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Biomass Demand-Resources Value Targeting

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As the global awareness toward sustainability is become one of the main focus in the development nowadays, Malaysia has started to be implementing "GREEN" practices in many industry. One of the main highlight is to develop alternative energy resources for oil and gas by using bio-resources such as palm oil. As the world leading country in palm oil production, many process waste has been generated during production, which known as palm biomass. In order to solve the problem, a Waste-To-Wealth (WTW) approach has been introduced from previous study to convert the biomass into a higher value product. However, the efficiency of the biomass management in Malaysia, especially the supply chain is still questionable. Even though many researches and integration of supply chain have been conducted, less has considered the potential value of each of the biomass available, resulting in under utilisation of certain type of biomass. A new Demand-Resources Value Targeting (DRVT) approach is introduced in this study in order to investigate the value of each of the biomass available in Malaysia in order to fully utilise the biomass available. DRVT approach will be conducted by detail study of potential value of biomass available based on market demand and its downstream product. With systematic biomass value classification, integration of supply chain based on biomass value from resources-to-biomass-to-downstream product can be developed. Therefore, a more detail integration of supply chain is expected with optimum utilisation of each potential biomass in Malaysia, which leading to a better planning and development of the country.

1. Introduction

In parallel with the global awareness for the essential of sustainability, there is no doubt that Malaysia is starting to practicing "GREEN" concept in every sector for the development within the country (Ng et al., 2012a). As the highlight of the world, sustainability holds the power for a country to guaranty the economy stability and competitive internationally. This leads the developments in Malaysia focus more on renewable resources, such as biomass instead on conventional fossil fuel. With the increasing demand for energy globally, International Energy Agency has foreseen a 53 % increase in energy consumption by 2030 (Ong et al., 2011). In Malaysia, the energy demand had increased about 66.5 % from 1999 to 2009 (Shafie et al. 2011). Based on a study in 2009, 94.5% of electricity in Malaysia is generated from fossil fuel such as natural gas (63 %), coal (30.4) , hydro (5.4 %), oil (1.1 %) and other (0.1 %), with most significant increment in demand of coal (from 9.7 % in 1995) (Ong et al., 2011). Even though current status has not show any major problem in the chain of energy demand, however, precaution for shortage of resources has to be taken for following reason (i) increasing demand over the local supply (ii) shortage of global supply resources and (iii) security, such as international conflict that leads to interruption of import and export. Therefore, development for alternative resources - renewable resources, is essential.
Many attempts have been done by Malaysia government since the Eight Malaysia Plan in 2001 (Wendy et al., 2012) to promote and encourage the development in sustainability, from public awareness to deliberately formulated energy-related policies and planning, such as 5th Fuel Diversification Policy in 1999 (Mekhilef et al., 2011). However, most of the planning or projects are more focus on reducing the waste of current facilities. For example, a Biomass Power Generation & Cogeneration Project (BioGen) was commissioned in October 2002 with objective of reducing emission of green house gases from fossil fuel fired combustion processes by utilizing biomass waste for alternative power generation (Mohammad

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and Lee 2006). Besides, many research has conducted upon solving the waste problem, including the Waste-to-Wealth (WTW) approach to utilize the by product produced from processes of renewable resources, for example biomass. With advantages of geology and climax, Malaysia has the advantage in the supply of renewable resources, especially in bio-resources such as oil palm. As the main plantation in Malaysia with more than 3.88 million hectares (Idriss et al. 2010), Malaysia has successfully becomes one of the world's largest in palm oil production which contributes to the total world palm oil production at about 41 % in 2008 (Yoon et al., 2011), 39 % in 2009 (Shafie et al. 2012), and 47 % in 2010 (Mohammed et al., 2011). However, the position as world first production in palm oil has been taken by Indonesia, with Malaysia as the second largest in world palm oil production (Shafie et al., 2012). According to Yusoff (2006), palm oil was once reaches 75.1 % of the total export revenue of Malaysia. This phenomenal is consider unhealthy as it illustrates that the development of plantation in Malaysia is too unified into palm oil industry due to its maturity and tradition of this country. This potentially resulted less utilisation in other available bio-resources presently available in Malaysia. Many oil palm industry in Malaysia has only focus in the up-stream product and unaware of the potential of the existing down-stream opportunities. For example, as the top producer in palm oil industry, approximately 82.5 % of palm oil product is exported as up-stream product in processed form such as crude palm olein, Refined Bleached Deodorised (RBD) palm oil, RBD palm olein and RBD palm stearin, or in crude form such as palm oil, palm kernel oil and palm kernel cake (Jabatan Perdana Menteri, 2010). A wider options in terms of bio-resources, plantation development plan and resources application should be introduced due to security issue.

Currently Malaysia are facing pressures as the world top palm oil producer due to the rapid development in Indonesia and Thailand, as well as the limitation of option in developing other bio-resources due to the unified development of palm oil industry previously. According to Mohammed et al. (2011), only about 10% of the whole palm oil tree consists of palm oil while remaining is palm biomass; while about 20% of pineapple is canned for nutrition usage and the rest are produced as biomass (Shafie et al. 2012). Hence, biomass is one of the bio-resources with highest potential as the alternative development plan in sustainability in Malaysia. One fine example will be the usage of palm oil where the crude oil is extracted and used for the production of bio-chemical, while the shell/biomass is utilised in bio-energy generation due to high heating value. Therefore, in order to have a better planning and development, a systematic and efficient integration for biomass in Malaysia is very important especially in supply chain.

Many integration techniques have been applied in the supply chain of bio-resources in terms of, for example system distribution, especially in Malaysia palm oil industry. However, in most of the supply chain integrations, the true value of the biomass are not been fully utilised due to the poor understanding of it's varies applications. For example, Empty Fruit Bunch (EFB) is use as mulching in many palm oil mills for soil nutrient recovery considering that EFB can be converted into a higher value product such as fertiliser prior to processes. In order to fully understand the application of each biomass and optimised their potential value, a new Demand-Resources Value Targeting (DRVT) Approach is introduced. The main advantage of this integration approach is that it allows proper study and analysis of each of the biomass and fully utilized its value. Previously, biomass is characterised as negative-cost material where it cost money for waste management, or which neither losing nor earn money (Ng et al., 2012b). However, with the awareness of the potential value in the biomass, many studies have started to look for alternative way to turn the biomass into a positive earning material (Ng et al., 2012b). Therefore, integration in terms of biomass value will be more effective and efficient. In parallel with the WTW, the result from the integration of the biomass supply chain network might be far superior compare with current development that more focusing in distribution network of single or limited potential application for each type of biomass. This optimised network alone can yield a better management for existing facilities, but also can provide a strong basis for further planning.

2. Objective

The target of this research is to explore the opportunity of expanding the development of supply chain of biomass in Malaysia by implementing the newly introduced DRVT Approach in parallel with WTW approach. In order to achieve the respective target, three objectives have been identified as follow (i) To investigate and analysis the value for potential biomass and its downstream product in Malaysia (ii) To maximise the utilisation of biomass value as sustainable resources (iii) To syntheses an efficient supply chain for biomass system in Malaysia. By achieving these objectives, this study will allows (i) maximised biomass' value and system efficiency in biomass industry based on potential market demand (ii) good understanding of the true potential of bio-resources industry in Malaysia leading to improved planning and strategic in the process of development.

3. Scope of work

In order to accomplish the objectives, the foreseen scope of research to be covered is identified as follow: (i) identified and classified potential biomass in Malaysia based on its potential value in application (ii) identified potential technology or process of biomass into higher value of down-stream products based on the market demand (iii) investigate optimum supply chain for the system in terms of economy benefits, sustainability, WTW and zero waste. As the case study will based on the biomass industry in Malaysia, the selection of biomass will mainly focus on oil palm industry due to the highest resources availability, followed by the study of other potential biomass such as rubber biomass, coconut biomass, pineapple biomass, and etc.

4. Methodology

A general research methodology with the fields of novel research and its attributes are presented in Figure 1. The main research fields of the project are potential discovery, market forecasting, system evaluation and supply chain management. The first step is exploitation of potential biomass and market demand of down-stream products. It follows with an analysis and optimisation, which contributes to the proper selection of resources and processing systems by using DRVT Approach. The activities toward achieving the objectives are summarised in Figure 2.

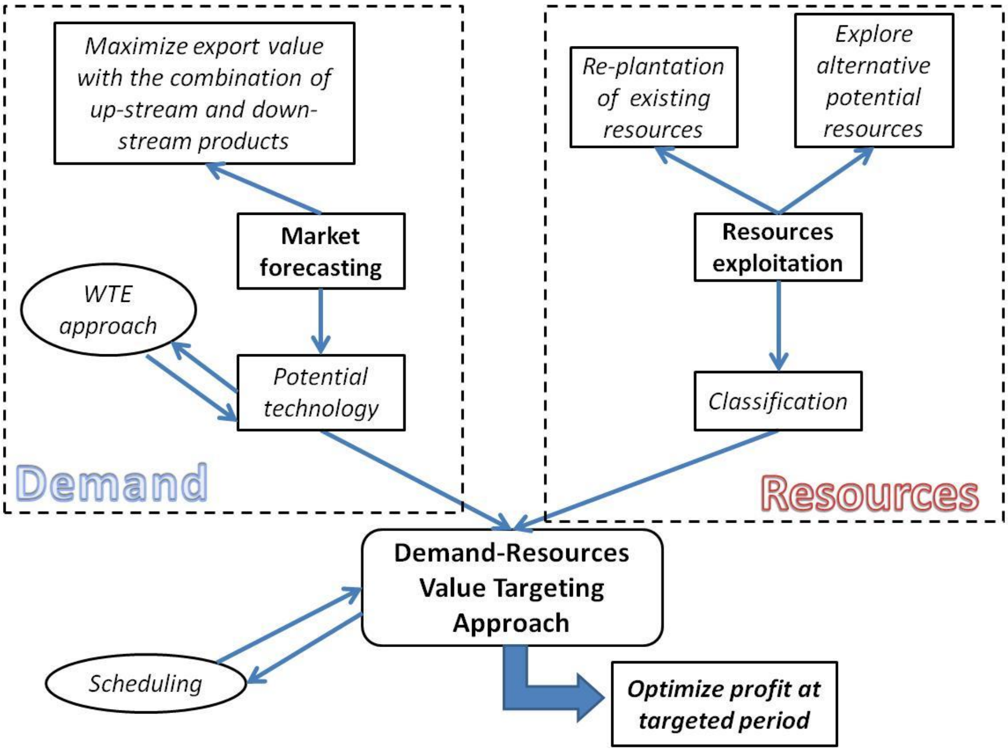

Figure 1: General methodology

4.1 Exploitation of the sustainable energy sources in the region

A good interaction of the research group with regional authorities and with industry is essential to provide the data of the potential biomass such as the locations of source points, the biomass generation rates and patterns. The characteristics of the biomass (heating value, water content etc.) can be obtained from the database if available or tested in the laboratory.

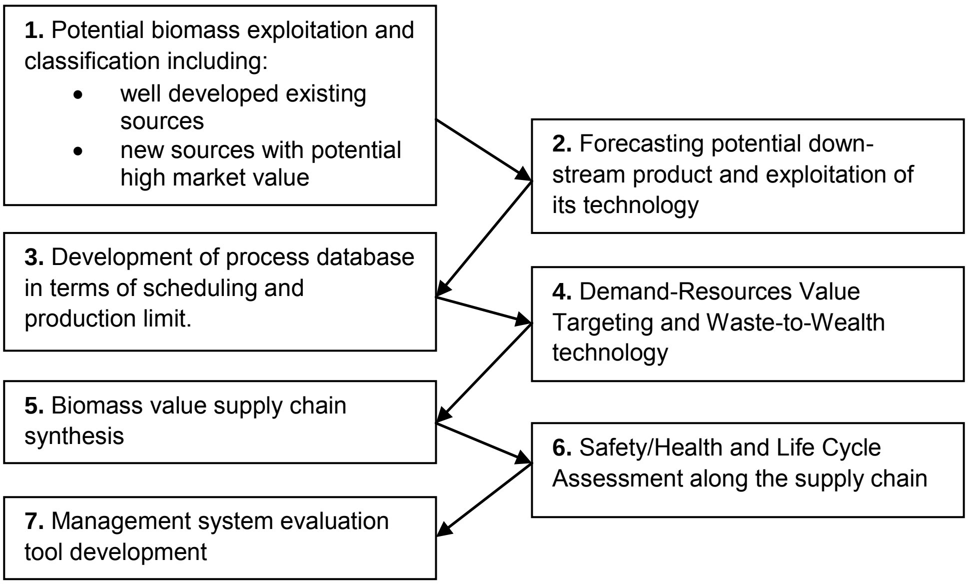

Figure 2: General activities

4.2 Classification of biomass according to its potential applications

A systematic classification of biomass based on the characteristic obtained will be conducted. The classification will be conducted based each of the components in respective industry, such as the palm kernel shell, empty fruit bunch and etc. in oil palm industry. A simple illustration of biomass classification is presented in Figure 3. The understanding of the potential in each component available will allow higher quality of integration and optimised result. Besides, the time factor will be taking into account as well. For example, generation rate of specific biomass and transportation time from collection points are very crucial in the system.

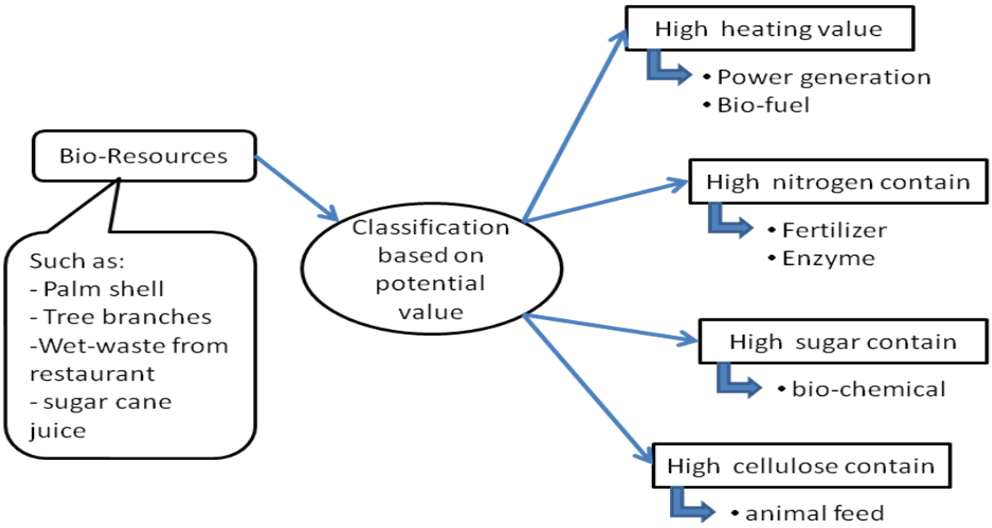

Figure 3: Resources classification illustration

4.3 Investigation and forecasting market demand for biomass down-stream products

Forecasting of potential market demand in biomass down-stream product will be performed. This process can focus based on two basis: (i) Investigation of biomass downstream product with highest demand or profit margin. (ii) Investigation of biomass downstream product based on highest availability of biomass resources.

4.4 Technology review and compilation

All feasible technologies from industrial processes to generate more biomass for utilisation or create higher value down-steam will be evaluated. This data base allows the integration of the system to determine the best combination from the bio-resources to biomass, and the utilisation of biomass into higher value downstream product.

4.5 Supply Chains Integration and Management

Besides the proposed DRVT approach in parallel with WTW approach, the system is enhanced with integration and management methods to optimise biomass value in Malaysia. The main purposes of this part are to (i) Enable more effective demand/marketing planning based on potential biomass resources; (ii) Minimise the fluctuation problem in the supply and demand flow; (iii) Enhance the collaboration between the agents in the network; (iv) Reduce overall operational costs within the network.

A method for the synthesis of regional renewable energy supply-chains, based on Mixed-Integer Linear Programming (MILP) will be developed which specially address the need and characteristics of WTW Management in Malaysia. The main challenges are the distributed and varied availabilities regarding both location and time. A four-layer supply-chain superstructure will be developed, which includes the collecting, preparation, core processing, and distribution of products/energy. This considered system's boundaries involve a region, which is then divided into zones for optimising conversion operations and transportation flows. An MILP model will be formulated with profit maximisation as the optimisation criterion. The environmental impact is evaluated by the carbon footprint. The sensitivity of the optimal solutions is analysed for different regions sizes, transportation costs, pre-processing alternatives, and the co-production of food and energy.

4.6 Safety and Health Assessment

One of the most important components in a sustainable development of a new process is the safety and health criteria. After the integrated WTW process has been designed, the potential safety and health hazards inherently exist in the process will be evaluated. For the safety criterion, the process will be assessed from three major aspects of the materials involved, operating conditions employed, and equipment installed. The evaluated hazards in the process will be presented graphically to allow the designers to compare and percept the hazards level in the different sections of the process. As for the health criteria, the human health risk due to the exposure to the materials being emitted from the process will be quantified. For airborne emissions, inhalative exposure risk will be calculated based on the physical conditions of an average adult male. For liquid and solid discharges, skin exposure risk will be estimated qualitatively. Based on the risk estimates, the different sections in the process can be classified under risky on non-risky zone.

4.7 Life Cycle Assessment (LCA)

One of the very perspective areas within the proposed project will be use of the concept of LCA, which constitutes a comprehensive approach for the reduction of harmful impacts on the environment. In essence, this concept embodies influencing and forming of approaches and methods supporting calculations and assessment of the investigated processes with the objective of improving environmental behaviour of these processes. For example, from the point of view of combustion processes to generate electricity, application of LCA does not only monitor the immediate effect (concentration of emissions during combustion etc.), but also all attributes of the process from waste transportation, sorting, feeding, down to handling of residues (i.e. the remaining wastes from combustion processes and flue gas cleaning). The deployment of the LCA concept for newly developed processes and devices in the framework of this project should constitute a qualitatively novel approach.

4.8 Energy management system evaluation tool development

An IT tools with user-friendly interface is important in the implementation stage especially involving the policy makers who do not understand the mathematical programming behind the complex modelling. This management tool should able to syntheses a DRVT with WTW supply chain and provide the result of LCA and safety/health assessment.

5. Conclusion

In conclusion, the newly introduced Demand-Resources Value Targeting approach is expected to be able to improve the current biomass supply chain and planning by providing a more efficient and systematic distribution network. Date base for biomass value classification enable better understanding of biomass application and hence fully utilised potential biomass available in Malaysia.

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