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Highlights

- Extend the FiT bandwidth capacity restrictions to all of the eligible renewable technologies under the FiT systems.
- Differentiate the tariff level by considering the location and local conditions of the plant site.
- Modify the revenue streams from the renewable fund.
- Revise the quota system.
Generating renewable energy from oil palm biomass in Malaysia: The Feed-in Tariff policy framework

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ABSTRACT

The renewable energy (RE) industry in Malaysia began in 2001 in the context of the growing concern about future depletion of conventional fuels and the global environmental concerns about greenhouse gas emissions. The Small Renewable Energy Power Programme (SREP) is a tool that was first designed to drive the development of the industry based on the abundance of oil palm biomass reserves and other identified renewable energy resources. Due to the slow uptake of this scheme, a new system, the Feed-in Tariff (FiT) was introduced in 2011 to stimulate the industry. By considering the deficiencies of the previous scheme, this paper examines the sustainability of the FiT policy framework in steering the future expansion of small-scale biomass renewable energy businesses in Malaysia. Resulting from the evaluation of the current policy settings and a market based appraisal, this work outlines strategies for enhancing the scheme and suggests future studies aimed at improving the flaws in the present system.

1. Introduction

The International Energy Agency (IEA) in its New Policies Scenario predicts that the world energy demand is expected to continue to increase annually by about 1.2% from 2008 to 2035, with 70% of the demand coming from the developing countries [1,2]. This increase will be largely (87%) met by energy derived from finite, non-renewable fuel sources [2].

While the demand for energy is predicted to continue to rise for the next few decades, energy security is becoming a serious issue, as traditional fuels are non-sustainable and are fast diminishing [1,3]. The IEA [2] attributes the rise of the total global energy demand to the expected growth of the world population and global economic expansion. As an approach to alleviate the problems associated with the current methods of energy production, Ong et al. [4] assert that an energy mix is the best alternative for security of supply and to protect the country from external issues. Renewable technologies therefore are a good option, but they must be appealing to the market, cost-competitive and supported by a significant policy framework and resource base.

The use of renewable energy sources continues to grow strongly and has begun to replace fossil fuels and now provides 16% of global final energy consumption in 2009 [5]. The share of the market provided by mature renewable energy technologies, including wind, photovoltaics and biomass, is projected to climb from 19% in 2012 to 46% or about...
19,000 TWh (terawatt hours) in 2050 [6]. Biomass is expected to become the most prominent renewable energy source with a four-fold increase to 23% of total world primary energy by the year 2050. Interestingly, agricultural crops and forest residues are predicted to generate about half of the 15,000 million tonnes of biomass around the globe [6].

In Malaysia, oil palm biomass power stands out as a promising technology for contributing to a more sustainable clean energy market. Nonetheless, the renewable technology can only be lifted to a greater height with strong policy support. Unfortunately, the former Small Renewable Energy Programme (SREP) mechanism failed to increase the share of biomass projects, thus affecting the overall national renewable energy capacity target. The past policy drawbacks provide useful lessons for the country to avoid such mistakes in formulating future energy policy.

Thus, this paper aims to examine and identify the areas that require more attention in order to ensure that the current renewable energy policy framework is socio-economically sustainable and reliable to drive the industry forward. Results from this policy investigation are expected to outline the strategies to improve the FiT system and identify potential research areas for future studies. This is achieved by conducting an assessment of the strengths and weaknesses of the policy settings which pave the way for understanding the essence and character of the present system. Apart from the evaluation of the secondary source materials, particularly the government reports and industry-related academic publications, the lead author’s vast experience in energy policy making provides valuable insight about the industry and the governing legal framework.

Realising the Malaysian FiT scheme is relatively new, the authors are aware that there is very little published literature or peer-reviewed academic research to examine its sustainability in supporting industry development. Most of the existing studies focus on common issues that impede the growth of the renewable energy industry in Malaysia, including a recent publication that examines the overall performance of the SREP [7]. Hence, this paper aims to fill that gap.

This paper is organised in 5 sections. It begins with an overview of enabling factors that catalysed the growth of the renewable energy market in Malaysia (Section 2). These include the future energy demand, influence of domestic economic growth towards energy consumption and the competitive advantage of the oil palm sector, which has a direct impact on the development of the oil palm biomass renewable energy industry. Section 3 provides a snapshot of the renewable energy policy systems which shape the industry landscape. The forward strategies are presented in Section 4 after an extensive discussion of the strengths and weaknesses of the FiT system. Section 5 summarises the key findings and conclusions of this work.

## 2. Enabling factors

### 2.1. Future energy demand

Crude oil supply is expected to exhibit a downward trend as part of the global primary energy mix towards the year 2035. This is a result of resource depletion and associated fluctuations in the global oil market price and government policies in favour of low carbon energy sources. Chuah et al. [8] anticipate that other energy sources, such as natural gas and modern renewable energy (including biomass sources), will expand to fill the gap in global energy demand. The global demand for both of these sources is forecasted to rise by 44% and 16% respectively, between 2008 and 2035 [2]. As for Malaysia, it is fortunate to be blessed with plenty of energy resources in the form of oil, natural gas and renewable sources [4].

Notwithstanding, like other economies, Malaysia is over-dependent on hydrocarbon sources for its power sector and these are vulnerable to externalities such as global market volatility and the gradual exhaustion of these traditional resources. The record indicates that within 14 years from 1995 to 2009, electricity generation in Malaysia has increased by 154% while annual electricity consumption has risen by 9.2% [9]. Based on the business-as-usual (BAU) scenario, the final energy demand (referring to the quantity and types of energy that are delivered to the final user) is projected to grow at an annual average rate of 4% and to reach a maximum demand for electricity of 23,088 MW by 2020 [1]. The upward trend of electricity demand over recent years can be observed in Table 1, with a steep rise from 11,833 MW in 2002 to 16,332 MW in 2010 or more than 38% increase [3,9]. Unfortunately, about 94.5% of electricity production in Malaysia is derived from the combustion of carbon based fossil fuels [9].

As such, the escalation in energy consumption, conventional fuel market price uncertainty and global climate change obligations explain the urgent need for more green solutions to replace large-scale power generation plant and produce reliable power. Concerted efforts to reduce emissions should complement a commendable public policy to move the country away from dependence on a single source of energy. On the other hand, Malaysia is 34% more energy intensive than other peer countries and this indicates the need for a more balanced and diversified supply and demand side energy management.

### 2.2. Economic growth

It is common for industries to grow in size and capacity as a consequence of the economic growth of the nation. Over the years, Malaysia has enjoyed steady and robust economic growth. According to EPU [10], the Malaysian GDP is forecast to record an upward trend over the period of 2011–2015 with an average annual growth rate of 6%. The GDP growth during this period will be driven by the services sector (7.2%), manufacturing sector (5.7%), agricultural sector (3.3%) and construction sector (3.7%). As shown in Table 2, the agricultural sector contributes a 5.6% share of the country’s GDP,
which comes after the services sector (61.1% of GDP) and manufacturing sector (26.3% of GDP) [10].

On the regional stage, Malaysia has experienced strong economic growth in recent years. Now it is among the fastest growing emerging economies in Asia with an economic growth rate averaging over 8% between 1970 and 1980 and 5.2% from 1980 to 1990 [11]. Beyond 1998 the annual GDP growth of most the Asian economies, including that of Malaysia, declined to an average of 4.3% per annum, due to the chaos of the Asian Financial crisis. Malaysia’s GDP grew at an average rate of 9.2% during the 1991–1997 period, surpassing most of the industrialised economies in Asia (Table 3). Since 2001 the Malaysian economy has continued to grow at a more modest rate of 4.3% per annum, which is similar to that of other ASEAN countries.

As part of its wider economic transformation plans, to move away from low value to high value industries, Malaysia, during the 9th Plan had established five economic clusters which include: the Iskandar Malaysia corridor in Johor; the Northern Corridor Economic Region (NCER), which covers the states of Kedah, Penang, Perlis and part of Perak; the Sarawak Corridor on Renewable Energy (SCORE) that is concentrated in Sarawak; and the Sabah Development Corridor (SDC) in Sabah [10,13]. These economic areas are designed to be the key engines of growth to promote balanced regional development based on the common resources available. The map in Fig. 1 depicts the newly-developed economic corridors in Malaysia which will spearhead the economic development of the country over the next 5 years.

Under the 10th Plan, the future economic landscape of Malaysia is built on the Economic Transformation Programme (ETP) and the New Economic Model (NEM) [12]. This tremendous economic structural reform would reinforce the momentum of future economic growth towards achieving a progressive and high income nation by the year 2020 [11,12]. The blueprints provide a basis for enhancing Malaysia’s economic profile by focusing on 12 key growth engines or the National Key Economic Areas (NKEAs). More interestingly, the oil, gas and energy sector is recognised as one of the main components in the roadmap, contributing a significant share of 16% of the Gross Domestic Product (GDP) in 2000 to about 19% in 2009.

These comprehensive economic reforms will greatly influence Malaysia’s long term investment patterns. Increased economic intensity will produce a need for a reliable, high quality and cost effective energy supply [3,14]. When the entire ETP planning comes on stream, the energy demand growth especially in residential, manufacturing and transportation sectors is projected to escalate. A work by Lean and Smyth [11] finds that over the coming years the demand for energy in Malaysia will surge at a rapid pace, proportional to the growth of industries. In addition, Gan and Li [15] predict that energy use will increase three-fold by the year 2030. The diversification of energy sources is therefore crucial and Malaysia will need to replace fossil hydrocarbon sources in order to accommodate the increase in energy demand across all sectors of the economy.

### 2.3. Competitive advantage of the oil palm sector

According to Tan et al. [16], the world demand for vegetable oil is rapidly increasing in tandem with vast economic and population growth in developing countries as well as the urbanisation trend. By volume, oil palm accounts for 41.31 million tonnes of the total world consumption of major vegetable oils, overtaking soybean, rapeseed and sunflower seed oil with 41.28 million tonnes, 18.24 million tonnes and 9.91 million tonnes respectively in 2008 [17]. The global oil palm demand is expected to continue growing and reach 256 million tonnes CPO/year by the year 2050 [18].

At an international level, Malaysia is recognised as the world’s second largest producer and the largest oil palm exporter with 17.7 million tonnes or a 41.3% share of the total world oil palm production in 2008 [17,19,20]. In the last two consecutive years 2011 and 2012 the statistics indicated that the country exported 17.99 million tonnes and 17.58 million tonnes of oil palm oil.

### Table 2 – Gross domestic product (GDP) by sector in Malaysia for 2011–2015 [10].

<table>
<thead>
<tr>
<th>Sector</th>
<th>Annual growth (%)</th>
<th>Share of GDP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services</td>
<td>7.2</td>
<td>61.1</td>
</tr>
<tr>
<td>Manuf.</td>
<td>5.7</td>
<td>26.3</td>
</tr>
<tr>
<td>Constr.</td>
<td>3.7</td>
<td>2.1</td>
</tr>
<tr>
<td>Agric.</td>
<td>3.3</td>
<td>5.6</td>
</tr>
<tr>
<td>Mining</td>
<td>1.1</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Fig. 1 – The five economic corridors in Malaysia [13].

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**Table 3 – Gross domestic product (GDP) of Asian economies, 1991–2009 [12].**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>11.5</td>
<td>10.3</td>
</tr>
<tr>
<td>Malaysia</td>
<td>9.2</td>
<td>4.3</td>
</tr>
<tr>
<td>Singapore</td>
<td>8.6</td>
<td>4.2</td>
</tr>
<tr>
<td>Vietnam</td>
<td>8.3</td>
<td>7.3</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>7.5</td>
<td>3.9</td>
</tr>
<tr>
<td>Taiwan</td>
<td>6.7</td>
<td>3.1</td>
</tr>
<tr>
<td>Indonesia</td>
<td>6.9</td>
<td>5.1</td>
</tr>
<tr>
<td>Thailand</td>
<td>6.7</td>
<td>3.9</td>
</tr>
<tr>
<td>India</td>
<td>5.3</td>
<td>7.2</td>
</tr>
<tr>
<td>Philippines</td>
<td>3.1</td>
<td>4.4</td>
</tr>
</tbody>
</table>

**Table 3**}
tonnes of oil palm respectively to more than 100 countries all over the world with an average of 2.1 million tonnes supplied to 24 European Union (EU) economies [21]. The bar chart in Fig. 2 illustrates the strong domination of the industry by Malaysia and Indonesia, as the major global oil palm producers in the year 2008.

Despite the environmental controversy, Malaysia has committed to the international agreement during Conference of the Parties (COP) in Rio de Janeiro, 1992 and reiterated at COP15 in Copenhagen 2009, to keep 50% of its land as forested areas. Through sustainable forest management, in 2007 the country remains covered with 18.30 million hectares (or 55%) of natural forest with 4.69 million hectares (or 14.9%) of its land used for oil palm cultivation activities [22]. More interestingly, Malaysia continuously stands among the most highly forested countries in Southeast Asia and the world [22]. In order to maintain consistent growth of the oil palms, while mitigating environmental degradation and minimizing land use change (LUC) due to uncontrolled deforestation, the industry is replacing low value crops with other export commodities including of oil palm crops [19,23]. Moreover, the plantation growth of prominent crops like oil palms follow sustainable practices, including the utilization of idle agricultural land and optimization and certification systems [22].

High productivity and effective land use are part of the sustainable development strategy for the industry expansion. In comparison, the annual production cost of oil palm in Malaysia was twice as cheap as the production cost of other major vegetable oils like rapeseed oil in Europe and soybean oil in the United States of America (USA) with a cost of USD239/tonne compared with USD400/tonne and USD459.90/tonne respectively in the year 2001 [24]. In regard to agricultural land use, oil palm cultivation occupies less than 4.74% of the world’s agricultural land, but represents 33.6% of the total global market share of vegetable oils [19]. In contrast, its competitor soybean and rapeseed utilise 42.50% and 12.25% of cultural land and optimisation and certification systems [22].

The massive expansion of this domestic agricultural industry holds great promise for the future large commercial scale biomass-based energy generation. It is important to note that the capacity projection under the FiT has considered market trends in the world oil palm demand and therefore does not affect future global oil palm supply. With regard to the oil palm waste generation, it has been noted that the industry produces an average of 53 million tonnes of residues per annum in recent years [25]. Nevertheless, a study by the Agensi Inovasi Malaysia (AIM) reports that the oil palm sector produced about 80 million dry tonnes of biomass in 2010 and the amount is projected to reach 100 million dry tonnes by 2020. Depending on the efficiency of the technology installed, about 3.5–9 million dry tonnes of biomass could be mobilised to achieve the generation capacity targets for 2015 and 2020 as set for the FiT scheme [27]. Overall, biomass from the oil palm plantations accounts for 85.5% of the total biomass that is available in the country [3]. Theoretically, these data would suggest abundance and sufficient fuel supply in the market, and thus it would become more appealing to catalyse development of the oil palm biomass renewable energy industry. Fig. 3 shows a pie chart of the percentages of biomass share from various industries in Malaysia.

Domestically, the oil palm industry is one of the key agricultural activities, which rank it as the fourth largest contributor to the Malaysian economy with an 8% contribution to the total national Gross Net Income (GNI) per capita or 7% of the country’s GDP [12]. About 51% of the plantations are concentrated in Peninsular Malaysia (West Malaysia) and an estimated of 49% are located in East Malaysia [25]. The latest available data indicates that Malaysia has 4.7 million hectares in oil palm plantations, with 417 mills, 43 crushers, 51 refineries, 18 oleo chemicals plants and 25 biodiesel plants. The industry utilises 71% of the total agricultural land bank, and thus it is the main driver of the country’s agriculture sector [12].

Over the decades, Malaysia has experienced a steady and robust growth of its oil palm industry. Since 1980, the total oil palm production has sharply increased from 2.6 million tonnes in 1980 to 17.8 million tonnes in 2009, while exports have climbed from 2.3 million tonnes in 1980 to 13.7 million tonnes in 2007 [12]. Table 4 shows the crude oil palm production and export trends in Malaysia between the years 1980–2009. The steady growth is likely to continue, reaching 20.6 million tonnes in 2013 and 21.5 million tonnes in 2015, in response to the increasing global demand for vegetable oil [19].

The table below illustrates the trend in crude oil palm production and exports from 1980 to 2009 for Malaysia [19,26].

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (million tonnes)</th>
<th>Export (million tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>2.6</td>
<td>2.3</td>
</tr>
<tr>
<td>1990</td>
<td>6.1</td>
<td>5.7</td>
</tr>
<tr>
<td>2000</td>
<td>10.8</td>
<td>9.1</td>
</tr>
<tr>
<td>2005</td>
<td>14.9</td>
<td>13.5</td>
</tr>
<tr>
<td>2006</td>
<td>16.5</td>
<td>14.4</td>
</tr>
<tr>
<td>2007</td>
<td>14.0</td>
<td>13.7</td>
</tr>
<tr>
<td>2008</td>
<td>17.7</td>
<td>NA</td>
</tr>
<tr>
<td>2009</td>
<td>17.8</td>
<td>NA</td>
</tr>
</tbody>
</table>

The table below illustrates the trend in crude oil palm production and exports from 1980 to 2009 for Malaysia [19,26].
Eventually, piles of oil palm biomass resources for generating clean energy can only be fully capitalised with support of a strong and sustained policy environment. Without a reliable policy framework, the industry would not have the confidence to expand and sustain production at the desired level.

Fig. 3 – Biomass share from various industries in Malaysia [3].

3. Malaysia’s renewable energy policy

As a background, Malaysia embraced the renewable energy business in 2001 when the Fifth Fuel Diversification Policy was introduced as one of the major policy components in the 5 year development program, the Eighth Malaysia Plan (2001–2005). Besides aiming for reliability and optimising energy security, this policy document contained measures to protect the country from the adverse impact of the volatility of energy prices and overdependence on traditional fuel sources including oil, gas and coal [1,28]. The main focus of this policy framework at that time was to increase the share of renewable energy in the power supply by encouraging small-scale renewable power producers to generate electricity from sustainable sources and feed their excess power to the main grid. Due to poor performance [10], the policy direction for the industry has undergone a major overhaul in order to address inadequacies of the previous system.

Fig. 4 shows the policy timeline and the revised capacity target since its inception in 2001.

Two major policy initiatives to foster the development of the industry are discussed below.

3.1. The Small Renewable Energy Power (SREP) Programme

The Small Renewable Energy Power (SREP) portfolio was embedded in the 5th Fuel policy and had been conceived as the main vehicle to navigate the industry forward [29]. Without the backing of any detailed policy analysis, the system envisaged a 500 MW or 5% capacity share in the energy mix by 2005, while six (6) renewable resources consisting of biomass, biogas, municipal waste, solar, wind and mini-hydro were identified to spearhead the industry [3,9]. To coordinate the program, an ad-hoc Special Committee on RE (SCORE), was created to oversee the development of the industry.

After years of operation, the scheme achieved only a low response from the market players. Responding to this discouraging situation, the capacity size of the renewable share in the energy mix was trimmed down to 1.8% for the Ninth Malaysia Plan (2006–2010). Even after this revision, the final capacity share remained low with only 0.4% of the country’s total electricity generation coming from renewables in 2010 [30]. Overall, the final grid-connected capacity under the SREP regime ended up at 65 MW, which is certainly far behind the original capacity target of 350 MW envisaged early in the 9th Plan (2006). Biomass residues, particularly from oil palm plantations, contribute the most with 40 MW of grid-connected capacity [31,32], outweighing other renewable resources as shown below:

- 4.95 MW of biogas;
- 12.5 MW of small hydro;
- 5 MW of solid waste sources; and
- 2.5 MW of solar sources.

Sovacool and Drupady [7] in their assessment attribute the low success rate of the SREP scheme to unattractive connection price to the grid, irregular biomass supply, the low efficiency of combustion technology, the poor supporting systems (including interconnection infrastructure), institutional fragmentation, obstacles to securing funding from financial institutions and other utilities’ non-compliant procedures. The government reports [10,30,33] confirm these barriers which prevent extensive deployment of renewable technologies and subsequently contribute to the shortfall from the national capacity target during these plan periods.

A decade period for promoting this high cost business is a short learning curve for a carbon fuel dependent country like Malaysia. Less experience and being a new entrant in the
renewable industry exposes it to many impediments that need to be rectified.

3.2. The Feed-in Tariff (FiT) system

The National Renewable Energy Policy and Action Plan 2010 is the main policy document that points to the need for legislative solutions if Malaysia is to increase the renewable share in its energy mix [9,33] while reducing carbon emissions. The country has recently enacted two legislative mandates; these are the Renewable Energy Act 2011 and the Sustainable Energy Development Authority Act 2011. The FiT system, which commenced on 1 December 2011 emerges as the main tool and central component to intensify future expansion of the renewable energy industry. Under the scheme, the utility is legally bound to purchase electricity generated from any of four identified indigenous resources (biomass, biogas, small hydro and solar photovoltaic) at a fixed rate and duration stipulated in the law [34]. A guaranteed capacity payment is paid to the FiT energy developer for every kilowatt hour (kWh) exported to the main grid. All manual and web-based submissions for a new entry are evaluated by the Sustainable Energy Development Authority Malaysia (SEDA), the governing body entrusted to administer and manage the FiT system in the country [32]. As one of the countries which has a regulated electricity market, the source of funding for the FiT is limited to a fixed percentage imposed on the utility’s electricity sale revenue. To overcome cash flow constraint in the FiT, therefore a different capacity limit or quota mechanism is set every year to ensure there are adequate funds available to pay successful FiT participants. The quota is reviewed every 6 months and any unused capacity is transferred to other renewable resources with higher demand [32].

In terms of capacity target, it is forecasted to grow at an exponential rate from 985 MW (5.5%) in year 2015 to 21.4 GW (73%) by 2050 [33] (see Fig. 5). Most interestingly, the biomass source is projected to dominate the capacity share in the initial years with an estimated 330 MW (33.5%) in 2015 and continues to surge to a significant 800 MW (38.5%) of total power generated from renewable resources in 2020 [9,32]. To reach such a high capacity target from the one achieved in the SREP, certainly demands a strong and consistent supporting system. Despite a major revamp to the energy system, it is crucial to identify and bridge any gaps in the present mechanism. Evaluation of the strengths and weaknesses of the FiT system therefore is necessary to determine its future sustainability.

A summary comparison of these two schemes is presented in Table 5 below.

3.2.1. The strengths and weaknesses of the FiT

There are numbers of strengths and weaknesses observed in the current policy driver. It is imperative to note that the FiT scheme is indeed a radical change from the dismal failure of the SREP mechanism. The system is technically designed to be a major driving force to stimulate changes in the renewable energy system and create market growth [35]. Of all, the most visible improvement in the current scheme relates to the elimination of economic barriers that have long been a stumbling block to the renewable energy market growth; including the capacity generated from the oil palm biomass resources. Detailed examination of the FiT policy reveals a comprehensive revision on the economic structure of the industry, which in turn offers more attractive business opportunities to energy entrepreneurs. The strengths and weaknesses of the FiT are examined by using academic

Fig. 5 – Renewable energy capacity targets for Malaysia, 2011–2050 [33].
Table 5 – An overview of the SREP and the FiT systems.

<table>
<thead>
<tr>
<th>SREP</th>
<th>FIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Administered by an Ad-hoc Committee (Special Committee on Renewable Energy, SCORE)</td>
<td>Establishment of SEDA</td>
</tr>
<tr>
<td>5. Six (6) eligible renewable sources including biomass, biogas, municipal waste, solar, wind and mini-hydro</td>
<td>Four (4) eligible renewable sources including biomass, biogas, solar photovoltaic and mini-hydropower</td>
</tr>
<tr>
<td>6. Low payment structure</td>
<td>A fixed and guaranteed payment scheme</td>
</tr>
<tr>
<td>7. ‘Willing buyer willing seller’ model</td>
<td>Purchase obligation and long term payment contract</td>
</tr>
<tr>
<td>8. Lack of a financial support scheme</td>
<td>Creation of the Renewable Energy Fund and quota system</td>
</tr>
<tr>
<td>9. Maximum exporting capacity 10 MW</td>
<td>Maximum exporting capacity 30 MW</td>
</tr>
<tr>
<td>10. Original capacity target of 500 MW or 5% of energy mix in 2005</td>
<td>Original capacity target of 21.4 GW or 73% of energy mix in 2050</td>
</tr>
</tbody>
</table>

3.2.1.1. Strengths

(i) A fixed and guaranteed payment scheme: comprising basic fees and special bonuses for every identified technology. As for biomass technology, the payment rate rises from USD0.07/kWh (SREP) to USD0.10/kWh (FiT) and the enterprises can expect an extra benefit, up to a maximum of USD0.006/kWh, for any installation of efficient technology at a plant site. Table 6 illustrates that the new energy tariff scheme in Malaysia is almost equivalent to or better than those of other renewable economies;

(ii) Purchase obligations and long term payment contracts (15–20 years): a maximum of 16 years is set for biomass technology. This is important to control and reduce the overall system cost, to increase investment security and to facilitate attractive financing conditions;

(iii) Increase of exporting capacity to the grid: exporting capacity size to the main grid is lifted from 10 MW during the SREP to a maximum of 30 MW for the FiT;

(iv) Creation of a different payment structure: due to economics of scale, the payment structure is based on resource types, on-site technology application, plant commencing date and its capacity. This is to encourage wide range participation, including small-scale players who have small budgets and limited capability to invest;

(v) Establishment of a renewable energy fund: 1% levied from selected electricity consumers is collected to fund renewable energy development. The end users concerned constitute 41% of industry and commercial consumers, while domestic users (with more than 300 units of electricity consumption per month) represent the remaining 18% of the final electricity consumers. This measure will eliminate financial barriers that impede the industry. Table 7 explains the competitive retail price in Malaysia compared with other FiTs in renewable economies;

(vi) Imposing of a quota system by setting a capacity limit for new entries: this will prevent the possible overheating of the market and ensure sufficient funds to cover the entire duration of the FiT period;

(vii) Enforced tariff derogation: an automatic annual reduction of tariff ranging from 0% to 8% depending on the type of renewable resources. Biomass installation is subject to 0.5% annual derogation rate. The fee derogation factor corresponds to the downward trend of renewable energy technology costs over time before achieving grid parity. This component is influenced by technological learning, economies of scale, rationalisation and innovation pressure. The effective period for biomass technology is set for 16 years before it reaches grid parity in 2029;

(viii) Strengthening the institutional framework: After a decade of being administered by an ad-hoc committee, the setting up of the SEDA is another distinctive enhancement to enable more coordinated and systematic diffusion of renewable technology across the country. The body serves as a one-stop reference point to facilitate expansion of the industry. Notwithstanding, apart from executing its role in processing renewable project application and promoting renewable technology [32], it is essential to consider enforcement as one of the major function or area that need more attention.

Table 6 – Comparison of basic FiT tariff in selected economies (USD/kWh) [36].

<table>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas</td>
<td>0.09–0.10</td>
<td>0.06</td>
<td>0.11–0.16</td>
<td>0.07</td>
<td>0.09–0.19</td>
<td>0.09</td>
</tr>
<tr>
<td>Biomass</td>
<td>0.08–0.10</td>
<td>0.06</td>
<td>0.11–0.16</td>
<td>0.07</td>
<td>0.13–0.14</td>
<td>0.09</td>
</tr>
<tr>
<td>Small hydro</td>
<td>0.07–0.08</td>
<td>0.06</td>
<td>0.09–0.17</td>
<td>0.08–0.12</td>
<td>0.12–0.13</td>
<td>0.05–0.06</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0.27–0.39</td>
<td>0.36–0.42</td>
<td>0.33–0.46</td>
<td>–</td>
<td>0.62</td>
<td>0.52</td>
</tr>
</tbody>
</table>

(Notes: Exchange rate on 19 September 2013, 1 USD = RM3.10).
Most importantly, constant enforcement would avoid abuse and manipulation of project licence by a dishonest holder. Since the FiT is still at an infant stage, the effectiveness of this policy remains questionable. A periodic meeting with members of the industry therefore is necessary for receiving feedback about any discrepancy in the policy that needs prompt improvement.

3.2.1.2. Weaknesses

(i) Lack of policy support for sustaining feedstock: resource availability has been identified as one of the major barriers to massive undertaking of biomass projects [7]. Except for the major developers who have full control of their biomass feedstock, the absence of long term supply contracts partly contributes to the low interest of small producers to enter the business. Analysis of the FIT provisions reveals the supply issue remains idle without a definite solution. It has been noticed that the current regime leaves the responsibility for securing resource supply to the plantation owners, enterprises and feed-in approval holders alone if they are to embark on the business [32]. The government non-intervention approach risks the unstable supply of biomass fuel to the market. As a consequence, this would create a problem for small developers who are relying on third party supply, which will trade at market price. The seasonal nature, due to 25-year replanting cycle, and the low cropping trend are other constraints that contribute to a low amount of biomass feedstock in the marketplace. Multi diversified use of oil palm biomass, due to competition with other industries, coupled with business decisions to use the wastes for other means such as mulching, composting and animal feeding activities make the supply problem worse [27]. Without any expansion plan, a study by the AIM [27] projects the current plantation pattern is capable to providing an adequate supply of oil palm biomass resource in supporting the FIT renewable capacity target as shown in Fig. 5. However, inefficient resource management is likely to be the key factor that could hinder the expansion of the biomass industry in a sustainable manner [38]. Therefore, it is vital to find permanent solutions to remove this barrier;

(ii) Less efficient conversion technology: The wide use of low pressure boiler systems within the industry communities would affect the capacity of electricity production in the existing mills, thus impacting the exporting capacity to the main grid. At present, 77% of palm oil facilities in Malaysia are fitted with either a combustion engine, combined heat and power (CHP or cogeneration) systems or a combination of both technologies [39]. A very minimal 5% of plants are installed with a gasification technology. It must be remembered that most of the existing plants have been in operation for years and their installation might not be compatible and capable of generating sufficient energy for connection to the main grid. Apart from extra incentives for the use of efficient technology, there are no sustainable solutions offered in the FIT to accelerate conversion to a modern system. A more coherent and sustainable policy including an increase in local technology providers and developing local expertise in design, operation and maintenance are amongst the strategies that merit consideration to minimise foreign equipment expenditure;

(iii) Lack of a feasible interconnection scheme: The slow progress of biomass projects undertaken in the previous regime could be explained by the absence of transmission lines to connect the main grid with participating biomass plants in remote locations. An excessive capital cost for a grid extension line would prevent biomass renewable producers from exporting their excess power to the grid, due to low economies of scale of the biomass project. Apparently, the FIT law does not provide an attractive mechanism to support grid connected generation. In fact the law demands the licence holder to finance all related costs (including costs for power systems studies) up to the point of interconnection [32]. The law also sets a condition that the eligibility for the scheme benefits is strictly confined only to the community that is serviced by the utility. The move implies that isolated mills without transmission infrastructure are denied from benefiting from the scheme. Without a feasible interconnection scheme in the policy, it is very unlikely to produce surplus power from the facilities in the less served areas to the national network system;

(iv) Mismatch of objectives between the low carbon and carbon-based power generation industry: On a larger perspective, further examination on the overall energy system in the country reveals flaws in the energy policy direction. Under the ETP, the country is committed to reducing its reliance on petroleum products from 21% to 14% of GDP by the year 2020 [12]. Despite this positive note, the blueprint predicts a significant shift from a predominantly natural gas based system towards increasing dependence on coal for use in the power sector. To this end, the use of coal in the power generation mix shows an ascending trend from 9.7% in 1995 to 30.4% in 2009 [9]. Natural gas remains the main fuel for power production with a 58% share in the country’s energy mix, while hydro contributes 5% and oil primarily serves as a back-up fuel [4]. The continuing reliance on coal-fired and other hydrocarbon resources in the power generation sector is substantial and contradicts the spirit of the FIT in combating carbon emissions from the burning of carbon-based fuels. A

Table 7 – Comparison of retail tariff and FiT percentage in selected economies [37].

<table>
<thead>
<tr>
<th>Economies</th>
<th>Germany 2007</th>
<th>Italy 2009</th>
<th>Thailand 2008</th>
<th>Malaysia 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail electricity tariff (average)</td>
<td>0.28 USD/kWh</td>
<td>0.24 USD/kWh</td>
<td>0.09 USD/kWh</td>
<td>0.09 USD/kWh</td>
</tr>
<tr>
<td>FIT cost to consumers (% of retail tariff)</td>
<td>4.8%</td>
<td>7.3%</td>
<td>Incorporated in Tariff</td>
<td>1%</td>
</tr>
</tbody>
</table>
document on the national greenhouse gas (GHG) inventory of Malaysia to the United Nations Framework Convention on Climate Change (UNFCCC) for the year 2000 reports that the energy sector, including electricity generation, is a major greenhouse source by emitting 58.48 million tonnes of CO₂ or 35% of the total of 167.44 million tonnes of CO₂ across all sectors [22]. In contrast, the capacity target of 2,080 MW and 21,370 MW of electricity generation in years 2020 and 2050 respectively set under the FiT would translate to an estimated cumulative total of 45.7 and 629.2 million tonnes of CO₂ eq emissions avoided from non-carbon based sources displacing conventional fuels for electricity over the same period. Interestingly, the oil palm biomass wastes alone are projected to generate 800 MW and 1,340 MW of grid-connected capacity share in year 2020 and 2030 respectively, which correspond to a cumulative total of 17.6 million tonnes CO₂ eq and 29.5 million tonnes CO₂ eq of emissions removal [33];

(v) Heavily subsidised non-renewable sources: Another downside to the sustainable expansion of the renewable portfolio is the government subsidy for non-renewable fuel sources, which remains a common debate worldwide. There is no exception for Malaysia where the fuels subsidy is expected to soar from USD3.09 billion in 2010 to USD5.13 billion in 2011 [40]. At present, the government is subsidising 31% of the domestic fuel price which in turn makes the electricity generating cost from conventional sources lower than the power production cost from renewable fuels. Conversely, the long standing fuel subsidy system indirectly impinges on the growth of renewable technologies including the one from the oil palm biomass resources. Being a net oil exporter with an average of 10% oil export value in GDP between 2006 and 2010, Malaysia is ranked third in terms of oil reserves in the Asia-Pacific region behind China and India and emerges as a major oil-producing economy within the Association of Southeast Asian Nations (ASEAN) countries [41]. The proven oil reserves in 2008 stands at 5.46 billion bbl but it is projected to be exhausted at the latest by the year 2021 [41]. By default, a subsidy cut can be achieved if more in-house refineries are built to avoid the country from exporting crude oil to outside facilities and buying it back at expensive prices. To a certain extent, the impact from the volatility of the global market price can also be cushioned by exploiting the country’s oil resource availability. Apart from extending the subsidy for constructing physical infrastructure, subsidy rationalisation by shifting away from a fuels subsidy to finance renewable energy technology is a prudent alternative in responding to the climate change issues while encouraging more entry of entrepreneurs into the low carbon businesses.

4. The way forward

It is obvious that the FiT system is intended to address the market constraints as well as more complex issues within the industry. Most of the limitations in the industry have been addressed, particularly pertaining to the economic considerations and strengthening the cohesion between different agencies in the government sector. Without denying some valid suggestions presented by Jacobs [37] and Klein et al. [42], the law needs further detailed examination in some areas, especially with the aim of enhancing the biomass based renewable energy landscape. Even though it is premature to comment about its future performance, it is worth considering some adjustments to the FIT system by embedding the following distinct measures:

(i) over time, some modification may be required to extend the FIT bandwidth capacity restrictions. This should be applied to all of the eligible renewable technologies under the FIT system to allow continuous expansion of the industry;

(ii) differentiate the tariff level by considering the location and local conditions of the plant site. The remote oil palm facilities, together with other far reaching renewable installations, should be given priority and a better payment rate in future FiT reviews, due to their operational complexity;

(iii) explore the possibility of modifying the revenue streams from the renewable fund to guarantee the profit margin of the off-grid renewable energy power producers. It is also worth considering for the next FiT revision to include strategies to promote rural electrification based on biomass off-grid systems;

(iv) revise the quota system whenever the domestic market is ready to be deregulated or when the FiT mechanism is deemed to be mature. Failing which, would distract and limit the expansion and sustainable growth of the industry. More importantly, a larger quantum of capacity allowance would attract major oil palm operators to invest on a large-scale basis due to the viability and economy of scales of the businesses;

(v) identify other alternatives to financing renewable technologies. Some worth consideration include a carbon tax for conventional power generation, transferring some of the conventional energy subsidy to promote the renewable market and imposing a levy for exporting fossil fuels.

In addition, there are policy areas that require further studies including an evaluation of the socio-economic and environmental (e.g. carbon savings) sustainability of the oil palm biomass downstream value chain particularly with specific attention to the security of resource supply, additional support for technology advancement and a better grid extension system.

5. Conclusions

Judging from the assessment of the new policy system, it is clear that there are niches which can be strengthened as part of renewable energy market reform. The critical challenge confronting the industry is to maintain a progress towards sustainable development with a sound and dynamic policy instrument. Appropriate policy support and sustainable solutions are needed to bridge any gaps that exist in the present...
downstream components. This is to ensure that the identifiable barriers can be eliminated, the business environment can be improved and the potential of oil palm biomass technology can be fully explored by the entrepreneurs. To remain effective, the system may need constant review in order to synergise with the market conditions at that particular time. Malaysia can also learn some valuable lessons from other international best practices to enhance the sustainability of its low carbon industry. Overall, the recommendations from this paper have laid the foundations for an improved FiT framework.

Acknowledgement

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