

Best Practices & Success Stories of Biomass Industry in Malaysia

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Abstract: Sustainable development has always been one of Malaysia's key macro agenda that covers the three areas of development i.e. social, economy and the environment. Within this context, the biomass industry offers tremendous opportunity for Malaysia to achieve this agenda. The agricultural sector generates large amount of biomass, that just two decades ago was considered a waste but now increasingly valued as a resource for economic exploitation.

The amount of biomass generated annually in Malaysia totals to about 96 million tonnes (wet). The types of biomass available include palm-based biomass (empty fruit bunches, kernel shell, mesocarp fibers and liquid effluent), rice-based biomass (rice husk and straw), forestry waste (saw dust, timber offcuts), rubber wood as well as municipal solid waste. It is estimated that optimum utilization of these biomass resources will generate gross national income of USD 5-10 bil. per annum with total investments of USD15-20 bil.

Malaysia is presently moving towards achieving higher level of economic and environmental sustainability via the utilization of the biomass resources in areas such as bio-energy generation, production of compost and biofertilisers, manufacturing of eco-products as well as production of bio-based fuels and chemicals. Both large corporations as well as the small and medium enterprises (SMEs) are actively participating, investing and innovating in this new area of economy. The application of advanced biomass conversion technologies is also a key factor in producing high value products from the biomass resource.

1. Introduction

In less than two decades, biomass in Malaysia has seen its gradual transformation from being a form of polluting wastes into economically valuable resources. In the oil palm industry, the management of palm biomass such as empty fruit bunches, palm kernel shell and mill effluent used to be a contentious issue with the mill owners having to find ways and means to properly dispose away these wastes while government agencies have to prevent the wastes from polluting the environment. In the present scenario, enterprising biomass companies are now knocking on the doors of the mill owners wanting to acquire these biomass materials for their downstream value-adding activities. In the case of municipal solid waste, initiatives are also being implemented to exploit this resource for composting, bio-energy generation to grid and biogas production.

This transformation is driven by a few key drivers; the need to reduce carbon emissions to mitigate climate change, reducing Malaysia's dependency on finite fossil-based resources, maturing of sustainable bio-based science and technologies as well as the opportunity to utilize the biomass resources for green growth.

Realizing this opportunity, the Malaysian government has implemented a number of key policies and actions to drive the biomass industry forward. These policies include the nurturing of biotechnology to convert biomass into high-value products, creation of domestic market for renewable energy via feed-in-tariff, establishment of an export-focused biomass industry, and the positioning of Malaysia as the biomass hub in this region.

2. Status of Biomass Industry in Malaysia

The use of biomass wastes as resources for downstream industries is not a new development in Malaysia. In the agricultural processing sector, wastes from commercial crops such as sawdust, rice husk, rubber wood and palm fibers has traditionally being used as fuel sources to generate heat, steam and power for processing in rice mills, sawmills and palm oil mills. Some of the early successes in converting biomass waste into high-value products include the use of rubber wood for furniture making as well as the use of sawdust as feedstock for medium density fiber (MDF) composite wood and mushroom cultivation.

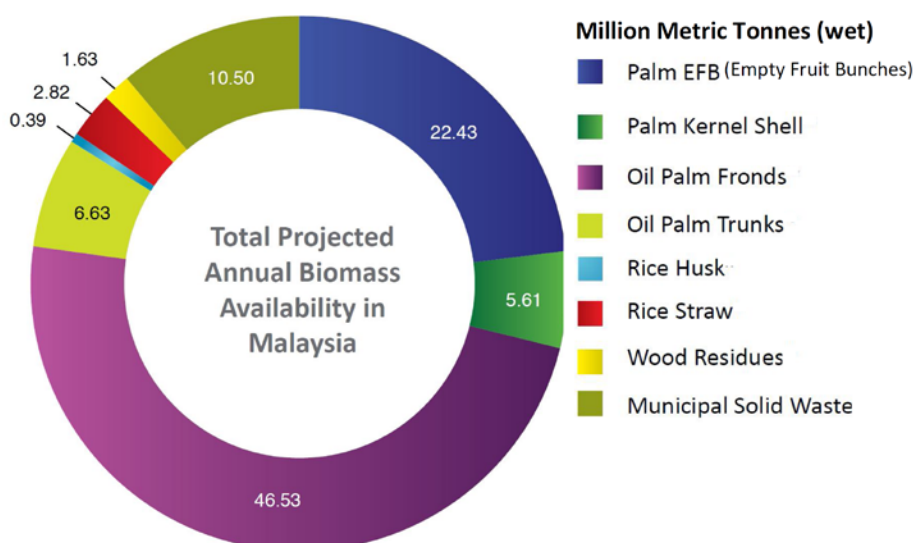


Figure 1. Annual Availability of Biomass Resource in Malaysia (2012).

A new era of biomass utilization took root in the 1990's to address increasing air and water pollution from the expanding oil palm sector. The concept of zero waste was introduced to the oil palm industry. One of the more widespread practice that developed during that time was mulching to return the empty fruit bunches (EFB) to the field as nutrient. The implementation of Clean Development Mechanism as part of Kyoto Protocol also sees a number of mills undertaking methane capture projects. Another technological breakthrough also took place during that period; where pre-treatment processes and equipment were successfully developed and perfected to fiberize the tough EFB, thereby enabling the EFB fibers to be treated and exported as commodity.

The last decade has witnessed a number of favorable policies and actions undertaken by the Malaysian government that further promoted the biomass industry in Malaysia. These policies and actions however, were not specifically developed for the industry per se as they reach out to a larger scope under three key areas; namely biotechnology, renewable energy and green technology. Nevertheless these policies and actions have brought about positive impacts on all aspects of the value chain in the biomass industry.

2.1 National Biotechnology Policy

The policy is announced on 2005 with the 15-year action plan to promote and develop the biotechnology industry in Malaysia with the aim of making the nation a key player in the global biotech sector. The key foundation for this policy is that Malaysia's rich biological resources and diversity can serve as a comparative advantage to excel in this sector globally if the right technologies, human capital and enabling environment can be developed, nurtured and promoted. This policy resulted the setting of Biotechnology Corporation Malaysia to oversee the implementation of the plans and actions.

One of the outcomes of this policy is the positioning of Malaysia as favorable location of investment to attract foreign technology providers to setup production plants to convert local biomass feedstock into intermediaries and end-products such as biosugars, biochemicals and biopolymers for the global market. This has resulted in higher demand for biomass feedstock in Malaysia as well as the awareness of the potential of biomass for Malaysia's industrial growth in the new millennia.

One of the major achievements of this policy for the biomass industry is the USD600mil. investment in an integrated

bio-methionine and thiochemicals plant by CheilJedang (CJ) South Korea and Arkema France in the East Coast of Malaysia.

2.2 National Green Technology Policy

This policy is launched in 2009 to develop and promote the implementation of 'green' or sustainable technologies in four major sectors i.e Energy, Building, Waste & Water Management and Transportation. The main objective of this policy is to promote green technology as a new driver for the nation's economic growth as well as sustainable development.

Implementation of this policy includes the provision of Green Technology Financing Scheme totaling USD1bil. in the form of soft loans to companies undertaking qualifying 'green' projects; investment and tax incentives as well as setting of Green Tech Corporation to promote and facilitate the greentech industry.

This policy has positive impacts on the biomass industry via the following means:

- Encouraging the production as well as the utilization of renewable energy from waste biomass (EFB, biogas, MSW) as fuel source;
- Promoting the establishment of biomass fuel pellets (palm and wood) production plants for export market;
- Promoting the utilization of biomass for manufacturing of high-value products for the Building and Transportation sectors such as bio-composite panels and construction materials from rice husk, kenaf and other types of biomass waste
- Promoting the utilization of municipal solid waste and other organic waste for biogas production and renewable energy generation;
- Creating the pull effect on biomass-related technologies and investments into the country

2.3 National Renewable Energy Policy & Action Plan

In 2009, the Malaysian government launched the National Renewable Energy Policy and Action Plan with the main objective of enhancing the utilization of indigenous renewable energy (RE) resources to ensure energy security in tandem with contribution towards sustainable socioeconomic development. This policy is further strengthen by the passing of Renewable Energy Act 2011 which among others, sees the implementation of feed-in-tariff (FiT) mechanism, setting up renewable energy fund as well as the formation of Sustainable Energy Development Authority (SEDA) to implement the policy.

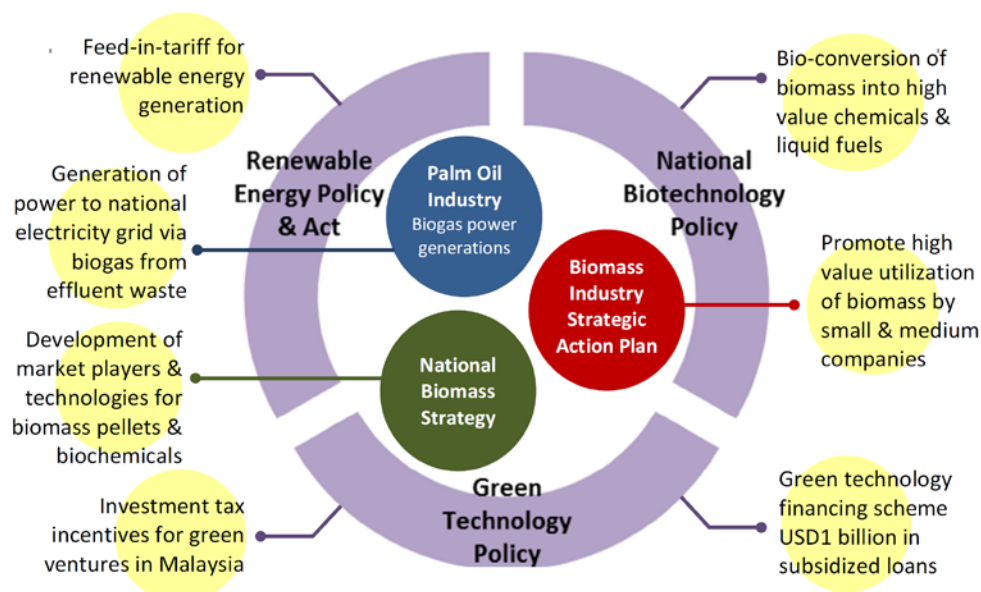


Figure 2. Overview of Policies and Actions Related to Biomass Industry in Malaysia.

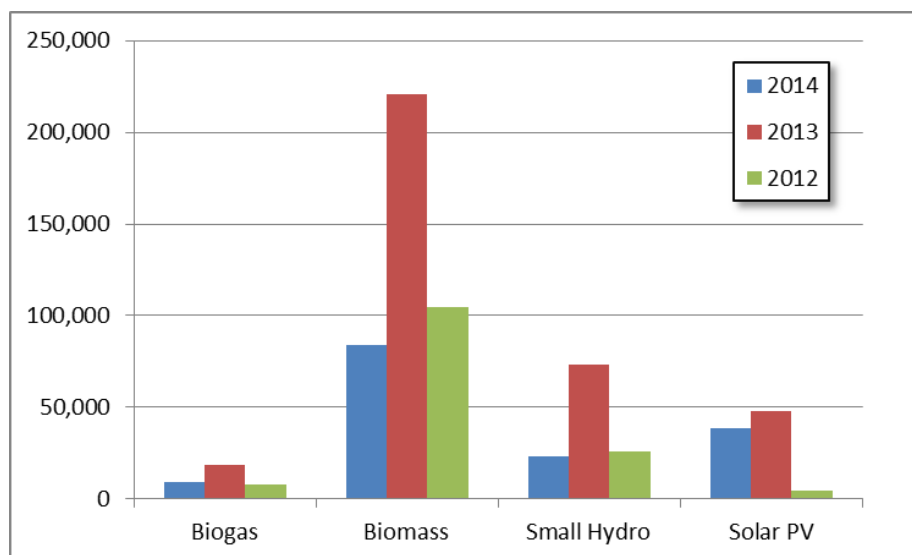


Figure 3. Annual Power Generation (MWh) of Commissioned RE Installations under Feed-in-Tariff (FiT) Scheme in Malaysia. Source: Sustainable Energy Development Authority of Malaysia (SEDA)

As of July 2014, the total grid-connected installed RE capacity under biomass and biogas resources are 52.3 MW and 11.74 MW respectively. Based on the RE projects approved up to 2016, Malaysia will have a total installed grid-connected RE capacity of 504 MW with biomass and biogas projects contributing 120 MW and 58 MW respectively. The impacts of the Renewable Energy Policy on the biomass industry are:

- a.) Create a larger demand pressure on local biomass resources, resulting in competing uses of biomass and upwards movement in pricing of feedstock;
- b.) Promoting the development of local technologies and know-how in bioenergy sub-sector such as boiler and pre-treatment equipment. Past experiences has shown that imported technologies faced challenges in utilizing local tropical-based biomass such as EFB, MSW etc. due to differences in physical and chemical characteristics from temperate-weather biomass;
- c.) Promoting the investment and financing in biomass-related projects as the FiT scheme provides market guarantee to the project promoters. This will have overall positive impact on the perception of investors and financiers on the financial viability of biomass industry as a whole.

2.4 Biomass Industry Strategic Action Plan

From 2010-2013, a joint programme was implemented between European Union and Malaysia to assist the small and medium enterprises (SMEs) in Malaysia to exploit local biomass resources for high-value utilization. The programme called Biomass-SP or Biomass Sustainable Production Initiative looks into the gaps in the value chain of the Malaysian biomass industry and develop sub-programmes to address these gaps. One of the major outcomes from this programme is the formulation of the Biomass Industry Strategic Action Plan 2020 to develop the whole biomass industry in Malaysia.

Three primary strategies are proposed under this action plan:

- i.) Unlocking biomass feedstock for downstream utilization via optimizing the efficiencies of resource utilization upstream at the plantation and milling stage.
- ii.) Smart utilization of biomass for high value production via commercialization and scaling-up of local know-how and expertise and setting of market-focused Biomass Smart Hubs.
- iii.) Positioning Malaysia as regional and international biomass hub via establishing the nation as the focal point for

internal and external biomass stakeholders in aspects such as trading, logistics, technology, engineering, equipment.

Four sub-industries have been identified that can contribute significantly to wealth creation for the nation namely; Bio-Energy, Green Chemical, Bio-Fertilizers, and Bio-Composites/Materials.

In addition, the programme also sees the formation of the *Malaysia Biomass Industry Confederation (MBIC)* which is initiated by the biomass players in the industry especially the SMEs. Via MBIC, the industry players such as biomass SMEs will have a collective voice to engage the Malaysian government, its relevant agencies and other stakeholders to develop and move this industry forward.

National Biomass Strategy 2020

Another key piece of document for the development of biomass industry in Malaysia is the National Biomass Strategy 2020 that was launched in 2011. The second follow-up version was later published in 2013. The main focus of this strategic document is the oil palm-based biomass ranging from EFB to oil palm trunks (OPT) and oil palm fronds (OPF). The main issues are the economics for the mobilization of these biomass resources from the field as well as the impact on the soil fertility of the removal of biomass from field.

The plan adopts the short-term (low-hanging fruit) strategy of promoting the export of palm biomass pellets for the global market; followed by the long-term strategy to develop the bio-based liquid fuels and chemicals sector via engagement of key stakeholders such as plantation companies, technology providers and oil palm industry clusters. This will be realized via the creation of the Oil Palm Technology Centre to consolidate the required resources.

There are great potential impacts of biomass industry for the socioeconomic as well as environmental development in Malaysia. From the economic perspective, it has been estimated that high-value utilization of biomass resources can immediately generate an annual gross national income of USD 4.4bil per annum, with the figure reaching USD10bil. by 2020. In 2014, it has been determined that the use of biomass and biogas for grid-connected RE generation will result in CO₂ avoidance of 307,000 tonnes. This has not taken into account yet of CO₂ avoidance from RE generation for factories in-house use as well as the export of fuel pellets.

3. Best Practices in Biomass Industry

The last fifteen years has seen Malaysia making great strides in the development of relevant policies, legislation as well as the implementation of the action plans to drive the biomass industry forward. In this section, we wish to share our insights and experiences in this journey for the benefit of policy makers, industry players and other stakeholders in the ASEAN region. These have been summarized below as '*best practices*' for easy reference.

3.1 SCP agenda as key guiding principle for biomass industry development

Sustainable Consumption & Production (SCP) agenda shall always be the key guiding principle for the development of biomass industry in Malaysia. It is very crucial that this agenda is understood and embedded at the national level prior to the development and implementation of any biomass-related initiatives. As biomass is also abundantly available from primary forests, implementation of wrong initiatives may inadvertently result in the exploitation of these natural resources that should be left untouched. As an example, it has been argued and well-documented that the incentive-driven biofuels market boom in EU and US during the mid to late 2010's has impacted negatively on the global food production as well as exploitation of more forest lands for energy crops production.

3.2 Biomass as resource for economic growth

In countries where agriculture is the main economic contributor, biomass is often treated as a waste due to its low value as compared with the agriculture main outputs. At best, the biomass is used for heat and power generation but in an extremely inefficient manner. In this new 'green growth' era, biomass is now a resource with increasing value that can contribute to more economic growth to these countries. Besides being utilized for the production of energy, advancement of bio-based technologies has enabled biomass to serve as feedstock for the production of a wide range of products such as bio-fertilisers, bio-composites, green chemicals as well as eco-based products. It is important that governments and policy-makers be able to see this potential in turning waste into resource; to exploit this resource for economic growth, social development as well as environmental preservation.

3.3 Making the business case

In pursuing the 'green growth' agenda, it has to be recognized that businesses, not matter how 'green' they are exists to make profit. The traditional approach of expecting businesses to preserve the environment as a cost to their business activities should be replaced with the new green business approach. There are two basic green approaches that can be promoted to businesses; (i) adopting of *clean production* processes and practices to prevent the generation of wastes especially the hazardous ones during the process design stage; and (ii) closing up the *sustainability loop* by exploiting the wastes (or by-products) generated for profit generation downstream. Biomass industry refers to the second approach by making use of biomass waste from agriculture and other human activities to create economically valuable products. For example, different businesses or industries can be physically aggregated together where by-products (i.e. wastes) from one factory can serve as feedstock for another factory, in a concept known as *industrial ecology*.

3.4 Market-pull policies

At the policy-making level, there are two approaches that can be adopted to drive an industry to growth i.e. push and pull policies. Push policies work by building the required

components from upstream towards downstream. For example, policy makers may choose to develop the biomass industry by ensuring the availability of feedstock at a certain quantity and pricing; or pushing the technologies into the market via tax relief, subsidies, grants and other monetary incentives. Pull policies, on the other hand work by creating demands for products at the market side. Examples include implementation of feed-in-tariff as well as implementing policy on public green procurement. Experience in Malaysia has shown that market-based pull policies are more effective in developing the biomass industry as compared to push policies. Nevertheless, it is important to analyze and study the conditions of each country before deciding on the best approach. In most cases, a hybrid of pull and push policies is probably the optimum choice.

3.5 E+E performance indicators

The progress and success of the biomass industry needs to be measured in both economic and environmental metrics in order to provide the dual benefits of sustainable consumption and production agenda. The right indicators need to be selected to provide an accurate picture of the success of policies and actions to develop the biomass industry. The choice of economic indicators is relatively conventional such as gross national income (GNI), gross national product (GDP), employment creation, foreign/domestic investments, as well as science, technology and innovation (STI) indices. As for environmental indicators, applicable metrics include GHG emissions avoidance, carbon intensity, as well as compliance of products and businesses to sustainability and green certifications (ISO14000, carbon footprinting, life-cycle analysis, RSPO etc.).

3.6 Smart utilization of biomass

In order to develop the biomass industry successfully, policies and actions also need to be 'smart' in utilizing the biomass resources. The following are some of these 'smart' approaches that are being adopted to develop the industry in Malaysia:

a.) Low-hanging fruit approach

To kick-start the industry, it is important to have quick wins to show positive results and overcome the inertia to move forward. In this respect, policy makers and industry players need to look for low-hanging fruits. In the case of biomass industry in Malaysia, it has been identified that the export of biomass pellets is one of these low-hanging fruits as the technology is relatively simple, equipment are readily available and most importantly, overseas demand for the pellets are already in existence. Another low-hanging fruit is the conversion of biomass into compost and biofertilisers to substitute imported chemical fertilisers.

b.) High-value utilization

The next phase of the industry is to develop sub-sectors that can utilize the biomass and convert into high-value products. As the industry develops, it is expected that there will be more demand for the biomass feedstock resulting in price increase. By moving up to higher value of utilization, businesses therefore can protect themselves from this upward price movement by maintaining a comfortable margin between the feedstock cost and product selling price. As part of the Biomass-SP programme, a benchmarking study was initiated to determine which forms of biomass utilization generates the highest value on weightage basis.

c.) Benchmarking

The purpose of benchmarking of biomass utilization is to provide policy makers and industry players with an objective overview of what are the best ways to exploit the biomass. With the maturing of different biomass conversion technologies, the types of products that can be manufactured from biomass are increasing and competition for feedstock is also getting intense.

In the case of Malaysia, it has been determined that (see figures below) biomass composite products such as particle board and activated carbon generates higher value for each unit weight of feedstock as compared to biomass solid fuel products (pellets, charcoal). It should however, be noted here that due to differences in socio-economics needs and conditions of specific countries; such benchmarking studies should be country-specific.

d.) Technology as entry barrier

At both the business and country level, the ability to harness technologies to create high-value products from biomass feedstock serve as an important barrier to compete with other businesses as well as nations. Therefore, the development and ownership of technologies especially indigenous ones must always be part of the long-term strategic development of the biomass industry. The technologies must also be appropriate to the needs and conditions of specific countries. In the case of Malaysia, part of the policies implemented serves to mobilize and internalize (via human capacity development) advanced technologies to convert biomass feedstock into high-value products such as biochemicals, advanced bio-materials, bio-composites as well as engineered bio-products.

e.) SMEs as sources of innovation

Innovation is an important enabling element to drive the biomass industry forward. In most, if not all the cases, products

made from biomass usually serve as substitutes for existing products made from fossil-based resources (see figure below). In order to compete with these existing products, the element of innovation must be present to convince customers and end-users to switch to biomass-based products. The savviness and agility of SMEs to respond rapidly to market needs and innovate on new product offerings is one of the key factors to ensure the success of the biomass industry. SMEs therefore need to be nurtured and provided with the right kind of assistance to help them to grow the industry via adoption of innovative ideas and solutions to serve market needs.

f.) Multi-feedstock technologies

The diversity of biomass resources in countries such as Malaysia and neighboring ASEAN countries means that technologies that are able to utilize multiple types of feedstock should be given preference over technologies based on single type of feedstock. In the selection and promotion of one technology over another, the differences in physical and chemical characteristics of the biomass feedstock must be taken into consideration. As an example, biomass power plants that are designed to utilize only single type of biomass fuel will risk having their profit margins affected if the price of that specific biomass become increasingly high due to other future competing uses.

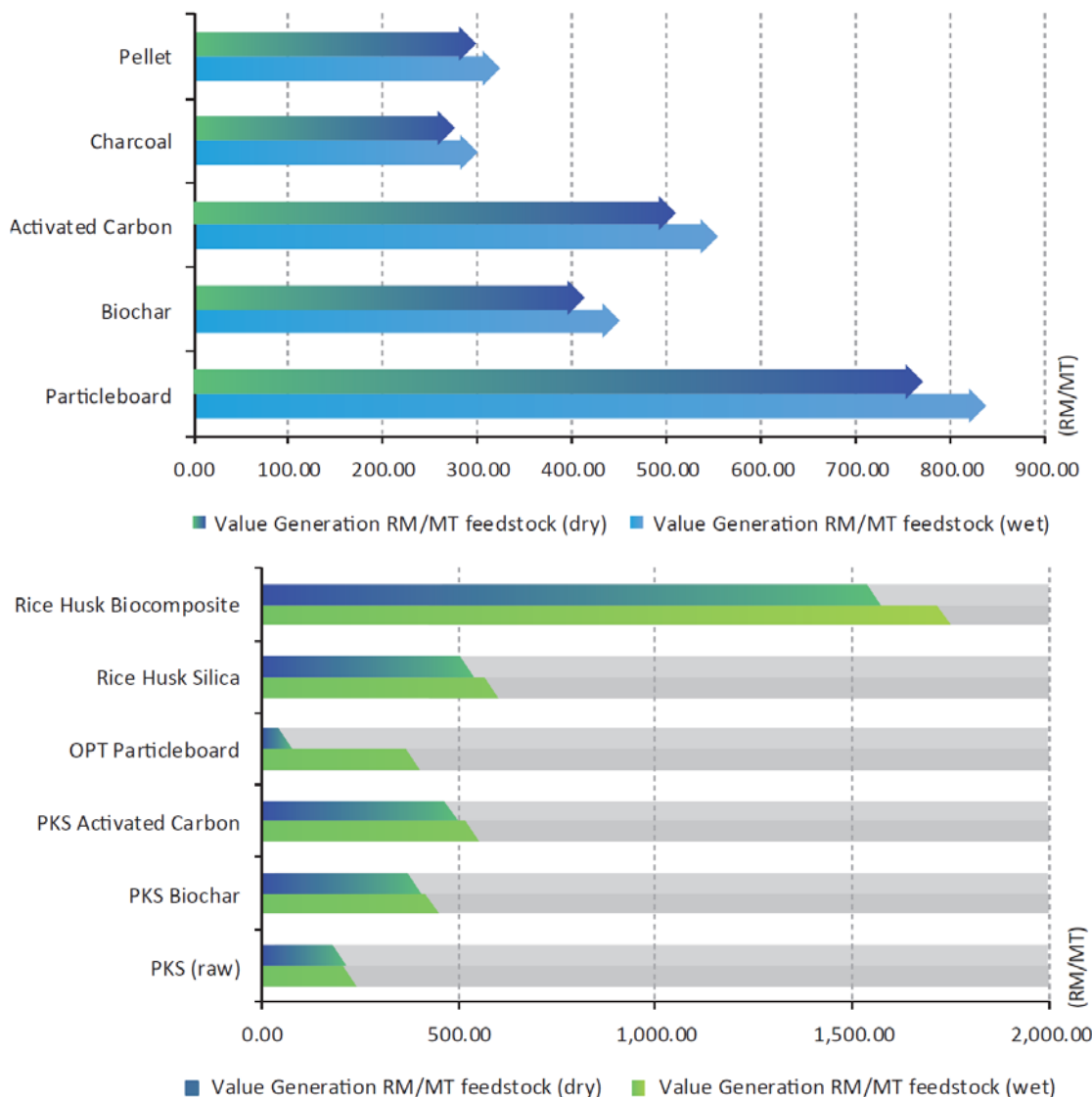


Figure 4. Benchmarking Study on the Economic Value Generation from One Unit of Biomass in Malaysia. Source: Biomass Benchmarking Study (2014) published by Malaysia Industry Group For High Technology (MIGHT)

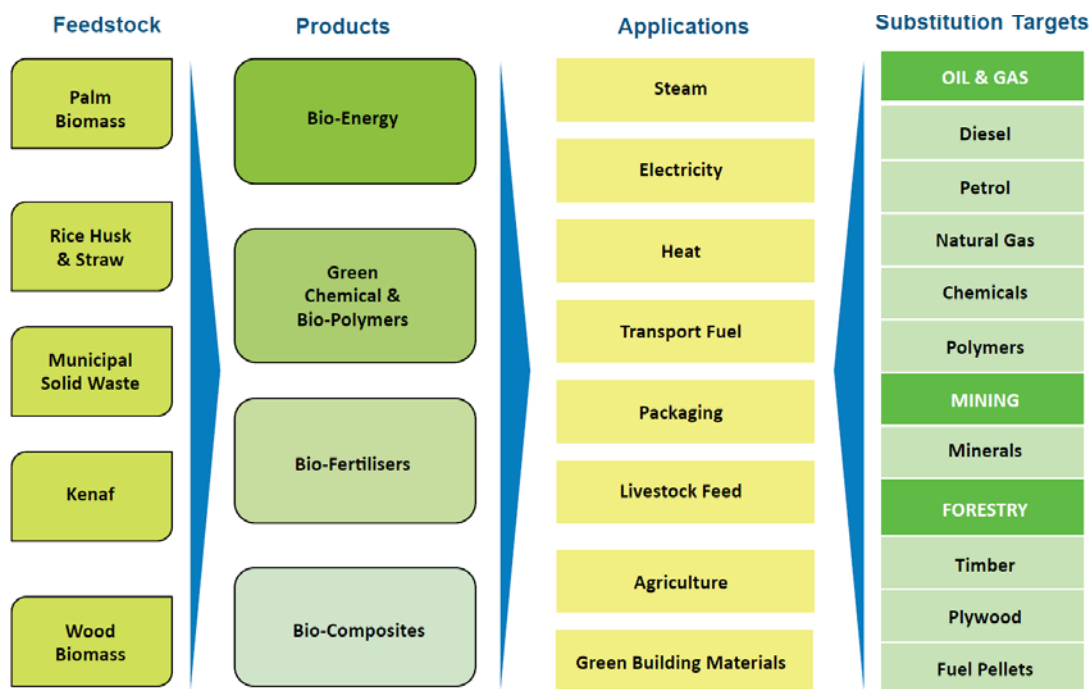


Figure 5. The Substitution of Fossil-based Products with Biomass-based Products.



Figure 6. The Value Chain Analysis Approach of Biomass Industry in Malaysia.

g.) Differentiated products

One of the more interesting findings of the benchmarking study is that differentiated products made from biomass generally give much higher economic values as compared to commoditized products. Differentiated products made from biomass include biocomposites, green erosion control products as well as packaging products; while commodity products are fuel pellets, compost and pulp fiber. Commodity-based biomass products are very much dependent on prevailing world prices (spot and futures) and therefore tend to be cyclical in nature. Biomass players wishing to enter these commodity-based markets need to take into consideration of the future pricings and risk so that they will not be caught between the upward price movement of biomass feedstock and downward price movement of the commodity products. On the other hand, differentiated biomass products are more resilient in terms of pricing as these products possess certain unique attributes that safeguard against other competitors. These attributes may include technical properties and specifications, product design, branding and reputation.

3.7 Value-chain approach

One key approach that has been adopted in the development of Malaysia’s Biomass Industry Strategic Action Plan is the analysis of the biomass industry along its value-chain. In this analysis, gaps along the industry value-chain are identified via stakeholders’ consultation. Firstly, stakeholders are consulted on all the key problems they face in their positions within the value chain. Next, these problems are analyzed via the logical framework approach to narrow down the problems to the major gaps in the industry.

The outcome of the analysis will again be presented to the stakeholders to move on to the next level i.e. generation of ideas and actions to close up the gaps. The value-chain approach implemented for the Malaysian biomass industry has uncovered a number of gaps that does not seem to be apparent in the early stage of the analysis. For example, one of the problems expressed

by majority of biomass SMEs is the difficulty in obtaining financing for their ventures has been linked to the lack of market information in the pricing and supply of biomass feedstock; thereby resulting in banks and financing institutions putting higher risk on the future financial returns of the ventures. With this gap identified, measures can then be taken to address it.

4. Conclusions

It has taken the Malaysian biomass industry more than two decades to evolve to the present status. At the present moment, it is still at the early stage of development with many opportunities remain unexploited. Despite the rapid progress of the industry witnessed in the last five years, many hurdles and challenges remain to be overcome. These challenges include:

- i. Access to biomass feedstock in terms of volume and pricing
- ii. Lack of technical standards and common commercial trading platform for biomass
- iii. Access to financing and investment for biomass ventures due to perceived risks on the industry
- iv. Lack of domestic pull market for biomass products especially the high-value products
- v. Low rate of commercialization of locally-developed technologies and R&D outputs from research institutions and universities
- vi. Lack of awareness and capacities of local businesses especially the SMEs to meet and comply with sustainability requirements and certifications
- vii. Lack of technical capabilities of SMEs to adopt technologies and move up the value chain in biomass utilization

Every stakeholder in the industry, from big and small businesses to industry associations and the government need to work in concerted effort to further push the industry forward; as the biomass industry is able to bring both sustainable economic and environmental benefits to the nation.