industrial, commercial, residential and transport sectors;
d. Improving governance to support the transition to market pricing, while providing assistance to mitigate impact on the low income group;
e. Ensuring that the New Energy Policy is implemented based on an integrated approach and according to schedule to achieve energy supply security.

The New Energy Policy further drives the message that current energy subsidy is not sustainable in the long run and there is a need for gradually reducing the subsidy so that the price eventually matches market level. Government subsidy can be a good or a bad thing depending on how it is managed and which goods it is allocated to. Subsidy creates a market distortion and therefore Malaysia has to be careful that the distortion is sending the right message to the market. A prolonged subsidy on energy, as is the case in Malaysia, sends the message that energy is cheap and thus is a perverse incentive against efficient utilisation. On top of that, energy subsidy can hamper the development and successful deployment of substitutes since the economic viability of the substitute will be benchmarked against the market dominant product, in this case fossil fuel, which has been made artificially cheaper and therefore alternative energy will appear unattractive. As a result, alternative and renewable energy will struggle to compete in a distorted market system since fossil fuel has the unfair advantage of lower price on top of economy of scale, experience gained through the learning curves and other institutional systems that create a lock-in condition. The removal of subsidy therefore is a good initial step for Malaysia to become more competitive in its energy landscape and the step-by-step removal is necessary to prevent a sudden price hike that can lead to general price inflation in the country.

Subsidy however can be a useful tool when trying to promote the initial adoption of new technology. Here it is believed that renewable energy would benefit from some form of short-term subsidy to incentivise and catalyse technological development, deployment and adoption. It is important though that the subsidy is not kept for too long such that it becomes too entrenched with the product that it creates contentment.

The planned gradual reduction of energy subsidies to reflect actual market conditions would mean that energy prices would be more susceptible to global price volatility. In such situations, it can be suggested that domestically produced renewable energy will play an increasingly important role to balance the energy mix portfolio to minimise risk to the nation's energy supply system as well as to cushion the impact of sudden oil price hike. The transport sector will be most exposed since it is the biggest energy consuming sector and which is expected to consume even more in the future. Hence, the role of the National Biofuel Policy will be ever more important.

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