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Sustainable electricity generation from oil palm biomass wastes in Malaysia: An industry survey

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ABSTRACT

The biomass wastes from the palm oil industry offer great potential for large-scale power generation in Malaysia. It has been estimated that 85.5% of available biomass in the country comes from oil palm agriculture. The introduction of the FiT (Feed-in Tariff) regime in 2011, which superseded the under-performing SREP (Small Renewable Energy Power) scheme, is expected to catalyse and accelerate the development of the renewable energy industry, including biomass technology. Despite a major overhaul of the market structure under the new scheme, the sustainability of the grid-connected oil palm biomass renewable energy industry downstream components remains questionable. Hence, this paper aims to investigate and analyse the market response to six sustainability-related topics. The research methods include electronic and conventional postal modes to disseminate questionnaires to all of the palm oil producers. The returned questionnaires were then analysed with a statistical tool and inferences were drawn to identify the gaps in the existing policy system. The survey identified several key factors for the government's consideration.

1. Introduction

In recent years, the Malaysian palm oil industry has generated an average of 53 million tonnes of residues each year [1]. However, a recent study indicates a significant increase of oil palm solid wastes with 80 million tonnes of dry biomass in 2010, which is projected to rise to 100 million dry tonnes by the year 2020 [2]. The abundant availability of oil palm biomass residues makes them potentially a major contributor to the overall capacity target in the FiT (Feed-in Tariff) policy system.

The main challenges to the oil palm biomass renewable energy industry now are to ensure sustainability of downstream components towards grid-connected generation including resource supply, conversion technology and the networking system. This was emphasised by Lior who pointed out that the sustainability aspects of the industry will always be questioned, even though renewable sources, including biomass technologies, are becoming important as substitutes for conventional fuels [3]. On the other hand, Lund suggested that a coherent energy system can be created by improving the efficiency of its energy production mechanism [4]. In this context, strong policy support is needed to enable the industry to grow in a sustainable manner.

Stakeholders' views and constructive inputs are fundamental in formulating an effective policy framework. This can be done by conducting a survey that covers a wide spectrum of respondents. Deriving from this understanding, this industry survey was designed to understand the market behaviour of the oil palm biomass renewable energy business in Malaysia. Stakeholders' opinions were the main concern in this study, as their comments provide useful market insights and valuable guidance for policymakers to improve and enforce their policy framework [5]. This paper, therefore aims to present results of the survey and compare the outcomes with existing literature and experiences from other countries.

This paper is organised in 5 sections. Section 1 provides a brief introduction on the background and aim of the paper, while an overview of the renewable energy policy systems in Malaysia is presented in Section 2. Section 3 outlines the survey methodology. Extensive discussion on the final results of the survey is presented in Section 4, followed by the conclusions and key findings from this study in Section 5.

2. An overview of the renewable energy policy systems in Malaysia

The country uses a five-year development plan, the "Malaysia Plan" in strategising its development program. The oil palm biomass renewable energy program began in 2001 during the

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implementation of the Eighth Malaysia Plan (2000–2005) when the SREP (Small Renewable Energy Power) program came on stream to spur the development and spearhead the growth of the non-carbon industry in Malaysia. The scheme was embedded in the Fifth Fuel Diversification Policy aiming at increasing the share of renewable energy in the country's energy mix, while protecting the country from the adverse impact of the volatility of energy prices and overdependence on the traditional fuel sources, particularly oil, gas and coal. At its inception stage, the system envisaged a 500 MW or 5% capacity share in the energy mix by 2005 by relying on six (6) identified renewable resources comprising biomass, biogas, municipal waste, solar, wind and mini-hydro. Due to the discouraging response from the market players, the scheme was reviewed and the capacity size was scaled down to 350 MW or 1.8% during the Ninth Malaysia Plan (2006–2010). The slow uptake of biomass and other renewable projects continued, and finally ended up at 65 MW or 0.4% of the country's total electricity generation by end of the 9th Plan [6]. Overall, oil palm biomass contributes the most with 40 MW of grid-connected capacity, far ahead from other renewable technologies including 4.95 MW of biogas, 12.5 MW of small hydro, 5 MW of solid waste sources, and 2.5 MW from solar sources.

A study of the SREP performance identified unattractive connection price to the grid, irregular biomass supply, low efficiency of combustion technology, poor supporting systems (including interconnection infrastructure), institutional fragmentation, obstacles to securing funding from financial institutions and other utilities' non-compliant procedures amongst the reasons that discouraged new entries, subsequently contributing to the overall national renewable capacity shortfall [5,7].

Despite of an unimpressive past performance, the government is committed to driving future expansion of the country's renewable energy portfolio. The introduction of legislative measures through the enforcement of the Renewable Energy Act 2011 and the Sustainable Energy Development Authority Act 2011 is merely major overhaul initiatives to address inadequacies of the previous system [8,9]. The FiT system that commenced on 1 December 2011, is a central component of the law, and is perceived as the main enabler to intensify the next 50-years (2011–2050) of the renewable energy industry's growth. Similar to the FiT system practiced in other renewable economies, the FiT energy developer in Malaysia is contracted with a guaranteed capacity payment for every kWh (kilowatt hour) exported to the main grid [9]. In this context, the utility is legally obliged to purchase electricity generated from any of four identified indigenous resources (biomass, biogas, small hydro and solar photovoltaic) at a fixed rate and for a period stipulated in the law [9]. Again, the biomass technology, particularly the wastes derived from oil palm agriculture emerge as a major contributor towards achieving the capacity target set under the FiT with 330 MW and 800 MW of grid-connected capacity by the years 2015 and 2020, respectively [5,10,11]. This is certainly a huge step from 40 MW grid-generation capacities achieved at the end of the SREP period in 2010. Fig. 1 displays the policy timeline and the revised capacity target since its inception in 2001.

Fig. 2 exhibits the capacity target sets under the FiT regime.

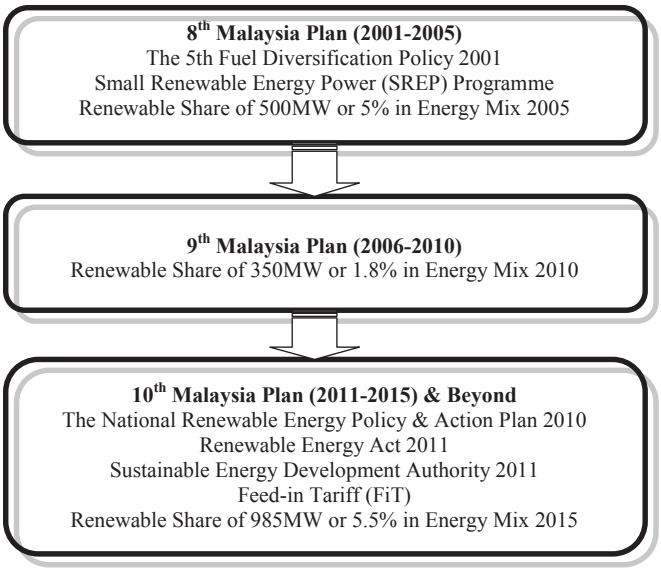

Fig. 1. Renewable energy policy development in Malaysia [5].

3. Methodology

This survey exercise was part of the data gathering activities for a study to evaluate the sustainability of the oil palm biomass renewable energy industry in Malaysia.

Apart from obtaining market information, the study integrated responses from the practitioners in a series of interviews before arriving at an aggregated consensus during the focus group meeting. The results from the interviews and focus group discussion will not be discussed here. The complete data gathering processes for this study are shown in Fig. 3.

3.1. Questionnaire structure

The survey questions were created based on the gaps and barriers that had been identified during a literature search of government reports, academic publications and other related secondary materials. The lead author's vast experience in the energy policy field was an advantage in drafting a concise questionnaire. Prior to final delivery to the intended recipients, the draft survey was pilot tested within a small group of respondents to ensure clarity of the questions and to avoid ambiguity [12]. The final modified questionnaire contained 72 questions covering six different themes addressing the research questions of the main study which were:

(i) Sustainability of resource supply;
(ii) Sustainability of conversion technology;
(iii) Sustainability of the network systems;
(iv) Key challenges and barriers;
(v) Awareness campaign; and
(vi) Future prospects.

The questionnaire involved a combination of table-type, descriptive format and open-ended questions. The table type questions used a Likert scale method to grade the strength of the responses on a five-point rating scale from 'strongly disagree' (1) to 'strongly agree' (5). The respondents were also invited to share their industry knowledge by stating any relevant comments in an open-ended format at the end of every topic.

The SPSS (Statistical Package for the Social Sciences) version 17 program was used for analysing the survey data. Descriptive analysis was conducted to acquire percentage and frequency counts for every data set.

3.2. Targeted respondents

The market respondents in this survey comprised of palm oil producers from all over the country. It has been well accepted that apart from producing edible oil, all the plants generate piles of