



MINISTRY OF PLANTATION
AND COMMODITIES

ACTION PLAN

NATIONAL BIOMASS ACTION PLAN 2023-2030



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National Biomass Action Plan 2023-2030

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FOREWORD BY

YAB Dato' Sri Haji Fadillah Bin Haji Yusof

Deputy Prime Minister &
Minister of Plantation and Commodities



Malaysia is unwavering in its dedication to fortify the biomass sector, aligning with our nation's ambitions and aspirations. The unveiling of this National Biomass Action Plan marks a significant stride forward, a testament to our proactive endeavours aimed at catalyzing economic expansion, bolstering sustainable development, augmenting industry exports, and propelling the transition to a circular economy.

This blueprint seamlessly dovetails with the **12th Malaysia Plan (12MP)**, an overarching blueprint that charts the course for comprehensive national development and advancement. Leveraging the latent potential of the biomass industry, we aspire to amplify the exports of biomass products while concurrently mitigating greenhouse gas (GHG) emissions through the prism of a circular economy framework tailored particularly for agricommodities.

I am confident our robust support for the biomass sector will serve as an economic fulcrum, propelling the trajectory of our nation's economy which will foster a plethora of job opportunities and notably elevating household income with a particular focus on uplifting agricommodities smallholders.

The execution of this action plan will pivot on invigorating the biomass domain, stimulating pioneering research and development in high-value biomass commodities and their affiliated industries. A nurturing ecosystem conducive to the growth of biomass products will be meticulously nurtured, thereby stoking productivity, bolstering competitiveness, and augmenting Malaysia's distinct edge in the global marketplace.

With the adoption of a circular economy principles, I am resolute that we shall magnify our nation's prowess in generating sustainable products and avant-garde technologies, simultaneously diminishing our carbon footprint. In the course of this journey, we shall forge fresh avenues for economic prosperity, fuel industrial expansion, and expedite the march towards sustainable development.

FOREWORD BY

Dato' Haji Mad Zaidi Bin Mohd Karli

**Secretary General
Ministry of Plantation and Commodities**



The National Biomass Action Plan is formulated with the great emphasis on the micro aspects and the positive impact experienced by individuals and communities in Malaysia. I firmly believe that the national biomass sector not only benefits the country as a whole but also opens up new job opportunities and increases the income of smallholders throughout the nation. This aligns with the **National Agricommodity Policy (DAKN 2030)**, which emphasizes the scaling up of the circular economy through agricommodity biomass.

I hope that this action plan will foster a favourable environment for the growth of the biomass industries in Malaysia, offering opportunities for both smallholders and industries to produce superior and high-value-added products. Through the provision of technical support, training, and essential resources, they will be able to seamlessly integrate traditional agricultural practices with the latest biomass technologies and innovations.

Through this action plan, the ultimate goal is to instil hope and confidence amongst the community that the growth of this biomass industry will provide a sustainable employment opportunities, stable incomes, and improved living standards for Malaysians. Furthermore, the biomass industry can offer a solution to address environmental issues and the impacts of climate change.

Finally, I call upon all stakeholders to collaborate in supporting and implementing this national biomass action plan, aiming for the betterment and a brighter future of Malaysia. Through the concentration of our resources and efforts, we can establish a resilient and competitive biomass sector that provides long-term benefits to both the country and the people of Malaysia at large.

Executive Summary

NATIONAL BIOMASS ACTION PLAN 2023-2030

The National Biomass Action Plan (NBAP) outlines Malaysia's focus on the abundant biomass resources found in plantations, forests, agriculture, livestock and fisheries sectors. The estimated biomass potential from these sectors is approximately 182.6 million tonnes per annum, with a significant portion of 85.17% derived from the oil palm biomass industry.

Despite ongoing efforts to develop the biomass industries, a significant amount of biomass remains underutilised due to various factors. To unlock the growth potential of the biomass industry, the government recognises the need for further mitigation and enabling actions.

The Plan is built upon the foundation of the 12th Malaysia Plan (12MP), the National Agricommodity Policy 2021-2030 (DAKN 2030), and other policy documents from respective ministries and central government agencies. It aligns with the five core thrusts of DAKN 2030: Sustainability, Productivity, Value Generation, Market Development and Inclusivity, along with 17 Strategic Thrusts.

To enhance the vibrancy of the biomass industries, strategic measures must be taken to address the challenges associated with the biomass industry. These measures include accessing biomass feedstock through multifarious strategies, assessing the biomass hub concept and considering joint ventures with biomass feedstock owners. Other strategies include encouraging private sector participation in biomass R&D, focusing on high technology readiness level (TRL) with quick win commercialisation, bridging the knowledge gap on soft loans and grants and formulating technology-driven business models. It is also essential for government agencies to review the constructive findings from overseas best practices related to biomass policies.

The National Biomass Action Plan aims to generate significant sustainable development benefits in terms of green wealth creation, socioeconomic development and addressing the net-zero emission target through circular economy practices. By 2025, it is expected that various institutional enablers will be further strengthened and by the year 2030, it is envisioned that the Plan will contribute to an incremental RM 17 billion economic value and generate around 33,000 jobs based on the desired results areas of the Plan.

Key breakthroughs envisioned in the plan encompass the implementation of a biofertiliser blending initiative, conversion of palm biomass into fuel pellets for export or co-firing with coal-fired power plants, development of bio-based carbonised products such as biochar, activated carbon and graphite as well as interventions to reduce imported animal feed for improved food security.

The National Biomass Action Plan's comprehensive approach and strategic thrusts set the stage for sustainable growth, increased productivity, value creation, market expansion and inclusive development in Malaysia's biomass sector. It benefits multiple stakeholders, including feedstock owners, smallholders, MSMEs, financiers, technology and ancillary service providers, while also promoting foreign direct investment (FDI) and domestic direct investment (DDI).



Chapter

Overview of the Biomass Industry in Malaysia



Overview of the Biomass Industry in Malaysia

The Biomass Sector has been replaced by the 12th Malaysia Plan (12MP) as one of the eight strategic and high impact industries to regenerate economic growth.¹ Malaysia is developing the potential of biomass industries in various sectors, including plantation, forestry, agriculture, livestock and fisheries industries. These sectors have been outlined as the focal areas of the National Biomass Action Plan 2023 – 2030. The Plan is mandated by the Ministry of Economy and spearheaded by the Ministry of Plantation and Commodities (KPK). The focal development of biomass industries in these five sectors has the potential to contribute to sustainable consumption and production, supporting Malaysia's transition towards a low-carbon and circular economy with the creation of new jobs. The following is a brief introduction to the biomass industries in these five sectors:

- **Plantation Biomass:** Malaysia is known for its vast plantations, particularly oil palm and rubber. Biomass generated from these plantations can be utilised as various value add products. The plantation sector offers abundant biomass resources that can be harnessed for bioenergy generation and bio-materials production. The plantation biomass sector provides huge circular economy opportunities.
- **Forestry Biomass:** Malaysia possesses rich forest resources and the forestry sector offers significant potential for biomass utilisation. Timber industry residues can be utilised for bioenergy production including heat and electricity generation. Wood waste can also be transformed into value-added products like wood pellets, medium density fibreboard (MDF) etc. The sustainable management of forestry resources ensures responsible biomass extraction and at the same time preserving forest ecosystems and biodiversity.
- **Agricultural Biomass:** Malaysia's diverse agricultural sectors generate substantial amounts of by-products and waste materials. Agricultural residues can be converted into biofuels, carbonised products or used for heat and power generation. Agricultural residues can also be processed into organic fertilisers or animal feed. The utilisation of agricultural by-products for biomass industries can help reduce waste, promote resource efficiency and create additional revenue streams for farmers.
- **Livestock Industry Waste:** Malaysia has a thriving livestock industry. Livestock wastes, such as poultry manure, swine slurry and biogas from anaerobic digestion can be utilised as sources of renewable energy. The utilisation of livestock wastes for energy generation not only reduces greenhouse gas emissions but also offers an opportunity for waste management in livestock farming.
- **Fisheries Industry Waste:** Malaysia's coastal and marine resources support a vibrant fisheries industry. Fisheries by-products can be processed into fishmeal, fish oil or hydrolysed for the production of bioactive compounds and liquid biofertiliser. Utilising fisheries by-products can reduce waste in the fishing industry and create additional economic opportunities.

¹ Eight high-impact industries outlined in 12MP : electrical and electronics, global services, aerospace, creative, tourism, halal, smart farming and biomass

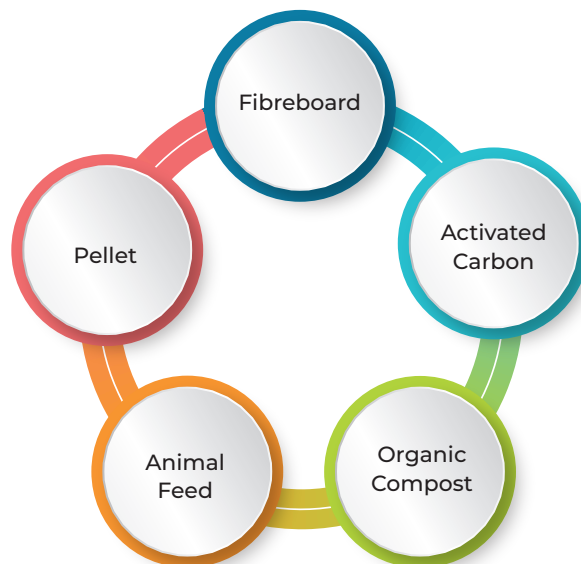
Out of all these five sectors, oil palm biomass remains Malaysia's primary biomass resource. The country has an estimated total of 5.67 million hectares of oil palm plantations, producing more than 90 million tonnes of dried palm biomass.² Oil palm biomass is derived from a variety of oil palm by-products, such as oil palm fronds (OPF) and oil palm trunks (OPT) from plantation operations. While empty fruit bunches (EFBs), palm kernel shells (PKS), mesocarp-fibre (MF) and palm oil mill effluent (POME) are generated from the milling operations. The oil palm biomass industry has been growing at a steady pace over the past few years, thanks to the interest and transition towards using low-carbon renewable energy. Based on the data of 2019 compiled by the Energy Commission, Malaysia has achieved a total installed capacity of 440.5 MW powered by biomass including 70.65 MW coming from grid-connected power plant which is equivalent to 1.2% share of total electricity generated in Malaysia with a total emission reduction achieved i.e. 395.22 Gg CO₂ eq.³ Hence, bioenergy can be used to decarbonise our electricity supply through dedicated action plan.

The Malaysia Government has acknowledged the significant contribution of biomass resources towards achieving our nation's Sustainable Development Goals (SDGs). This acknowledgement comes in the form of various incentives and supports provided by key government agencies such as the Malaysian Investment Development Authority (MIDA), Malaysia Palm Oil Board (MPOB), Sustainable Energy Development Authority (SEDA), Bioeconomy Corporation, Malaysian Green Technology & Climate Change Corporation (MGTC) etc.

The biomass industry in Malaysia has shown tremendous growth potential in the last decade or so. We are now producing and exporting solid biofuels such as palm kernel shells and wood pellets to key markets of Japan and the Republic of Korea. The biofertiliser sub-sector has also been growing to meet the demand for sustainable farming using EFBs, POME, chicken dung, fish waste, woody biomass etc.

More focused efforts are needed to ensure that the economic harnessing of our biomass resources is aligned with the concept of Circular Economy. Such efforts include close engagement and coordination between government and industry, development of effective policy and action plans, collaboration between industry and academia, facilitation to access biomass feedstock and financing etc. According to MIDA website, the most popular bio-based products manufactured in Malaysia are as follows:

Figure 1.1: Popular Biomass Business Models in Malaysia

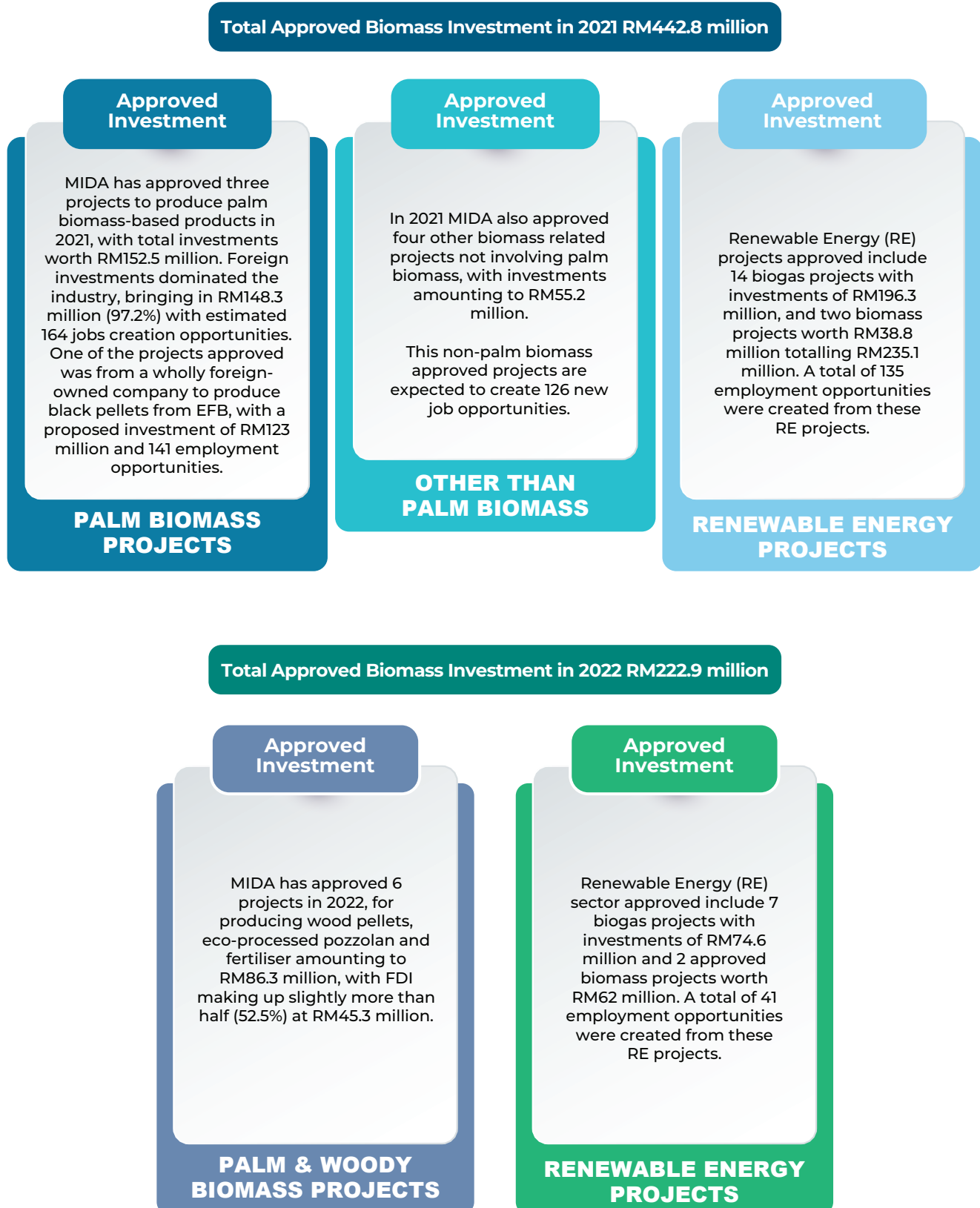


² MPOB 2022

³ National Energy Balance Report 2019, Energy Commission and Malaysia 4th Biennial Update Report (BUR) under the United Nations Framework Convention on Climate Change 2022

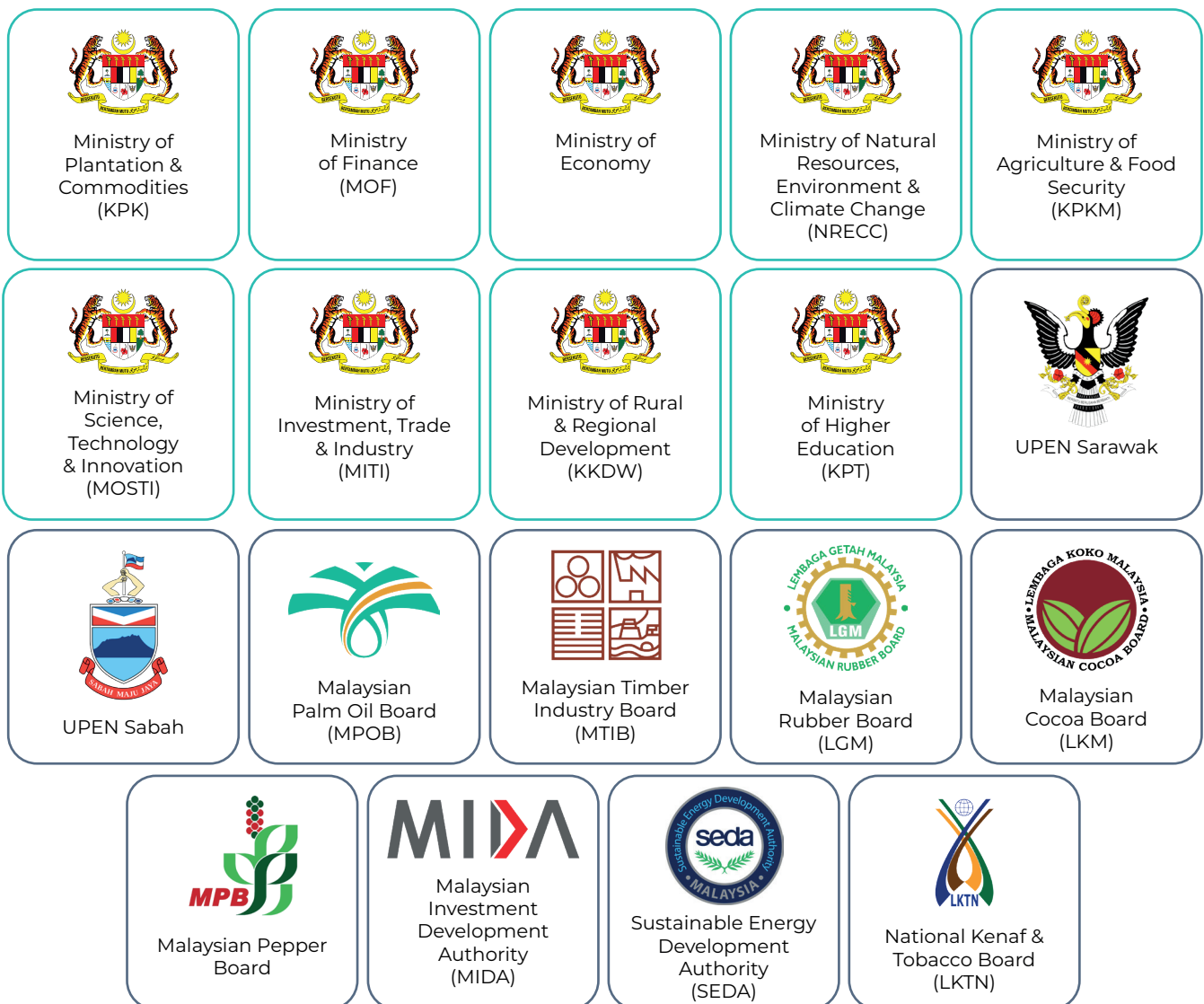
The following approved investment data compiled by MIDA presents a helicopter view of the recent biomass investment landscape in Malaysia for year 2021 and 2022.

Figure 1.2: Total Approved Biomass Investment in 2021 and 2022



Development of The National Biomass Action Plan 2023 - 2030

The Ministry of Plantation and Commodities (KPK) is the lead agency in the formulation of the National Biomass Action Plan (NBAP) 2023-2030 with invaluable support from the Steering Committee and Technical Committee. Both committees are chaired by KPK, comprise representatives from stakeholder ministries and agencies who have interests in the NBAP as policymakers or regulators. Their participation ensures a multi-agency involvement in the preparation, consultation and endorsement of the NBAP.



Methodology

The study on developing the National Biomass Action Plan 2023-2030 involves a comprehensive methodology to gather data, information, experience and insights from key stakeholders in the biomass industry. The target groups consist of biomass feedstock owners, multinational corporations (MNCs), small and medium-sized enterprises (SMEs), financial institutions, government agencies, academia and industry associations.

The modes are as follows:

(1) **Desk Top Research**

Various reports from both the government and industry locally and abroad related to the five biomass sectors have been analysed accordingly. The references of related Consultants' reports are done to garner findings, best practices and benchmarking. In addition, international agencies e.g. The International Renewable Energy Agency (IRENA) and the World Bank are also referred to.

(2) **Survey via Interviews and Questionnaires was Conducted**

In-depth interviews were conducted with the industry leaders and the subject matter experts to obtain valuable insights on biomass conversion technology, feedstock availability scenario and industry outlook both domestically and internationally. Structured survey forms and questionnaires were used to collect quantitative and qualitative data on important parameters from the targeted stakeholders of the five biomass sectors.

(3) **Focus Group Discussion**

Focus group discussions brought together representatives from the various target groups to facilitate knowledge exchange and capture diverse perspectives and position of various issues and solutions as proposed by the multi-stakeholders.

A total of eight FGDs involving 300 multi-stakeholders from the targeted groups have been intensively engaged in order to gather their valuable inputs and recommendations based on the prioritised areas in the study.

(4) **Insights Sharing by Government, Industrial and Business Contacts**

The consultancy team comprises industrial biomass stakeholders with vast expertise and experience. They provide unpublished data, facts and personal insights into the biomass ecosystems. They are familiar with the issues, challenges and solutions to harness the biomass upstream and downstream value chains. They are key members of the Malaysia Biomass Industries Confederation (MBIC).

The collected data covered vital aspects of the biomass ecosystems, providing a comprehensive understanding of technology availability, feedstock assessment, industry certification, R&D&C&I priorities, business models, desired government facilitation and communication dissemination of success stories.

Through this robust methodology, the study has gathered diverse data, perspectives, findings and insights from various stakeholders to formulate the National Biomass Action Plan 2023-2030. This Plan aims to support Chapter Nine of the National Agricommodity Policy (DAKN) 2030's five Policy Thrust and the seventeen broad strategies to unlock greater utilisation of biomass and also reap the inherent vast values in the biomass industry.

Chapter

**Estimated Biomass Quantities,
Current Utilisation & Findings**

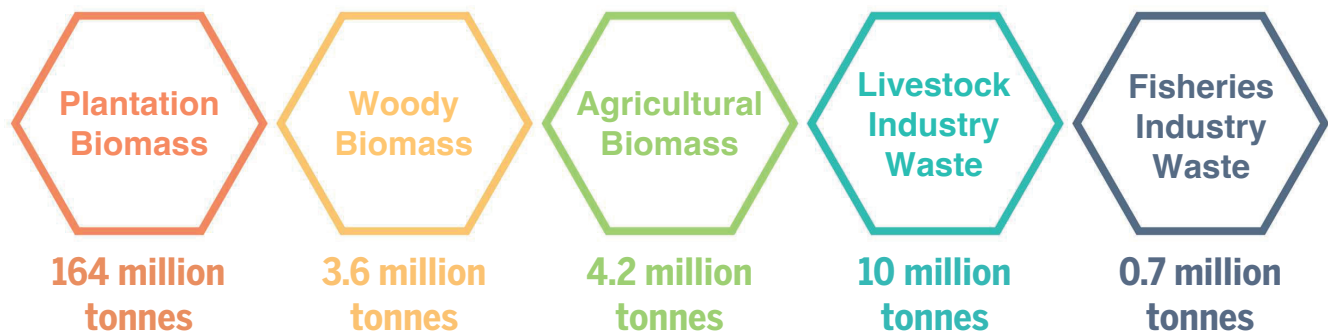


Estimated Biomass Quantities for the Targeted Sectors in Malaysia

BIOMASS ECONOMIC OPPORTUNITY MAPPING



Estimated Biomass Quantities for Year 2022 182.6 million tonnes



In Malaysia, the development of the biomass industry is at the different stages which cuts across various sectors. While some sectors have reached a more advanced stage, others are still in the early phases of development. The plantation biomass, woody biomass, agricultural biomass, livestock industry waste and fisheries industry waste sectors have been identified as potential areas for the growth of the biomass industry. Malaysia's dedicated focus on assessing the biomass potential in these sectors highlights the country's commitment to sustainable development and its drive to identify new opportunities within the biomass industry. By strategically nurturing and advancing these sectors, Malaysia aims to harness the full potential of biomass resources and paves the way for a greener and more sustainable future.

PLANTATION BIOMASS

89.8%

164 MILLION TONNES

Palm Oil Mills Fresh Fruit Bunch Production: 94,814,456 tonnes	Empty Fruit Bunch (EFB) Mesocarp Fibres (MF) Palm Kernel Shells (PKS) Palm Kernel Cake (PKC) Palm Oil Mill Effluent (POME)	7,300,713 tonnes 7,679,023 tonnes 4,427,835 tonnes 2,465,176 tonnes 63,525,686 tonnes
	Oil Palm Fronds (OPF) Oil Palm Trunks (OPT)	59,593,762 tonnes 10,548,826 tonnes
Cocoa Processing Factories: 537 tonnes	Cocoa Bean Shell Cocoa Hob & Pulp	49 tonnes 364 tonnes
Kenaf Planted Area: 1,500 hectares	Kenaf Shoot	3,000 tonnes
Sago Planted Areas: 33,928 hectares	Sago Palm Frond	53,564 tonnes
Palm Sagu Mill Production: 133,911 tonnes	Sago Bark Sago Hampas Sago Waste Water	147,302 tonnes 147,302 tonnes 8,034,660 tonnes

AGRICULTURAL BIOMASS

2.3%

3.6 MILLION TONNES

Paddy Production: 2,364,453 tonnes	Rice Straw Rice Husk	1,307,315 tonnes 534,356 tonnes
Banana Production: 329,573 tonnes	Banana Stalk	790,975 tonnes
Coconut Production: 604,428 tonnes	Coconut Husk Coconut Shell	271,993 tonnes 72,531 tonnes
Pineapple Production: 377,300 tonnes	Pineapple Peel Waste Pineapple Leaf	154,693 tonnes 565,950 tonnes
Durian Production: 455,458 tonnes	Durian Husk	296,048 tonnes
Sweet Corn Production: 63,155 tonnes	Sweet Corn Stalk Cob / Husk / Silk	113,679 tonnes 47,366 tonnes
Sugarcane Production: 25,032 tonnes	Sugarcane Top Sugarcane Bagasse Sugarcane Press Mud Sugarcane Molasses	5,006 tonnes 7,510 tonnes 876 tonnes 125 tonnes

WOODY BIOMASS**2.0%****4.2 MILLION TONNES**

Logging Production: 7 million m3	Logging Activity Residue	1,492,341 tonnes
Wood-based Industry Production: 4 million m3	Wood-based Industry Wood Residue	1,943,165 tonnes
Rubber Tree Replanting: 469,669 tonnes	Rubber tree biomass (Branches, twigs, leaves, roots)	212,120 tonnes

LIVESTOCK INDUSTRY WASTE**5.6%****10 MILLION TONNES**

Number of Poultry is approximately 295 million	Poultry Manure Poultry Waste from Slaughter House	4,000,531 tonnes 176,103 tonnes
Number of Cattle Livestock is approximately 721 thousands	Cattle Manure Cattle Waste from Slaughter House	4,418,016 tonnes 15,156 tonnes
Number of Goat Livestock is approximately 312 thousands	Goat Manure Goat Waste from Slaughter House	219,785 tonnes 237 tonnes
Number of Sheep Livestock is approximately 125 thousands	Sheep Manure Sheep Waste from Slaughter House	91,034 tonnes 158 tonnes
Number of Swine Livestock is approximately 1.7 million	Swine Manure Swine Waste from Slaughter House	1,161,551 tonnes 75,634 tonnes

FISHERIES INDUSTRY WASTE**0.4%****0.7 MILLION TONNES**

Production of the Fisheries Industry: 1,890,288 tonnes	Fish Waste	695,133 tonnes
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WOODY BIOMASS



Quick Fact

The primary sources of woody biomass are residues from logging activities, wood-based processing industries such as sawn timber mills, plywood mills, veneer processing centres and moulding factories as well as the biomass obtained from felled rubber trees during replanting activities.

Table 2.1: Estimated Woody Biomass for year 2021

Sector	Annual Production 2021	Type of Biomass	Estimated Quantities
Rubber Trees Replanting	Replanting production: 469,669 tonnes	Rubber tree biomass (branches, twigs, leaves, roots)	212,120 tonnes
Forest Residues	Log production: 7,043,000 m ³	Bark, stumps, tops, branches, broken logs	1,492,341 tonnes
Wood-Based Processing Industry	Total production for sawn mills (plywood, veneer and moulding processing factories): 4,725,824 m ³	Sawdust, offcuts, slabs, shavings, trimming edging	1,943,165 tonnes
Total			3,647,626 tonnes

Figure 2.1: Sources of Woody Biomass

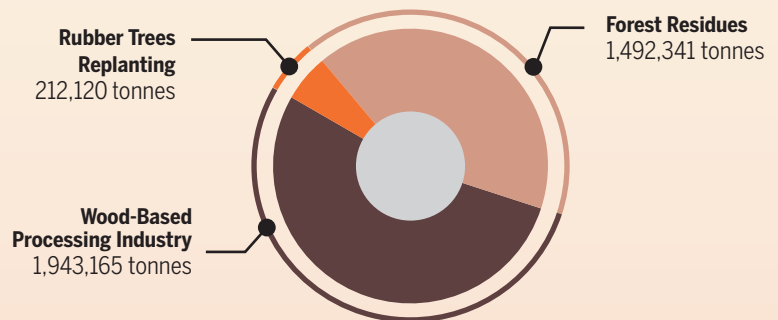
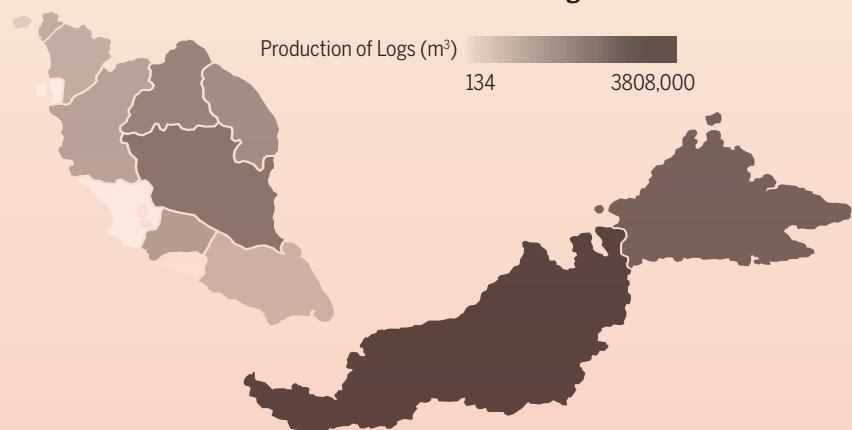


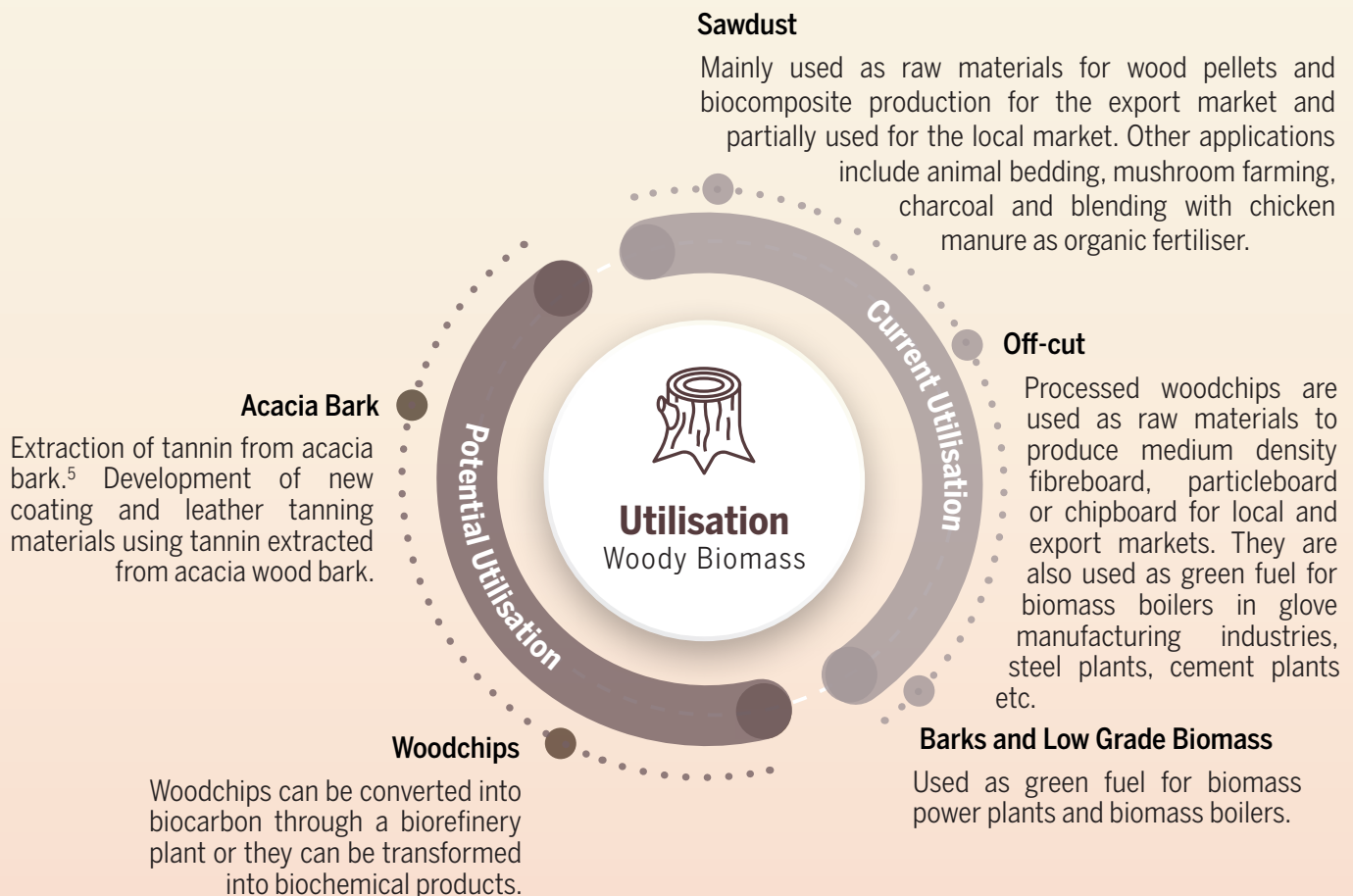
Figure 2.2: Map of Malaysia Colour-coded According to Production of Logs



Source: State Forestry Department

Findings: Utilisation of Woody Biomass

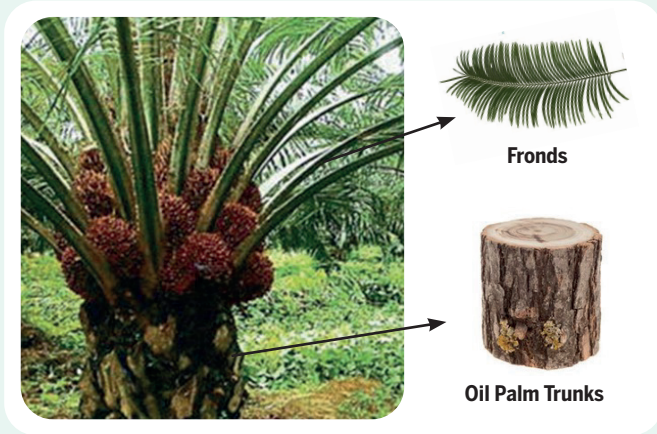
- There are approximately 5,000 primary wood-based factories in Malaysia producing an estimated 1,943,165 tonnes of woody biomass.
- Woody biomass which comprises offcuts and sawdust is produced in sawmills and other timber processing factories i.e. plywood, veneer, moulding etc.
- Woody biomass is optimally utilised through contractual arrangements or reserved for regular customers. New buyers or bidders of woody biomass are likely to trigger a price war in order to procure woody biomass on a big scale basis. Meanwhile, the woody biomass from milling operations are still available on a piecemeal basis, its availability is subject to higher bidding price offered by new entry buyers.⁴
- The utilisation rate of forest residues from post-logging is low due to high logistics and handling costs as well as the sustainable forestry management policy imposed by the Forestry Department which encourages post-logging residues to be used for mulching purposes.
- Forest plantations offer a reliable and abundant source of feedstock supply. Recently, a biomass power plant project developer has ventured into forest plantation to extract woodchips as green fuel.



4. Results of FGD, direct survey with timber processing factories, engagement with industry associations, input and output analysis of woody biomass data as well as feedback from MTIB.

5. R&D and patented technology owned by MTIB

OIL PALM BIOMASS AT THE PLANTATIONS



Quick Fact

The oil palm trunk (OPT) refers to the main stem of the oil palm tree which becomes available when the tree is felled during the replanting process.

Oil palm fronds (OPF) are obtained from the uppermost part of the oil palm tree, specifically the leaves or fronds which are available during annual pruning activity and replanting process.

Table 2.2: Estimated OPF and OPT for year 2022

Type of Biomass	Dry Weight (million tonnes)	Biomass Availability
Oil Palm Fronds (OPF)	59.593	Largely available
Oil Palm Trunks (OPT)	7.23	Largely available. Easier to source OPT from smallholders vis-a-vis major plantation companies.

Figure 2.3: Oil Palm Planted Area by Category for year 2022 (5,674,742 Ha)

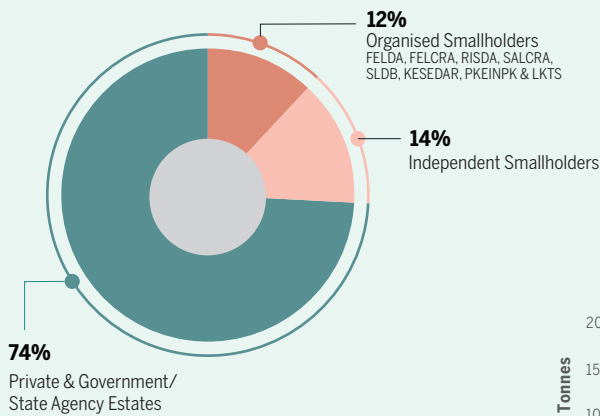


Figure 2.4: Projected Oil Palm Trunks Availability for year 2023 - 2040

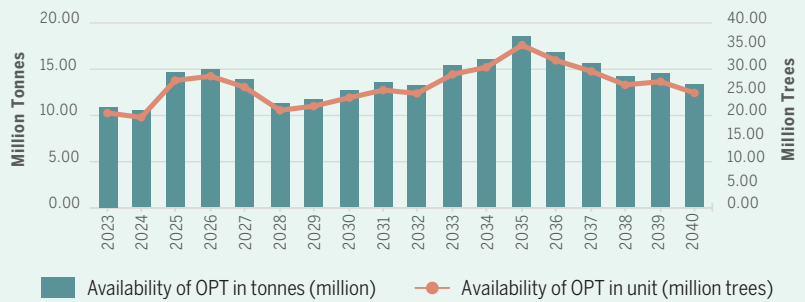
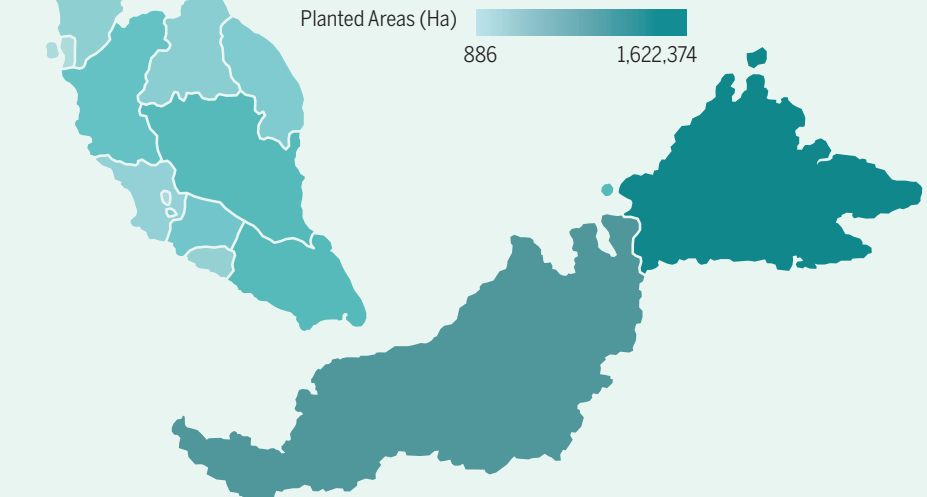


Figure 2.5: Map of Malaysia Colour-coded According to Oil Palm Planted Areas



State	Oil Palm Planted Areas 2022 (Ha)
Sarawak	1,622,374
Sabah	1,508,060
Pahang	749,813
Johor	676,853
Perak	352,098
N. Sembilan	178,560
Terengganu	170,825
Kelantan	161,852
Selangor	106,008
Kedah	86,487
Melaka	52,347
Pulau Pinang	8,579
Perlis	886

Source: Malaysian Palm Oil Board (MPOB)

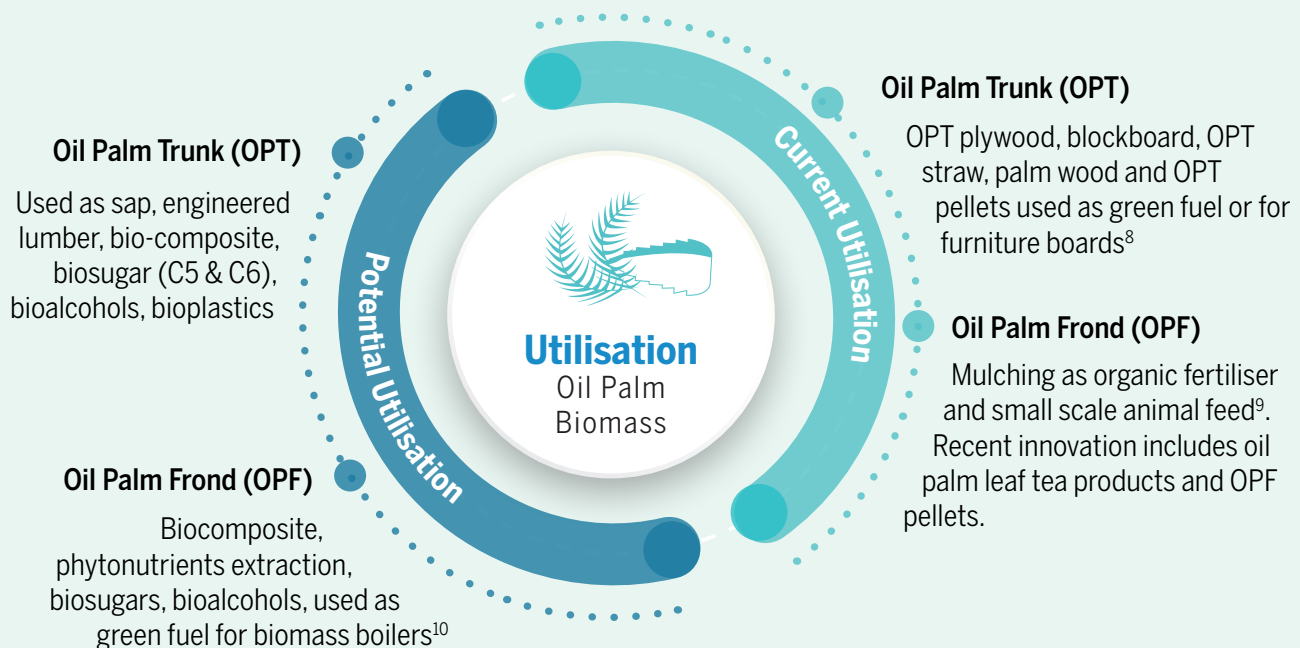
Findings: Utilisation of Oil Palm Biomass Generated from Plantation

• Oil Palm Trunk (OPT)

- Felled OPTs which are available during replantation scheme are projected to be between 7 million tonnes - 10 million tonnes⁶ per year subject to the actual schedule and operation of replanting activities.⁷
- Based on the feedback of engaged estate managers and findings of annual reports analysis of listed plantation companies, the OPTs are largely available in the plantation and are used for the purpose of mulching serving as organic fertiliser.
- Nevertheless, felled OPTs located in remote plantation areas still pose logistical challenges for commercialisation.

• Oil Palm Frond (OPF)

- Currently, OPFs are largely available in the plantation. Most of the engaged estate managers highlighted that the OPFs are left in the plantation to decompose and fertilise the soil, which is in line with the findings of annual reports of listed plantation companies.
- Although the fronds are available in large quantities all year long due to pruning or replanting activities, they have yet to be commercialised at the industrial scale level.
- This is partly due to the logistical challenges as well as the thorny nature of its petiole despite being the largest segment of oil palm biomass.



⁶ Dry weight

⁷ MPOB is in the midst of undertaking a comprehensive survey to ascertain the actual availability of OPTs

⁸ New Business Model

⁹ It was commercialised as animal feed by the GLC; the project halted due to logistical challenges

¹⁰ Pilot project proposed by China company.

OIL PALM BIOMASS AT THE PALM OIL MILLS



Quick Fact

Empty Fruit Bunch is the fibrous material that remains after the extraction of palm oil from the fresh fruit bunches.

Mesocarp Fibre is the fleshy middle layer of the oil palm fruit.

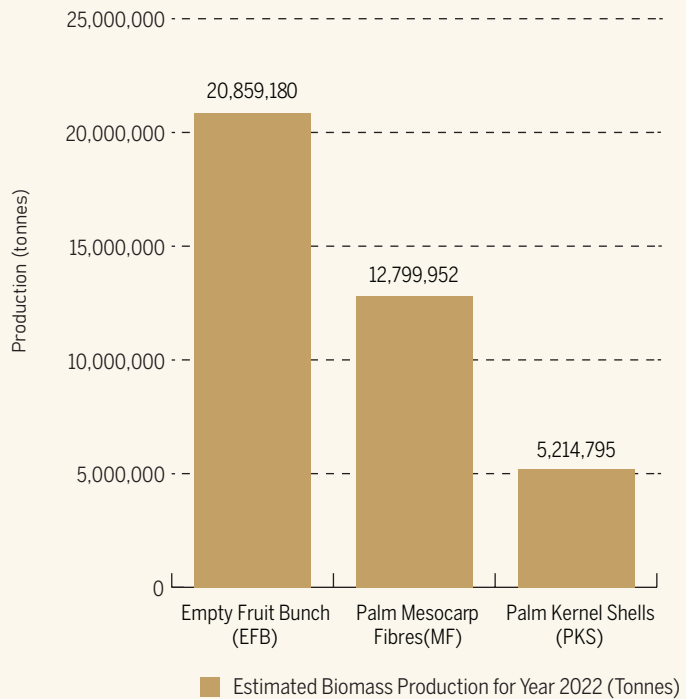
Palm Kernel Shell is a by-product of the palm oil extraction process.

Palm Oil Mill Effluent (POME) is produced during the processing of fresh fruit bunches in palm oil mills.

Special Mention:

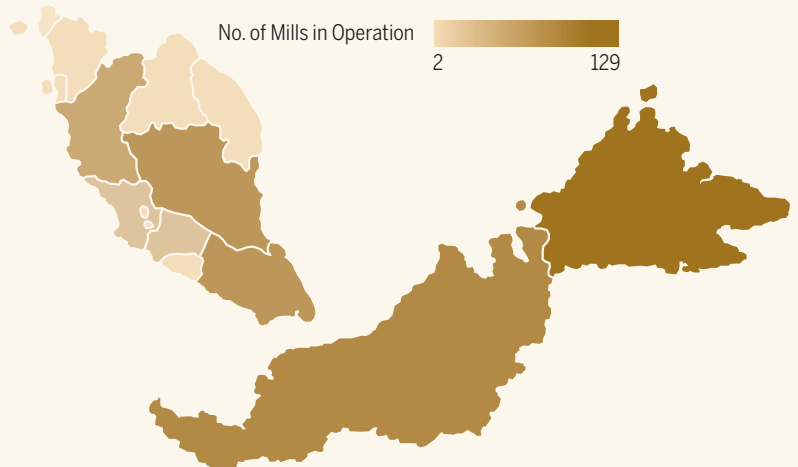
Palm Kernel Cake (PKC) is a by-product obtained after the pressing of kernel oil from the kernel flesh of the palm fruits; PKC is generated from kernel crushing plants.

Figure 2.6: Estimated Solid Biomass Production at the Palm Oil Mills for year 2022



State	No. of Mills in Operation for 2022
Sabah	129
Sarawak	84
Pahang	69
Johor	63
Perak	44
Selangor	15
N. Sembilan	14
Terengganu	12
Kelantan	10
Kedah	6
Melaka	3
Pulau Pinang	2

Figure 2.7: Map of Malaysia Colour-coded According to the Number of Palm Oil Mills



Source: Malaysian Palm Oil Board (MPOB)

Findings: Utilisation Oil Palm Biomass Generated from Milling Operation

Palm oil mills generate four types of biomass i.e. empty fruit bunches (EFB), palm kernel shell (PKS), mesocarp fibre (MF) and palm oil mill effluent (POME). The utilisation rate of these palm biomass are presented with the following findings.¹¹

➤ Empty Fruit Bunches (EFB)

Based on the recent data furnished by MPOB, the EFBs are available at the palm oil mills with low utilisation rates. Only 41.20% of the survey's respondents returned the EFBs to the plantation for the purpose of mulching and 3.8% of engaged palm oil mills used it for the purpose of incineration. In other words, its overall utilisation rate is less than 50%.

➤ Palm Kernel Shell (PKS)

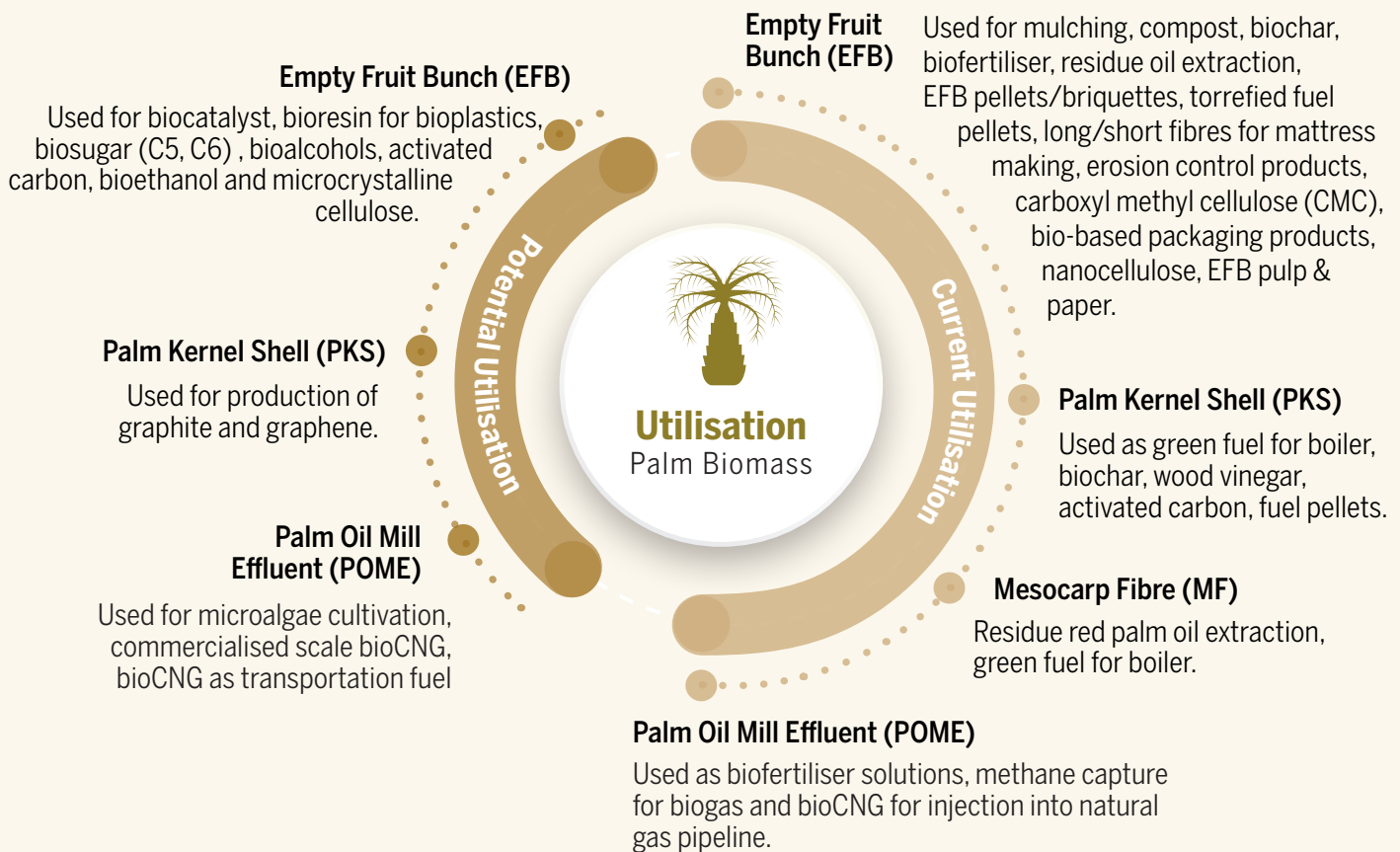
PKS is a popular green fuel mainly used by palm oil mills for the purpose of co-generation of steam and electricity. It is also a highly sought after fuel commodity and a total of 1.25 million tonnes of PKS has been exported overseas mainly to Japan in 2022. In other words, PKS has achieved almost 100% optimal utilisation rate.

➤ Mesocarp Fibre (MF)

MPOB's data also highlighted that close to 92.4% of the engaged palm oil mills utilised the mesocarp fibre as green fuel for their in-house boilers under the captive power practice. The rest of the respondents sell the MF to other parties.

➤ Palm Oil Mill Effluent (POME)

For POME, the majority of the millers i.e. 98.8% utilise the sludge and POME for their plantation activities due to the enriched content of bionutrient. Leading plantation companies are increasing the usage of POME as part of the biofertiliser solutions in the context of sustainable plantation.



¹¹ Data from MPOB and DOSM, results of FGD, engagement with plantation companies and palm oil mills as well as relevant industry associations.

COCOA POD HUSK, COCOA PULP AND COCOA BEAN SHELL



Cocoa Pod Husk



Cocoa Pulp



Cocoa Bean Shell

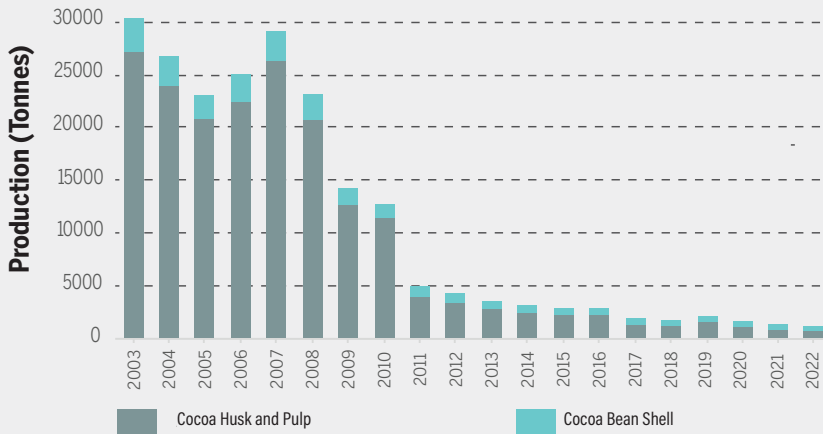
Quick Fact

The cocoa husk is the tough outer layer of the cocoa pod, providing protection to the pulp and beans. The cocoa pulp is the sweet and edible material that surrounds the cocoa beans within the cocoa pod. The cocoa bean shell is the thin, brittle covering of the cocoa bean itself, which is removed during processing.

Table 2.3: Estimated Cocoa By-products for year 2022

Cocoa By-products	Tonnes
Cocoa Pod Husk & Pulp	364
Cocoa Bean Shell	49

Figure 2.8: Cocoa By-products Production for year 2003-2022



Smallholding vs Estate



5,106 ha

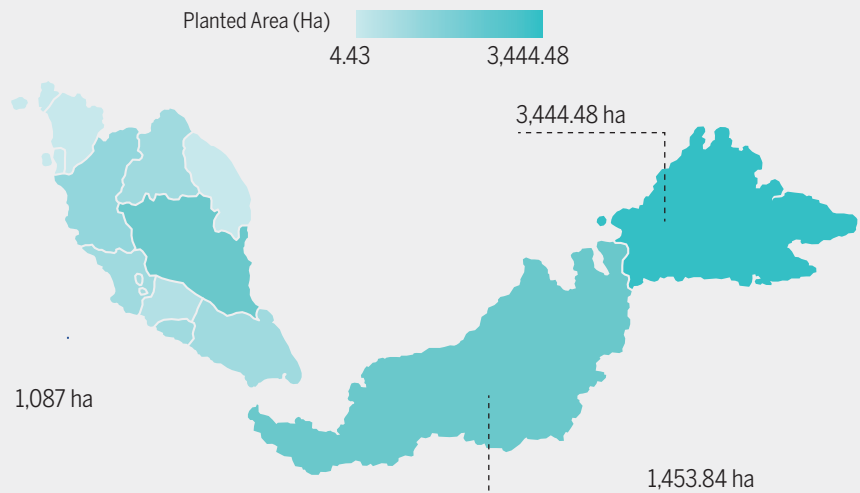


879 ha

Cocoa Cultivation Area for 2022 (Ha)

State	Cocoa Cultivation Area for 2022 (Ha)
Sabah	3,444.48
Sarawak	1,453.84
Pahang	468.29
Perak	389.10
Kelantan	64.60
Johor	51.54
Selangor	47.70
N. Sembilan	23.60
Kedah	14.25
Melaka	11.05
Terengganu	6.62
Perlis	5.57
Pulau Pinang	4.43

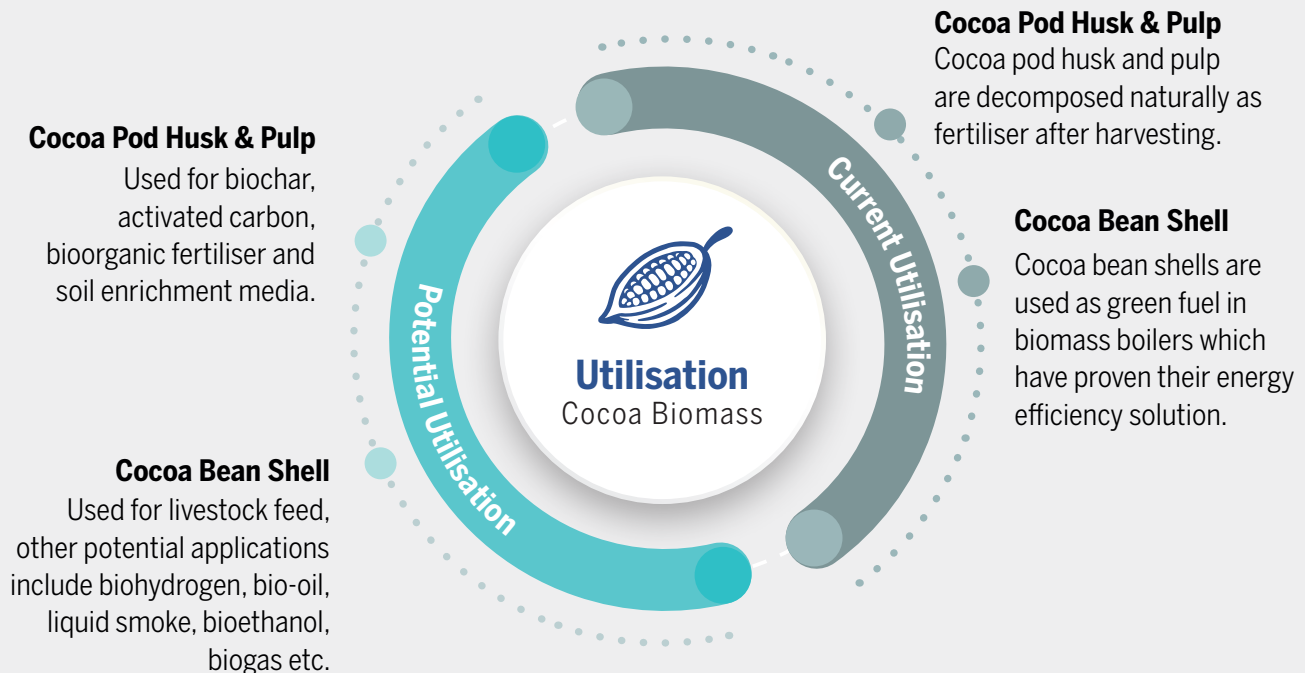
Figure 2.9: Map of Malaysia Colour-coded According to the Cocoa Cultivation Area



Source: Malaysian Cocoa Board (LKM)

Findings: Utilisation of Cocoa Biomass

- Cocoa pod husk is not being used for commercial purposes at the moment. After harvesting, the cocoa pod husk will be left at the plantation areas, to be decomposed naturally as fertiliser.
- While many processing centres may discard cocoa bean shells, there are cocoa grinding facilities that use these residual shells for biomass boiler operations, specifically for steam generation activities. This approach demonstrates a sustainable and resourceful use of cocoa bean shells as biomass fuel.
- By leveraging cocoa bean shells as a biomass resource, these grinding facilities contribute to waste reduction and act as sources of renewable energy in their operations.
- The Malaysian Cocoa Board (LKM) has successfully developed skincare products using cocoa pod husks, which are pending for commercialisation. At the same time, LKM is leading a research on the production of biochar from cocoa pod husks.
- Due to their nutritional composition, cocoa bean shells have the potential to be utilised as a component of livestock feed. They provide the sources of fibre, proteins, minerals and vitamins, which can contribute to the animal's healthy nutrition.



SAGO BIOMASS



Quick Fact

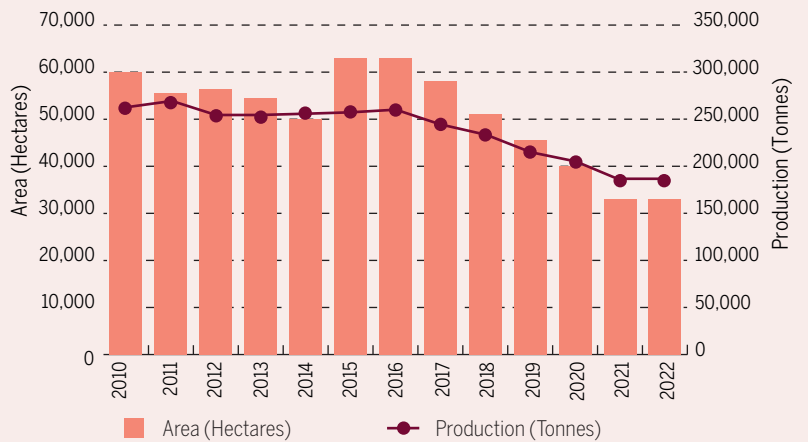
Sago biomass is generated through two distinct activities. Firstly, during the harvesting of sago logs at the plantation, fronds are produced. Secondly, at the sago mill processing centres, waste materials such as barks, hampas and sago mill effluent are generated during the starch extraction process.

Table 2.4: Estimated Sago Biomass/Waste for year 2022

Type of Biomass/ Waste	Estimated Biomass/ Waste (Tonnes)
Sago Palm Fronds	53,564
Sago Barks	147,302
Sago Hampas	147,302
Sago Waste Water	8,034,660

Source: DOA, Craun Research & Consultant's Analysis

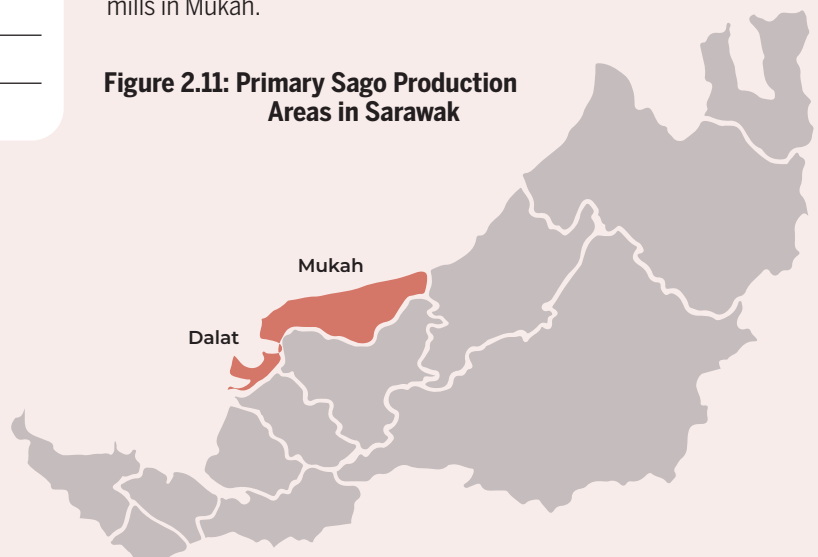
Figure 2.10: Statistics of Sago Production for year 2010-2022



Source: DOA

Malaysia's primary sago production areas are Mukah and Dalat regions in Sarawak with 6 mills located in Dalat and 2 mills in Mukah.

Figure 2.11: Primary Sago Production Areas in Sarawak



Findings: Utilisation of Sago Biomass

➤ Silage Made from Fermented Sago Fronds

The potential of utilising sago fronds as a source of feed material and lactic acid has been widely explored. Nutrient-rich silage without the need for additives has been successfully generated through the ensiling process. Preliminary tests on the palatability of sago frond silage were conducted using mixtures of young and mature goats at a training centre in Sarawak near Sri Aman.

➤ Bark Waste:

In the sago processing industry, bark waste is commonly discarded without any substantial utilisation. However, locals use the barks to construct platforms around factories, footpaths for houses and as materials for walls and fences.

➤ Hampas Waste:

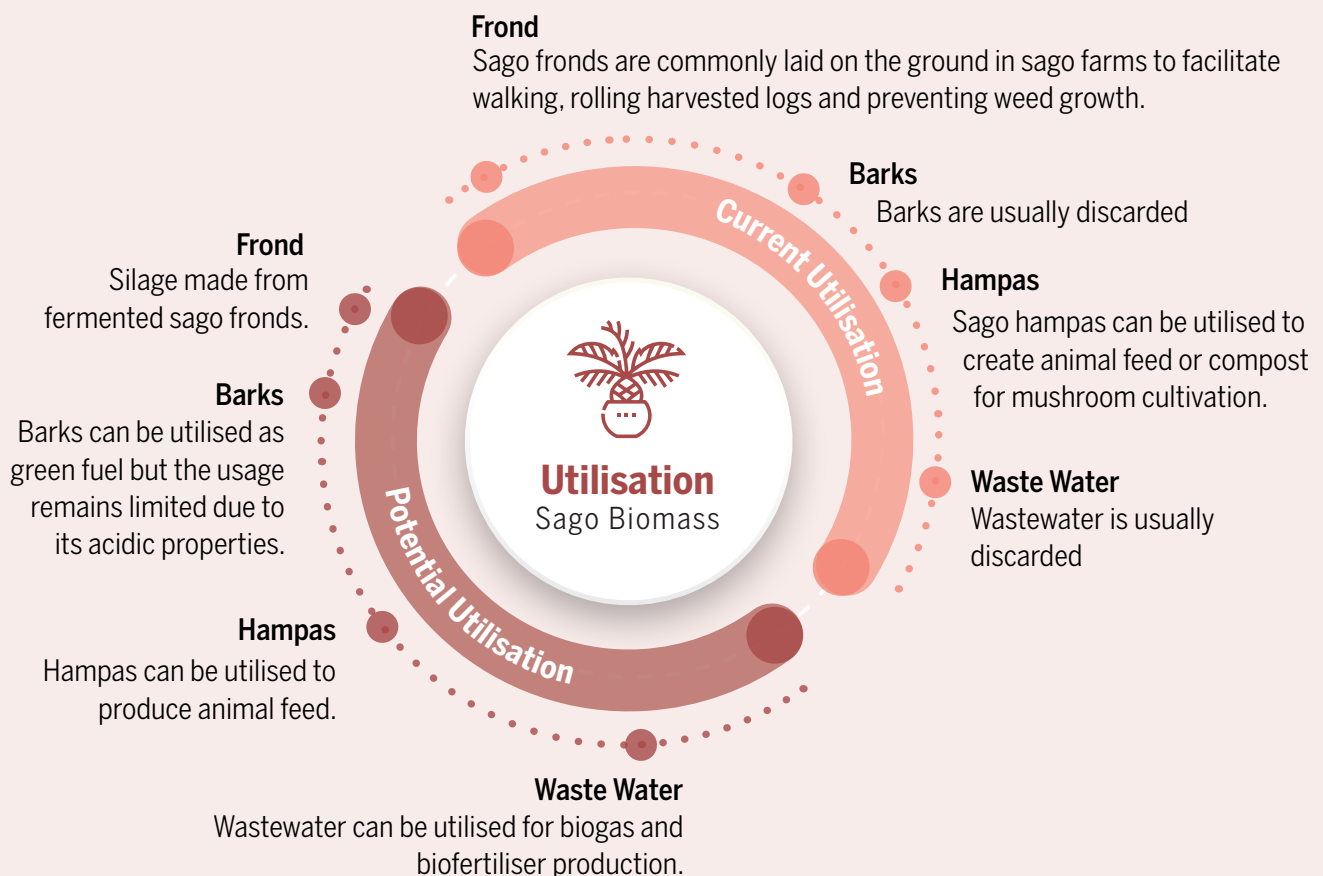
Sago hampas is used as animal feed and compost for mushroom cultivation.

➤ Waste Water:

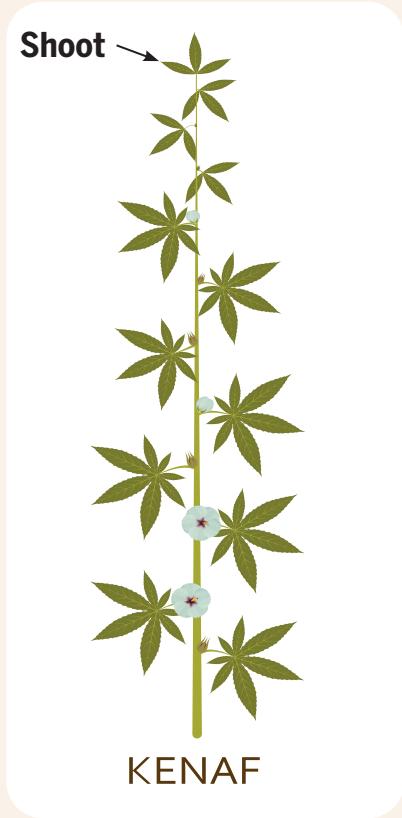
The waste water produced during the sago starch extraction process has been used as biogas for heat and power generation. Another utilisation is to produce biofertiliser.

➤ CRAUN Research

According to CRAUN Research which was established by the Sarawak Government, the current utilisation of sago waste does not fully harness the economic potential of the entire sago palm waste. These wastes are often left on the ground in the sago farms to facilitate movement and prevent weed growth. However, ongoing research and development efforts are focused on finding additional economic uses for these underutilised components in the sago industry.

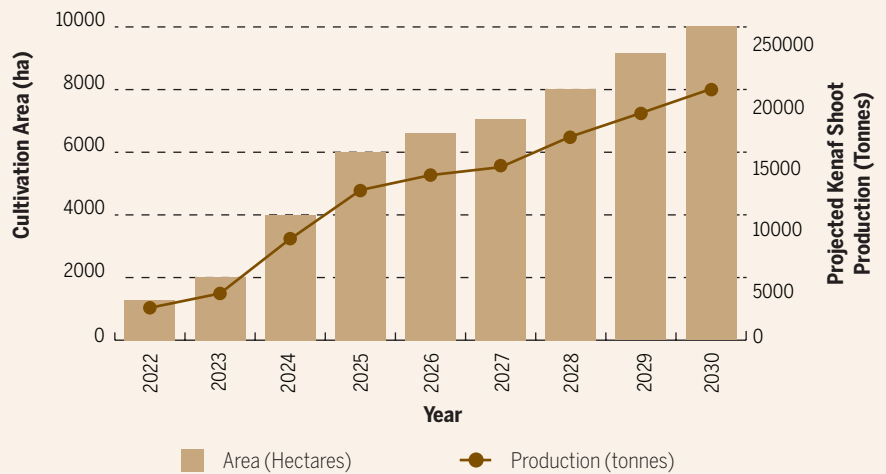


KENAF SHOOT



Quick Fact
 Kenaf is cultivated primarily for its fibre. During the cultivation process, tender and young stems known as kenaf shoots are produced. These shoots, located near the upper part of the stem, are harvested separately from the stalks and currently used as animal feed.

Figure 2.12: Projected Kenaf Shoot Production for year 2022-2030



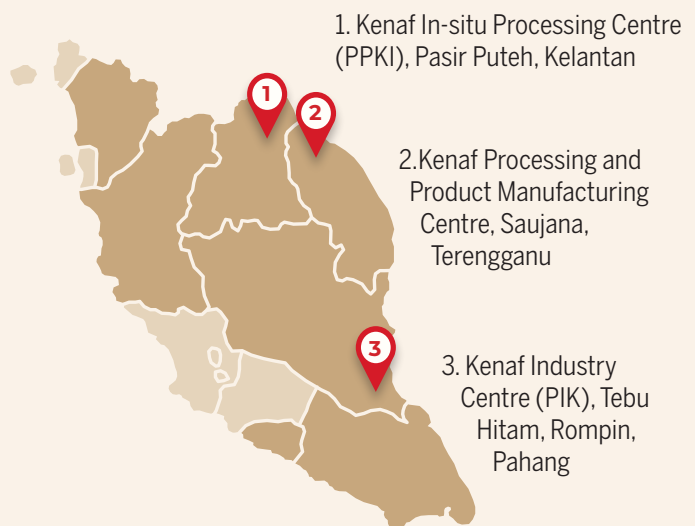
Location

Plantation Areas Kelantan, Terengganu, Pahang, Johor, Melaka, Perak & Kedah

- Kenaf Processing Centre**
1. Kenaf In-situ Processing Centre (PPKI), Pasir Puteh, Kelantan
 2. Kenaf Industry Centre (PIK), Tebu Hitam, Rompin, Pahang
 3. Kenaf Processing Manufacturing Centre, Saujana, Setiu, Terengganu

Source: 2021 Statistics from the National Kenaf and Tobacco Board (NKTB)

Figure 2.13: States with Kenaf Cultivation and the 3 Kenaf Processing Centres



The Current Utilisation of Kenaf Shoot in Malaysia

The kenaf industry in Malaysia is primarily driven by smallholders. Currently, kenaf shoots are utilised as animal feed. The nutritional composition of kenaf shoot makes it a source of valuable feed for livestock, providing essential nutrients and promoting healthy growth.

PEPPER



Quick Fact

Pepper is a woody climber that requires support to grow upward. The possible types of biomass are:

- 1) Trimmings from live trees, including leaves and small top branches, which are used to support the growth of pepper.
- 2) Grass cleared from the surrounding area of the pepper trees.
- 3) Trimmings from shoots and side branches of the pepper trees, which are pruned quarterly or annually.
- 4) Replanting activities of pepper trees, where old pepper trees become available for biomass utilisation.

Table 2.5: Estimated Total Planted Areas of Pepper for Year 2022

Region	Planted Areas (Ha)	Percentage
Peninsular Malaysia	90	1%
Sabah	60	1%
Sarawak	7,870	98%

Source: DAKN 2030

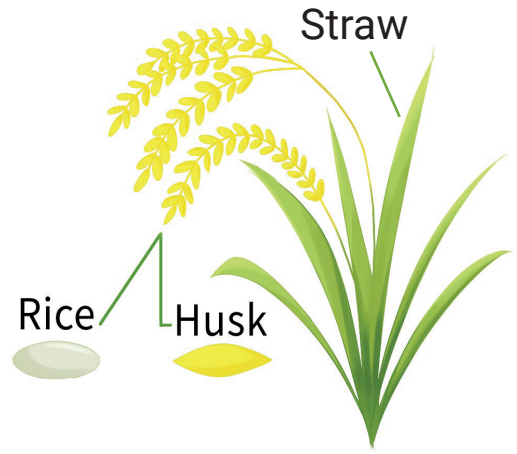
Figure 2.14: Major Production Area of Pepper in Malaysia



Findings on Pepper Biomass Utilisation

Presently, the biomass generated at the pepper planting site is left unused and allowed to decompose naturally. A well-maintained pepper plant typically remains productive for 15 to 20 years or even longer. During the replanting process, the old pepper trees are left at the site to decompose naturally. It is possible to plant up to 2000 pepper plants per hectare, with harvest usually taking place around the third year of growth. In new plantings, flowers are trimmed to promote healthy plant development, and the discarded flowers are left at the site. In terms of production distribution, Sarawak accounts for 98% of the pepper production.

RICE HUSK AND RICE STRAW



Quick Fact

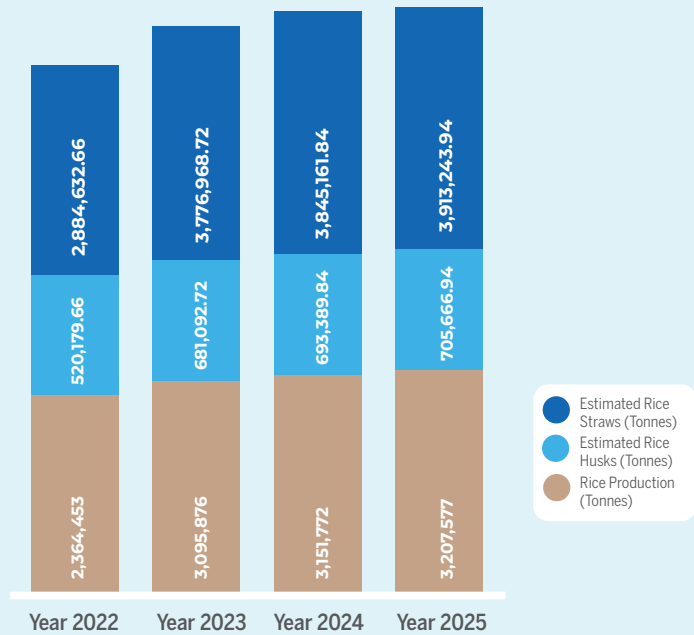
Rice straws and rice husks are residues from paddy cultivation and rice production process.

Rice straws refer to the stalks or stems left over after the grains of rice are harvested, while rice husks are the protective outer layer of the rice grain that are removed during the milling process.

State	Planted Areas 2022 (Ha)	Paddy Production 2022 (Tonnes)
Kedah	214,551	888,358
Perlis	60,478	272,786
Kelantan	74,017	272,496
Perak	74,594	269,790
Sarawak	77,493	146,951
Selangor	35,755	141,262
Pulau Pinang	24,210	122,321
Sabah	37,324	111,370
Terengganu	18,957	62,712
Pahang	13,635	50,327
Johor	2,776	10,832
Melaka	3,318	10,307
N. Sembilan	1,313	4,941

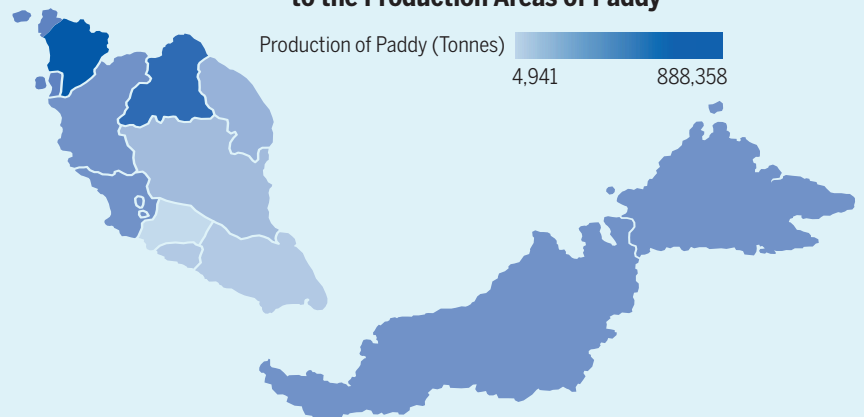
Source: Department of Agriculture (DOA)

Figure 2.15: Projected Rice Husks and Rice Straws for year 2022-2025



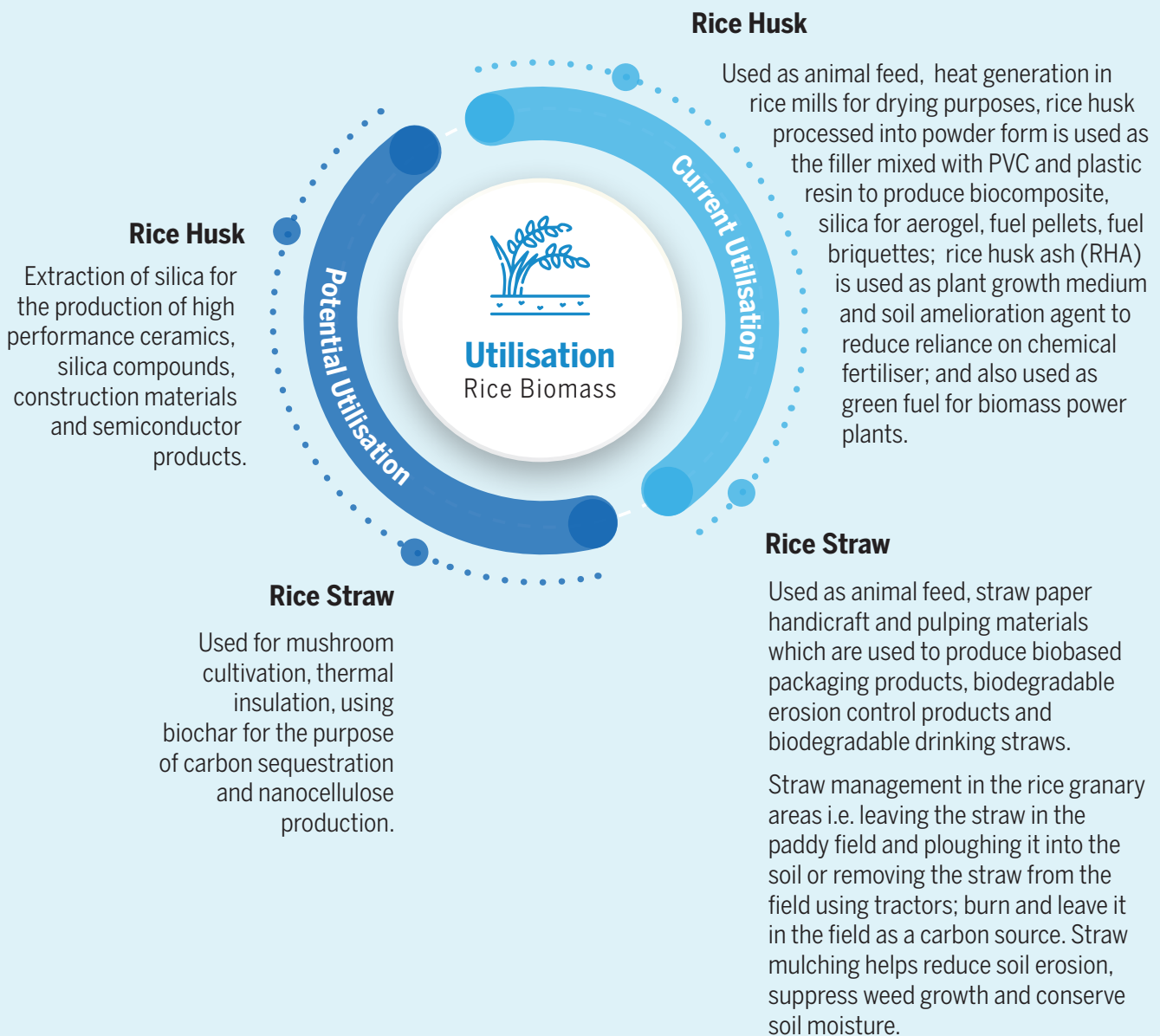
The table presents projections for rice husks and straws from 2022 to 2025. For the year 2022, with rice production of 2,364,453 tonnes, an estimated quantity of 520,179.66 tonnes of rice husks and 2,884,632.66 tonnes of rice straws are expected to be generated.

Figure 2.16: Map of Malaysia Colour-coded According to the Production Areas of Paddy



Findings: Utilisation of Paddy Biomass

- About 83% of paddy mills engaged in the survey highlighted that rice husks are utilised as green fuel in the biomass boilers to dry the rice. Malaysia has about 150 rice mills throughout the country.
- The pricing and supply of rice husks have been uncertain due to its nature as a seasonal crop.
- Rice husks and rice straws are relatively more costly as compared to other biomass such as woodchips or empty fruit bunches. Buyers of rice biomass need to convert the biomass into higher value products as the feedstock cost is higher especially the rice straws which cost more than RM200 per tonne.
- The utilisation rate of rice husks is considerably high, exceeding 90% according to the results of a survey conducted with the rice mills in Malaysia.
- While there is an abundance of rice straw feedstock, only a small percentage is being used to produce high-value products i.e. biobased packaging products and biodegradable erosion control products.



BANANA PSEUDOSTEM



Quick Fact

The banana pseudostem, also known as banana stalk, is a sturdy and fibrous structure comprising tightly packed leaf sheaths. It provides support for the leaves and fruit bunch of the banana plant.

Table 2.6: Estimated Production of Banana and Pseudostem for year 2022-2025

Year	2022	2023	2024	2025
Banana Production (Tonnes)	329,573	334,516	339,534	344,627
Pseudostem Production (Tonnes)	790,975	802,838	814,881	827,104

State Annual Production 2022 (Tonnes)

Johor	120,929
Sabah	50,594
Pahang	50,574
Perak	35,080
Sarawak	23,457
Kelantan	16,185
Kedah	8,717
Terengganu	8,480
N. Sembilan	7,659
Selangor	7,048
Pulau Pinang	766
Melaka	468
WP Labuan	230
Perlis	58

Source: Department of Agriculture (DOA)

Figure 2.17: Estimated Production of Banana and Pseudostem for year 2022-2025

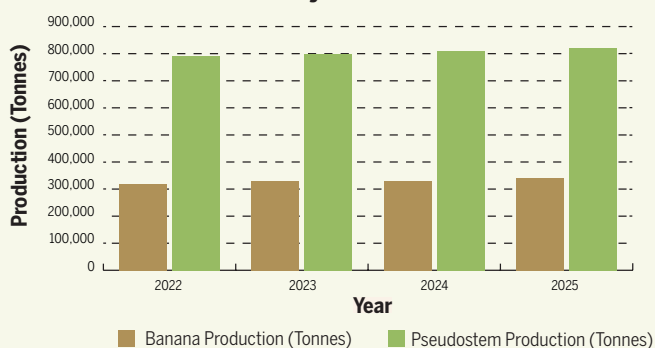
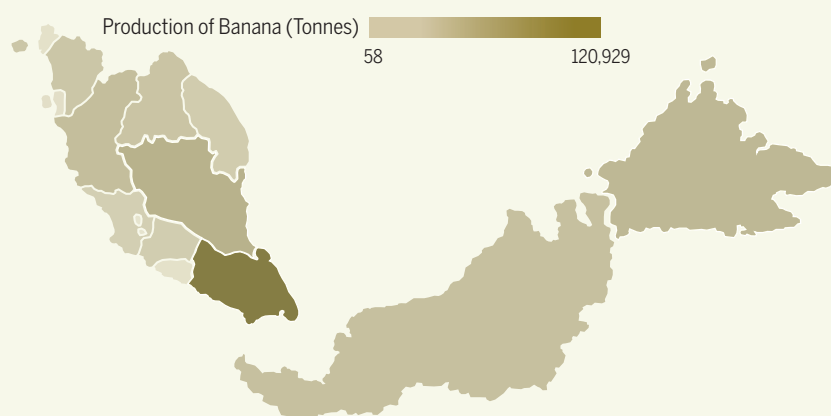


Figure 2.18: Map of Malaysia Colour-coded According to the Production Areas of Banana



Findings: Utilisation of Banana Pseudostem in Malaysia

- Currently, the pseudostem and leaves are commonly left to decompose in farms or plantations to replenish soil nutrients. There is no commercialisation of products made from banana stems after harvesting, according to the Crops Division under KPKM.
- Fibre Extraction for Textile Production: various technologies can be employed to process the pseudostem. One application is fibre extraction for textile production. Mechanical extraction or retting processes are used to separate the strong and durable fibres from the pseudostem. The fibres can be further processed and spun into yarn or thread for textile production.
- Paper Production: Pseudostem fibres can also be used for paper production. Pulping technologies break down the fibres into pulp, which is then processed into paper sheets.
- Liquid Organic Fertiliser: Another potential use of pseudostem is for the production of liquid organic fertiliser. This fertiliser can be applied to banana trees, vegetable crops, paddy fields and sugarcane, providing nutrient-rich organic matter.



PINEAPPLE LEAVES & PINEAPPLE PEEL WASTE



Quick Fact
Pineapple by-products include discarded leaves from the plantation and waste materials like crown, stem, peel, and core produced during pineapple processing.

Table 2.7: Estimated Pineapple By-products for year 2022

Types of By-Products	Estimated Annual Production (Tonnes)
Pineapple Leaves	565,950
Pineapple Peel Waste	154,693

State	Pineapple Production 2022 (Tonnes)
Johor	263,368
Pahang	29,632
Sarawak	26,996
Sabah	12,947
Selangor	12,370
Kedah	8,669
Perak	7,040
Kelantan	5,077
Pulau Pinang	3,651
Terengganu	3,573
N. Sembilan	1,576
Melaka	517
Perlis	9.4

Figure 2.19: Estimated Pineapple By-products Production in Malaysia for year 2022

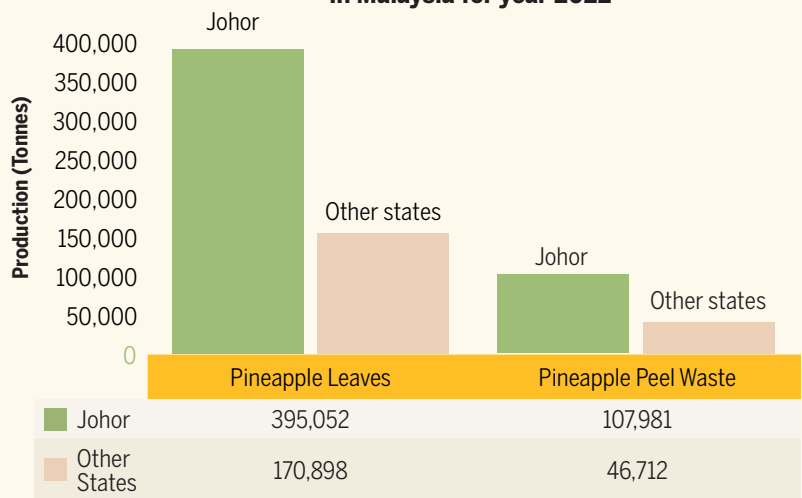
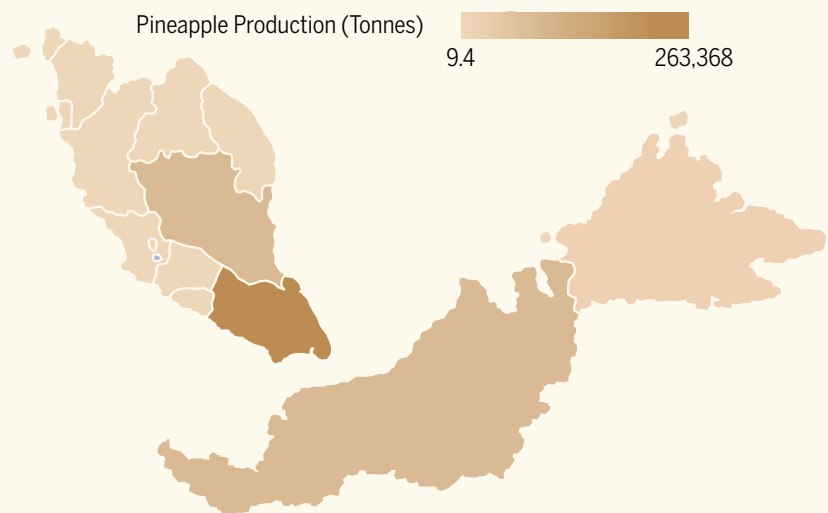


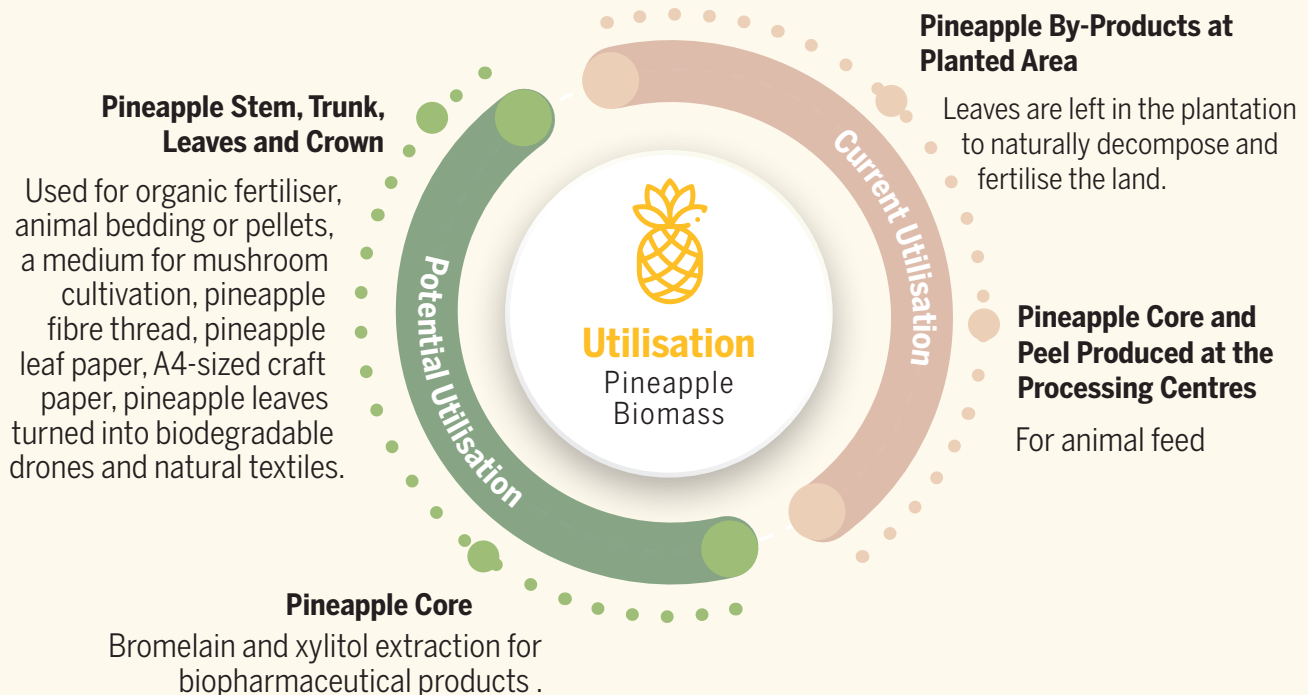
Figure 2.20: Map of Malaysia Colour-coded According to the Production of Pineapple



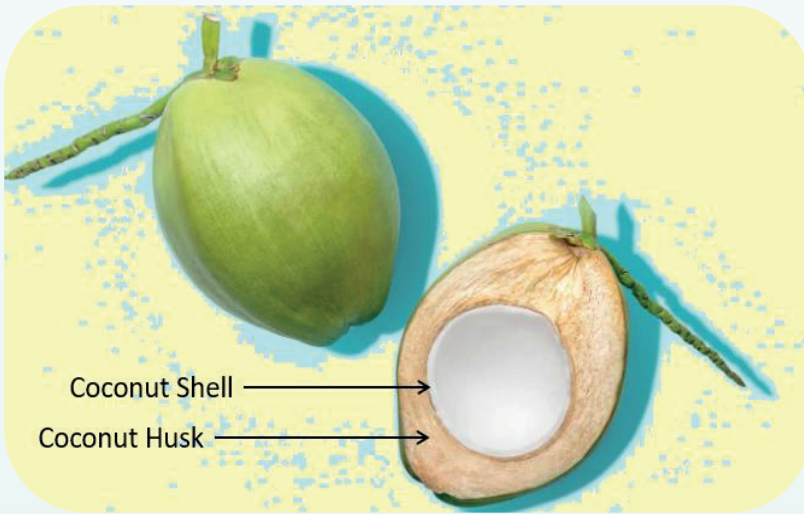
Source: Department of Agriculture (DOA)

Findings: Utilisation of Pineapple By-Products

- In a hectare of pineapple plantation, there are approximately 42,000 pineapple plants, each yielding 35-40 leaves and along with stems and crowns, resulted in significant by-products in the farm. These leftover parts are further categorised into wet waste and dry waste.
- Currently, the waste is not utilised by the farmers but left in the plantation to naturally decompose and fertilise the soil.
- The estimated wet waste generated from a one-hectare pineapple plantation is approximately 126 tonnes which can be used to produce an equal amount of animal feed silage. By effectively managing this wet waste, pineapple farmers can contribute to the livestock industry while minimising environmental impact and promoting sustainable practices.
- On the other hand, the dry waste produced from the pineapple plantation can be utilised for plant composting. This process resulted in the creation of organic plant compost which can be used as a natural fertiliser to enrich the soil. This practice can promote sustainable farming and reduce reliance on chemical fertilisers.
- The pineapple leaves have their own set of uses. The extracted leaf fibres can be transformed into the pineapple fibre thread while the leaf pulp can be made into pineapple leaf paper. Overall, these waste materials can provide a source of raw materials for further processing, contributing to the production of various end products.



COCONUT HUSK & COCONUT SHELL



Quick Fact

The coconut husk is obtained from the outer layer of the coconut and is known for its strength and water-absorbing properties. The coconut shell, on the other hand, refers to the hard outer covering of the coconut fruit.

State	Planted area (Ha)	Coconut Production 2022 (Tonnes)
Johor	12,276	119,461
Selangor	9,043	108,635
Perak	7,505	82,101
Kelantan	10,253	77,441
Sabah	18,104	59,807
Pahang	3,310	28,462
Sarawak	11,847	24,381
Terengganu	3,048	19,174
Melaka	2,171	14,181
N. Sembilan	1,488	13,995
Kedah	1,839	10,287
Perlis	388	3,165
WP Labuan	91	441
Pulau Pinang	35	249

Figure 2.21: Projected Coconut Husk and Coconut Shell for year 2022-2025

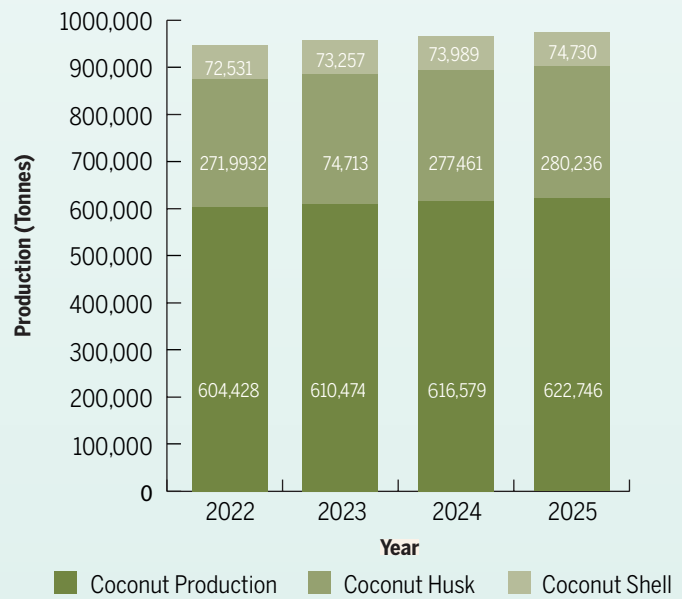
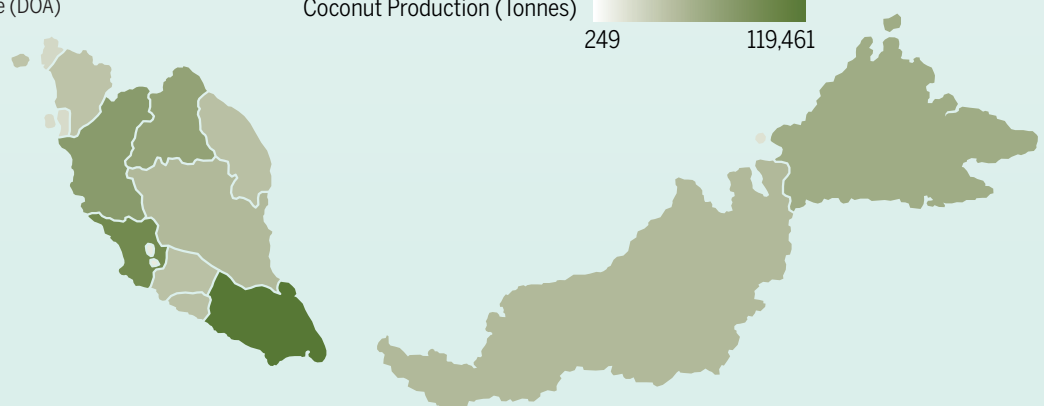


Figure 2.22: Map of Malaysia Colour-coded According to the Production of Coconut

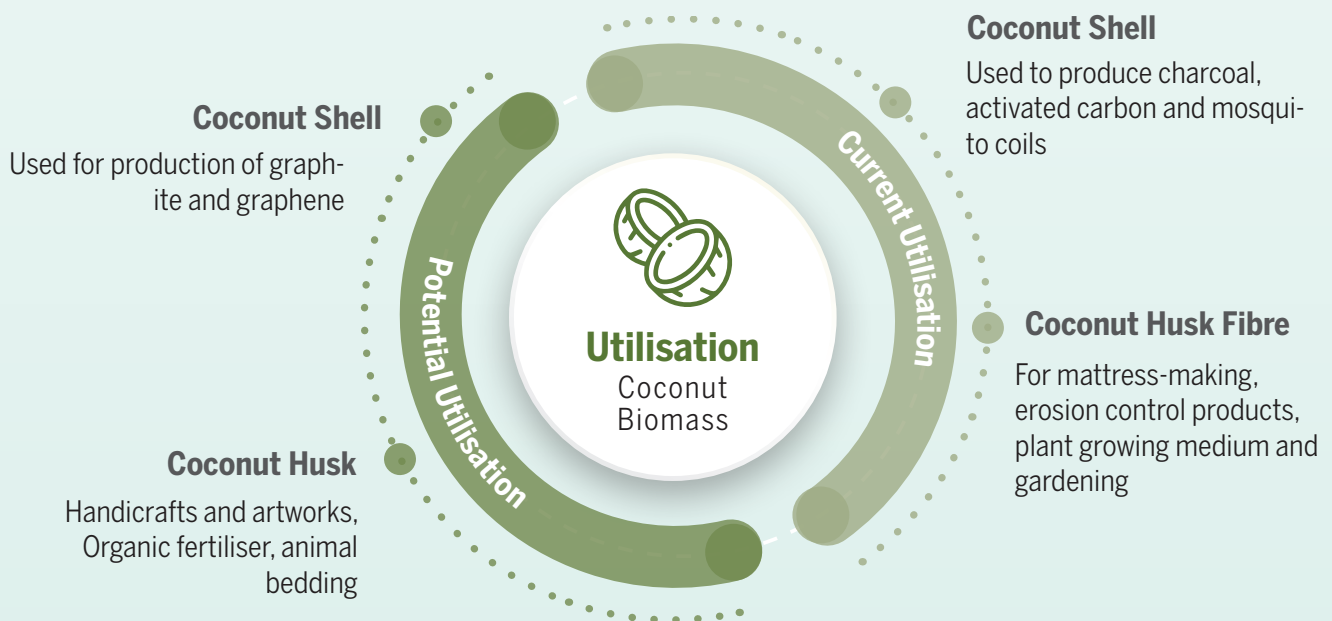
Source: Department of Agriculture (DOA)

Coconut Production (Tonnes)
 249 119,461



Findings: Utilisation of Coconut Husk and Coconut Shell

- Coconut biomass, i.e. coconut shells and coconut husks, is primarily produced in the coconut processing factories. These materials are highly sought after by midstream and downstream industries. The optimal utilisation of coconut biomass has been achieved.
- Most of the coconut processing factories (92%) sell coconut shells to charcoal factories. This is driven by the demand for charcoal and activated carbon, which are primarily exported to overseas. Additionally, China imports Grade A coconut fibre from Malaysia to produce mattresses. Grade A coconut fibre is known for its high quality and lack of powdery particles. In Malaysia, the demand for coconut fibre is mainly for nursery usage.
- Buyers of coconut shells primarily consist of charcoal/activated carbon factories and factories involved in mosquito coil production. To meet the demand for carbon materials production, buyers source coconut shells locally and also from Indonesia due to insufficient local supply.
- Overall, both coconut shell and coconut husk fibre have been integrated into local and overseas green supply chain opportunities.



SUGARCANE BY-PRODUCTS

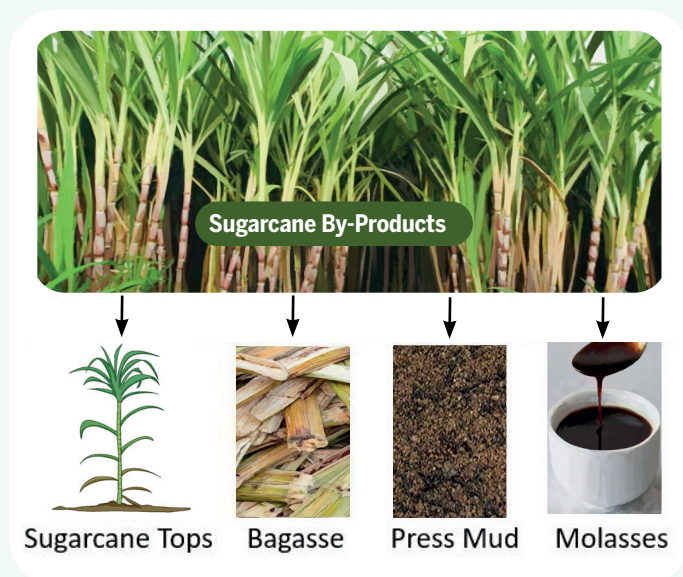
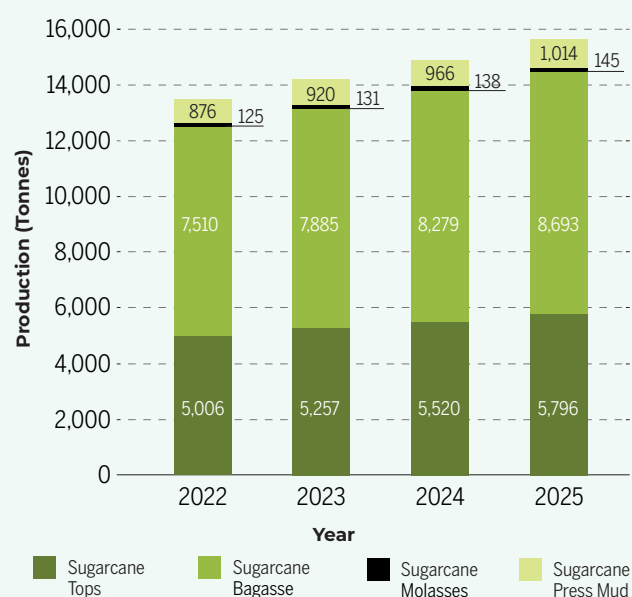


Table 2.8: Estimated Sugarcane By-Products for year 2022

Sugarcane By-Products	By-product production (Tonnes)
Sugarcane Tops	5,006
Sugarcane Bagasse	7,510
Sugarcane Press Mud	876
Sugarcane Molasses	125

Figure 2.23: Estimated Sugarcane By-Products for year 2022 - 2025

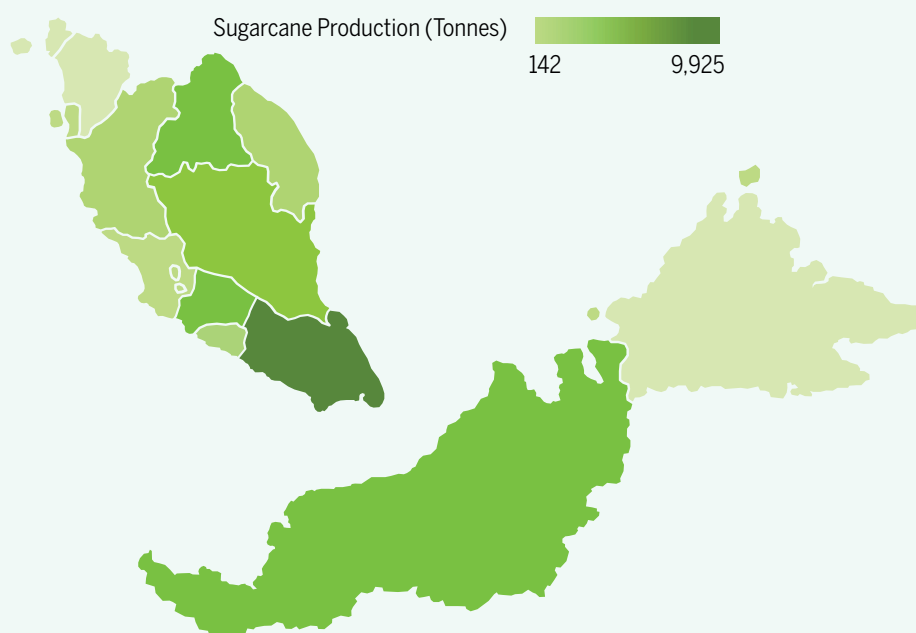


Quick Fact

The sugarcane tops are the excess leaves from the stalks that are stripped off during harvesting and remain in the field. Bagasse is the fibrous by-product resulting from the crushing of sugarcane stalks to extract juice. Press mud is the residue obtained from the filtration of sugarcane juice. Molasses is the thick, brown syrup that remains after sugar crystals are removed from the boiled sugarcane juice.

State	Sugarcane Production 2022 (Tonnes)
Johor	9,925
Sarawak	4,092
N. Sembilan	3,002
Kelantan	2,399
Pahang	2,061
Terengganu	1,318
Melaka	991
Perak	947
Selangor	241
Pulau Pinang	142

Figure 2.24: Map of Malaysia Colour-coded According to the Production of Sugarcane



Source: Department of Agriculture (DOA)

Findings: Utilisation of Sugarcane By-Products

➤ Sugarcane Tops

The sugarcane waste at the farm areas consists of dry leaves and the sugarcane tops mostly is being thrown away or the farmers use it as animal feed or to make it into organic fertiliser after burning the waste. Currently, there is not much demand for sugarcane waste in Malaysia.

➤ Bagasse

Currently, bagasse mostly goes to waste collection or is brought back to the backyard as organic compost. Bagasse is a potential resource as a feedstock of biomass boilers for generating heat through combustion or anaerobic digestion. Bagasse also can be used in various industries, including textile and paper production as well as enabling the creation of textiles, fabrics, pulp and hardboard.

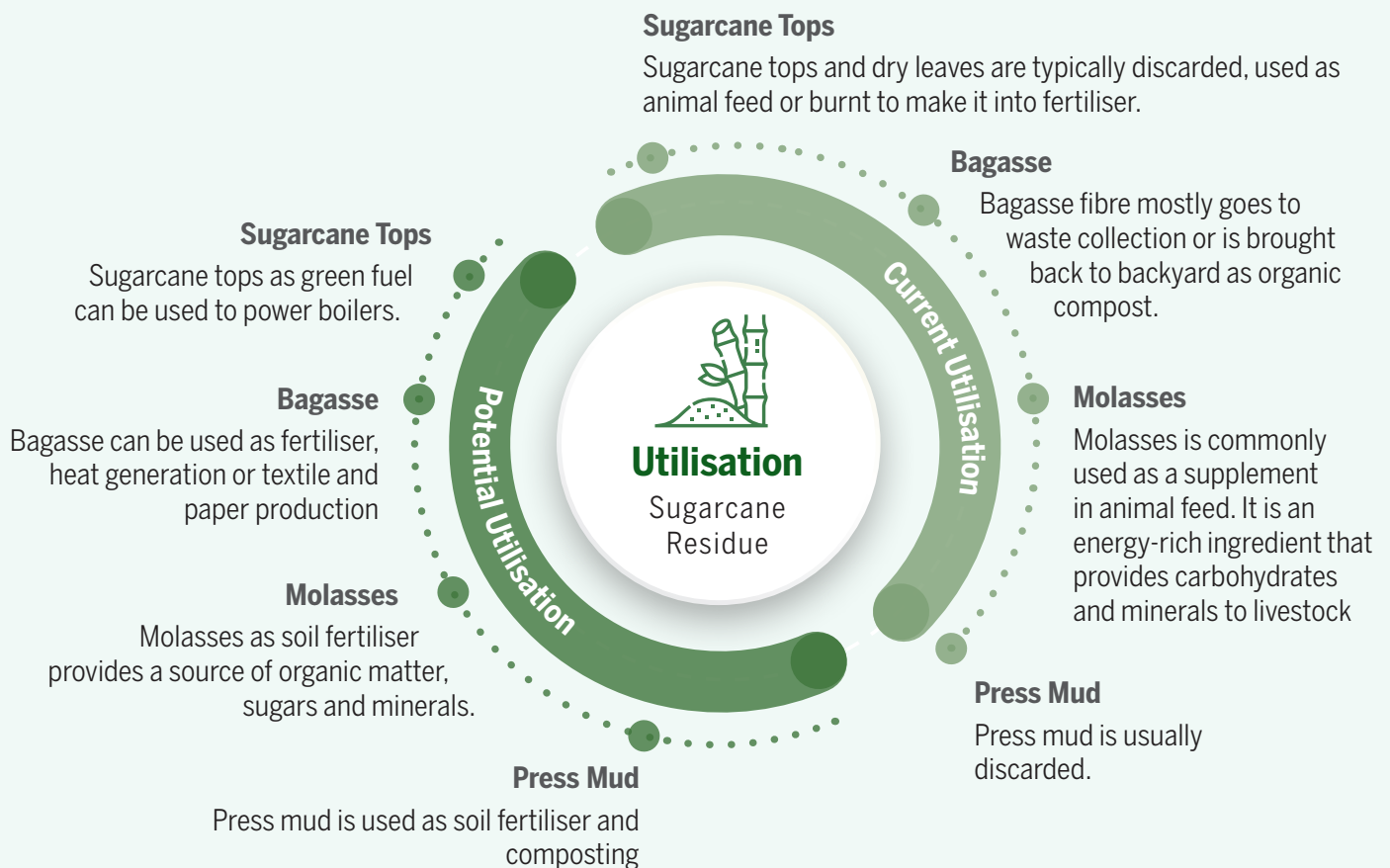
➤ Molasses

A sugar refinery plant in Malaysia has achieved success by selling molasses, a by-product, as animal feed. Additionally, molasses holds a good potential as a soil fertiliser due to its ability to provide organic matter, sugars and minerals. This makes it a valuable source of nutrients and organic content that can enhance soil quality and fertility.

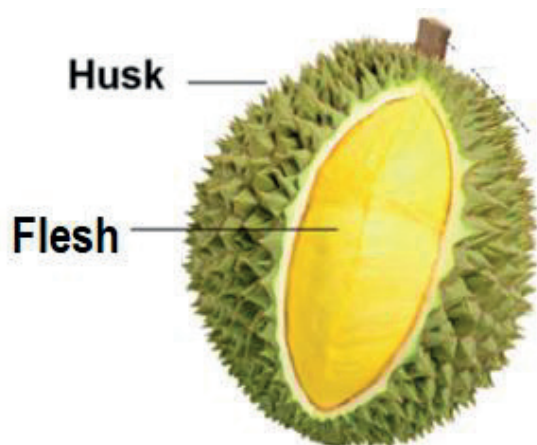
➤ Press Mud

Previously, the Department of Environment classified press mud as scheduled waste, thus requiring its removal from the site by licensed DOE contractors. However, there has been a recent development where the DOE has approved and recognised press mud as a by-product, allowing its utilisation for potential marketable products.

Recent research has revealed that press mud can reduce soil acidity, making it a viable option as a fertiliser. Additionally, press mud can undergo composting or be mixed with other organic materials to enhance the soil nutrient content and promote decomposition.



DURIAN BIOMASS



Quick Fact

The durian fruit consists of two main parts: the fleshy aril and the husk. The fleshy aril refers to the edible portion of the fruit. The husk refers to the outer covering or rind of the durian fruit, a thick and spiky protective layer that surrounds the fleshy aril that accounts for 20% – 35% of the fruit's weight.

State	Planted Areas (Ha)	Durian Production 2022 (Tonnes)
Johor	19,766	121,898
Pahang	14,803	107,386
Kelantan	8,667	41,815
Perak	5,499	36,224
Sarawak	12,740	33,990
Kedah	3,817	20,825
N. Sembilan	2,487	18,545
Sabah	6,571	16,060
Pulau Pinang	1,931	15,062
Melaka	2,275	14,078
Terengganu	3,129	12,508
Selangor	3,389	8,161
Perlis	200	1,698
WP Labuan	6	22

Source: Department of Agriculture (DOA)

Figure 2.25: Projected Durian Husk for year 2022-2025

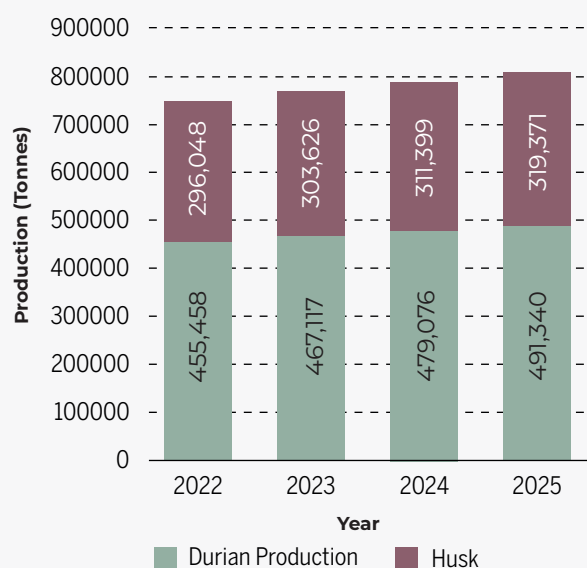
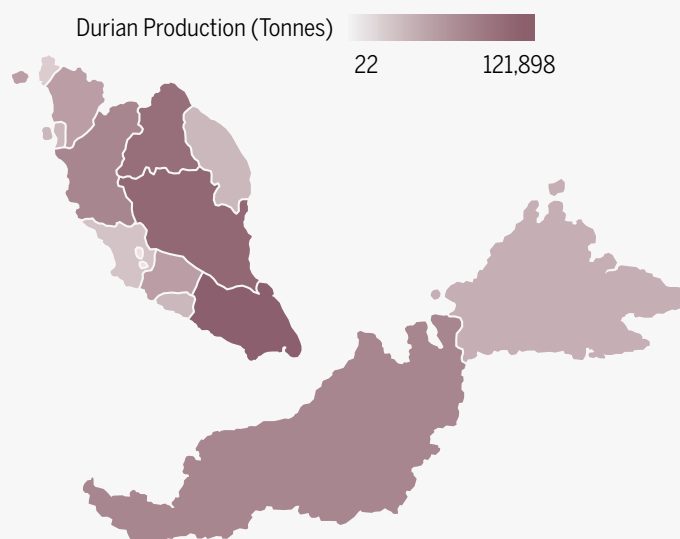


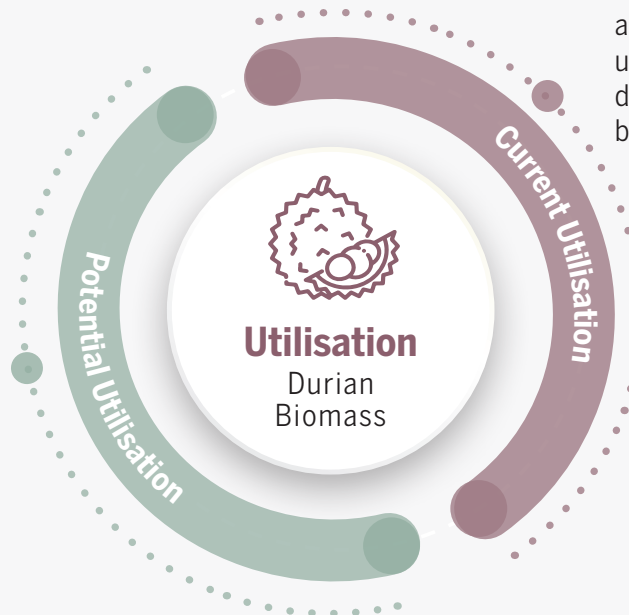
Figure 2.26: Map of Malaysia Colour-coded According to the Production of Durian



Findings: Utilisation of Durian Husks

- Durian husks in Malaysia are largely underutilised and disposed off at landfills.
- A pilot project in Malaysia focuses on converting durian husk waste into biofertiliser based on the feedback from the Malaysia Biomass Industries Confederation (MBIC).
- Durian husk fibres can be extracted to create fibreboards that can be used in non-load bearing construction applications such as partition walls.
- The durian husks can be processed into biodegradable materials that are suitable for food packaging. These eco-friendly packaging solutions aim to reduce plastic waste and provide a sustainable alternative for the food industry.
- A Singaporean start-up has successfully commercialised products made from durian husks, including self-sanitising wet wipes. They plan to distribute these wipes domestically and in several other countries.
- Singaporean scientists have developed antibacterial bandages using durian husks, utilising cellulose extracted from the husks.
- Improving awareness of the potential applications of durian husks in Malaysia can lead to increased utilisation and economic opportunities.

Durian Husks
Used for biomaterials as bioplastics and biocomposite, activated carbon, animal feed, natural dyes for textiles, charcoal briquette, biochar, wet wipes, antibacterial gel bandages, biodegradable food packaging products, particleboard and fibreboard etc.



Durian Husks

Largely underutilised and a pilot project is underway to convert durian husks as biofertiliser in Malaysia.

POULTRY INDUSTRY WASTE



Quick Fact

Poultry industry waste includes slaughterhouse by-products like blood, bones, feathers and internal organs as well as poultry farms' major waste, i.e. poultry manure.

Table 2.9: Estimated Poultry Waste Production for year 2022

Type of Waste	Unit of Poultry	Waste Production (Tonnes)
Poultry Manure	294,568,578	4,000,531
Poultry Slaughter House Waste	195,669,966	176,103

Figure 2.27: Composition of Waste Production of the Poultry Industry for year 2022 (Tonnes)

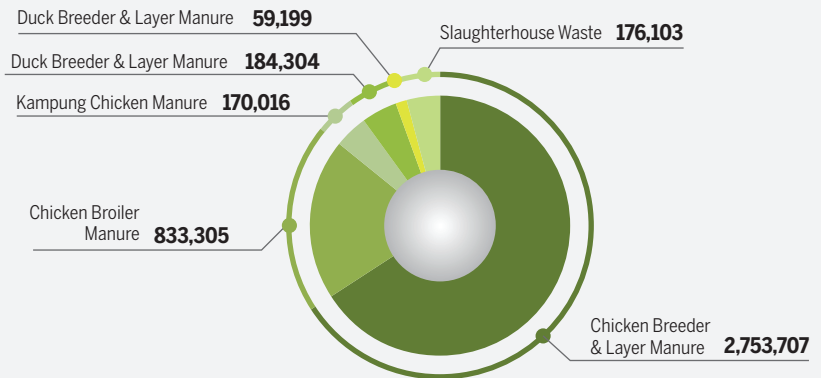
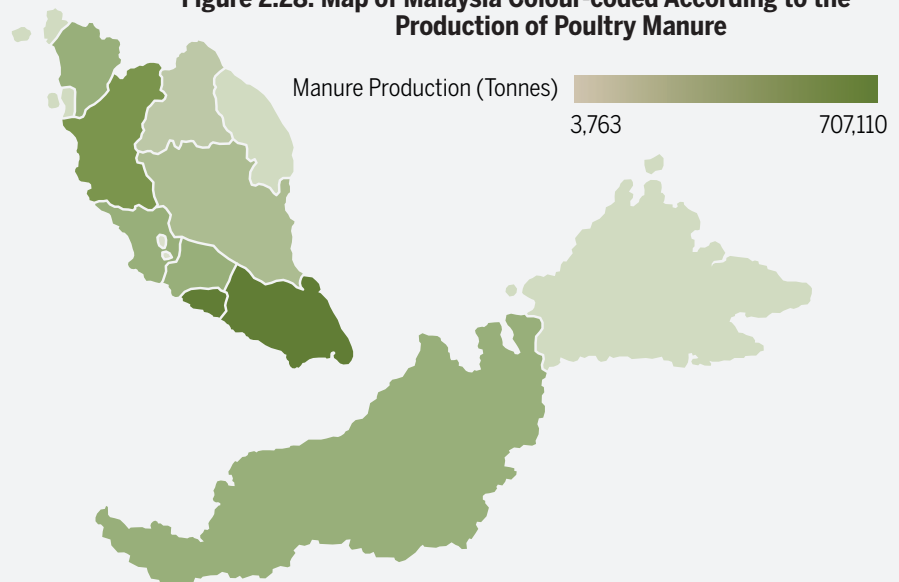


Figure 2.28: Map of Malaysia Colour-coded According to the Production of Poultry Manure



State	Poultry Manure Production 2022 (Tonnes)
Johor	707,110
Melaka	700,966
Perak	567,782
Selangor	384,922
N. Sembilan	348,976
Sarawak	321,965
Kedah	286,158
Pulau Pinang	148,233
Pahang	127,847
Sabah	99,782
Kelantan	30,996
Terengganu	15,623
Perlis	3,763

Source: Department of Veterinary Services (DVS)

Findings: Utilisation of Poultry Manure and Slaughterhouse Waste

- Poultry manure in Malaysia is commonly converted into organic fertiliser.
- Currently, there is an oversupply of biofertiliser made from chicken manure in the market.
- Feathers, which are another by-product, are typically disposed of in landfills. Nevertheless, an innovative start-up supported by government funding has successfully transformed feathers into aqua feed.
- For poultry slaughterhouse waste such as offal and by-products, is extensively used for producing fish meal or animal feed.
- There is a growing interest from off-takers to purchase biochar, a soil conditioner and amendment derived from chicken manure. This interest is often associated with earning carbon credits.
- However, the high costs associated with the biochar conversion technology have been a deterrent to investment decisions.
- Institutions of higher learning require livestock waste data for conducting relevant research and development (R&D) to explore potential commercialisation opportunities.



RUMINANTS AND SWINE INDUSTRY WASTE



Quick Fact

The ruminant and swine industry primarily produce two main types of waste. Firstly, the manure generated at the farms, which is a significant waste component resulting from farm operations. Secondly, the slaughterhouse waste which includes blood, heads, hides, feet, edible offal, white offal, stomach, intestine contents, bones and other related by-products.

State	Unit of Cattle 2022	Cattle Manure Production 2022 (Tonnes)
Pahang	152,695	935,211
Johor	106,323	651,196
Terengganu	85,594	524,238
Kelantan	75,425	461,955
Perak	56,573	346,493
Sabah	53,571	328,106
Kedah	51,161	313,346
N. Sembilan	44,185	270,620
Selangor	39,971	244,810
Melaka	26,056	159,585
Sarawak	13,786	84,435
Pulau Pinang	12,219	74,838
Perlis	3,782	23,164

Source: Department of Veterinary Services (DVS)

Table 2.10: Estimated Ruminants and Swine Industry Waste Production for year 2022

Type of Waste	Waste (Tonnes)
Ruminants and Swine Manure	5,890,386
Ruminants and Swine Slaughterhouse Waste	91,185

Figure 2.29: Estimated Manure Production for year 2022 (Tonnes)

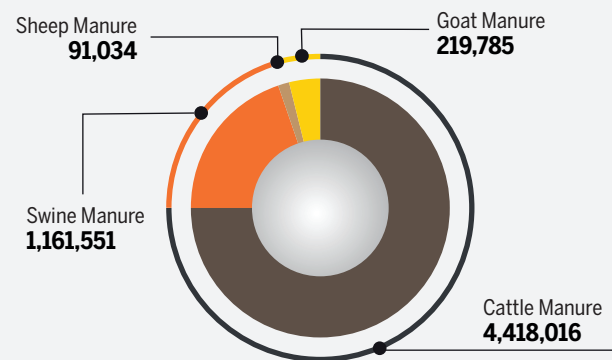
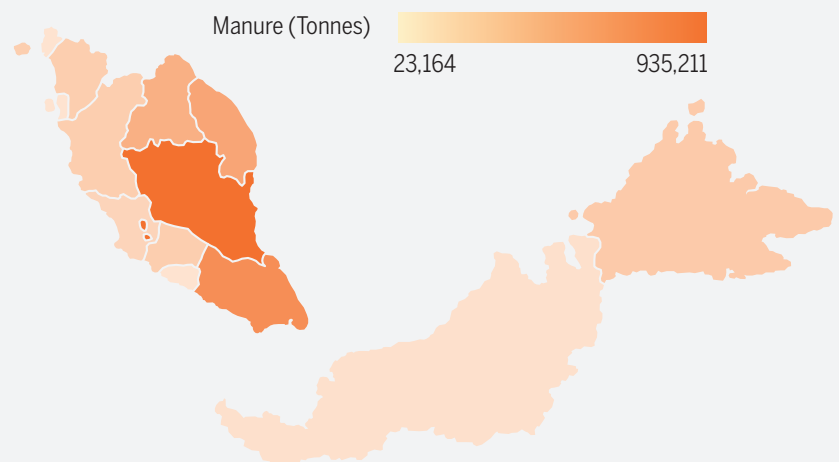


Figure 2.30: Map of Malaysia Colour-coded According to the Estimated Production of Cattle Manure



Findings: Utilisation of Ruminants and Swine Industry Waste

➤ Ruminant Manure

Although not highly sought after as bio-resources, ruminant manure is commonly utilised as organic fertiliser in agriculture with available buyers.

➤ Ruminant Slaughterhouse Waste

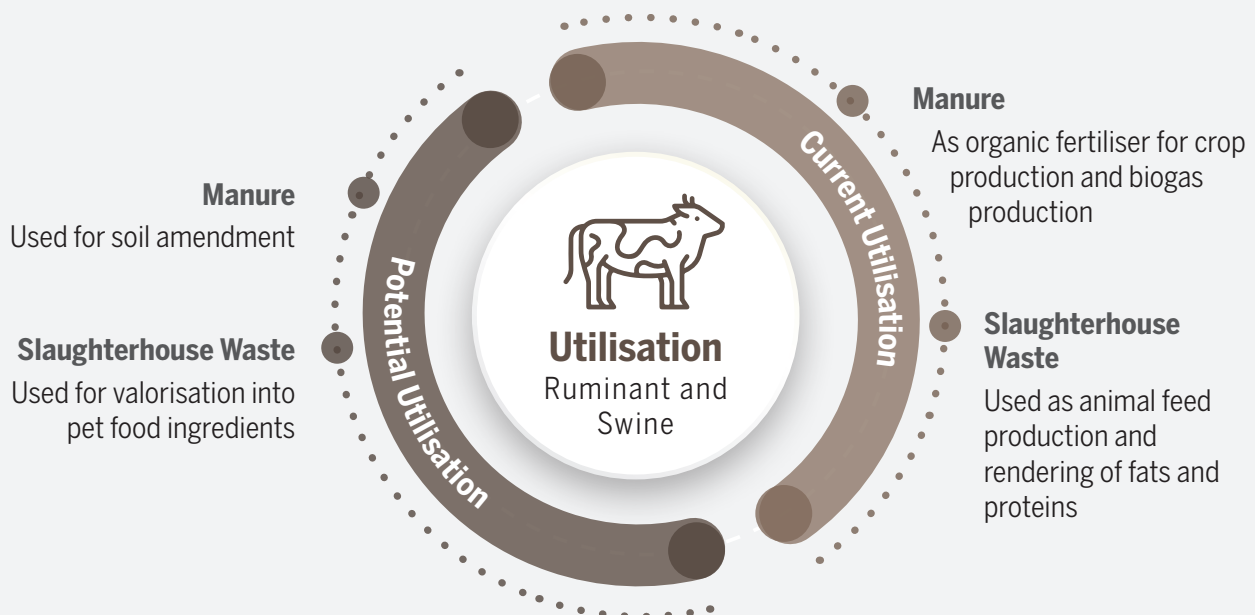
Ruminant slaughterhouse waste, including offal and by-products, is extensively utilised, except for blood, which has other potential applications and the waste is predominantly used for producing animal feed or converted into value-added products.

➤ Potential Utilisation and Collaboration

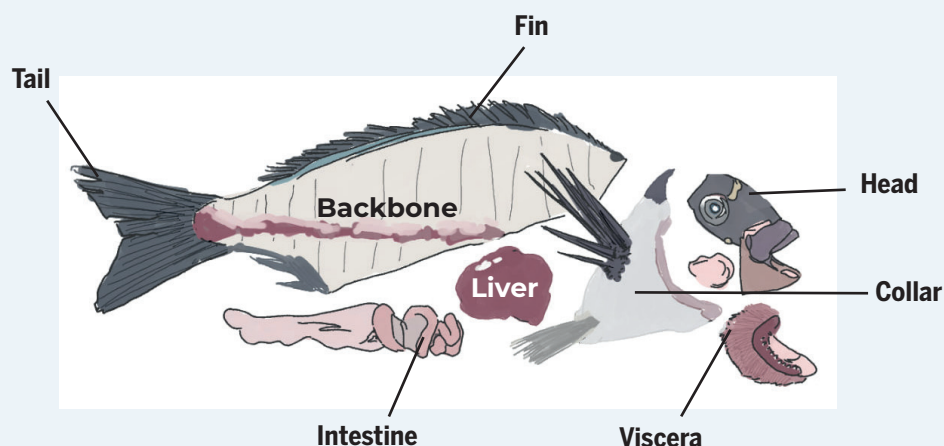
Innovative approaches supported by research and development (R&D) initiatives, are needed to fully explore the potential of ruminant waste streams. Efficient management and utilisation of ruminant waste can enhance agricultural sustainability, minimise waste generation and create new economic opportunities. Continued research and development efforts and collaborations among stakeholders are crucial to unlock the full potential of ruminant manure and slaughterhouse waste in Malaysia. By prioritising on these aspects, the agricultural industry can leverage on the benefits of ruminant waste that will contribute to a more sustainable and economically viable future.

➤ Ruminant Integration with Oil Palm Plantation

Practical circular economy practices are for the purpose of recycling of nutrients, reducing weedicide and chemical fertiliser, as well as efficient use of low-cost feed resources. This will contribute to agricultural and environmental sustainability system.



FISHERIES INDUSTRY WASTE



Quick Fact

Fish waste generated by the fisheries industry falls into two categories. Firstly, processed waste consists of fish parts such as skin, fins, viscera, bones, heads, scales, off-cuts and liver. These waste materials resulted from filleting, gutting, and scaling. Secondly, rejected fish include small, damaged or low-quality fish which are unfit for human consumption. These fish are rejected at the jetty or during sorting before reaching the market.

Table 2.11: Estimated Fish Waste Production for year 2022

Type of Waste	Waste (Tonnes)
Fish Processing Waste	695,133

Figure 2.31: The Average Ratio of Processing Waste of a Fish

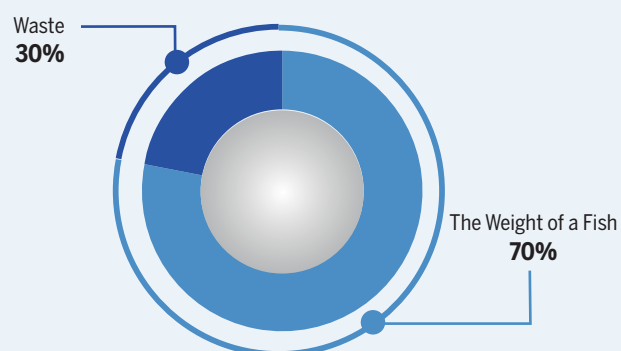
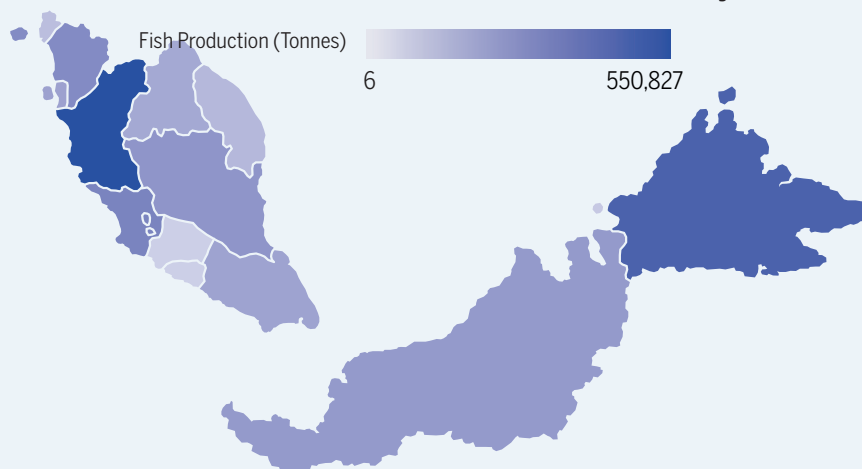


Figure 2.32: Map of Malaysia Colour-coded According to the Production of the Fisheries Industry



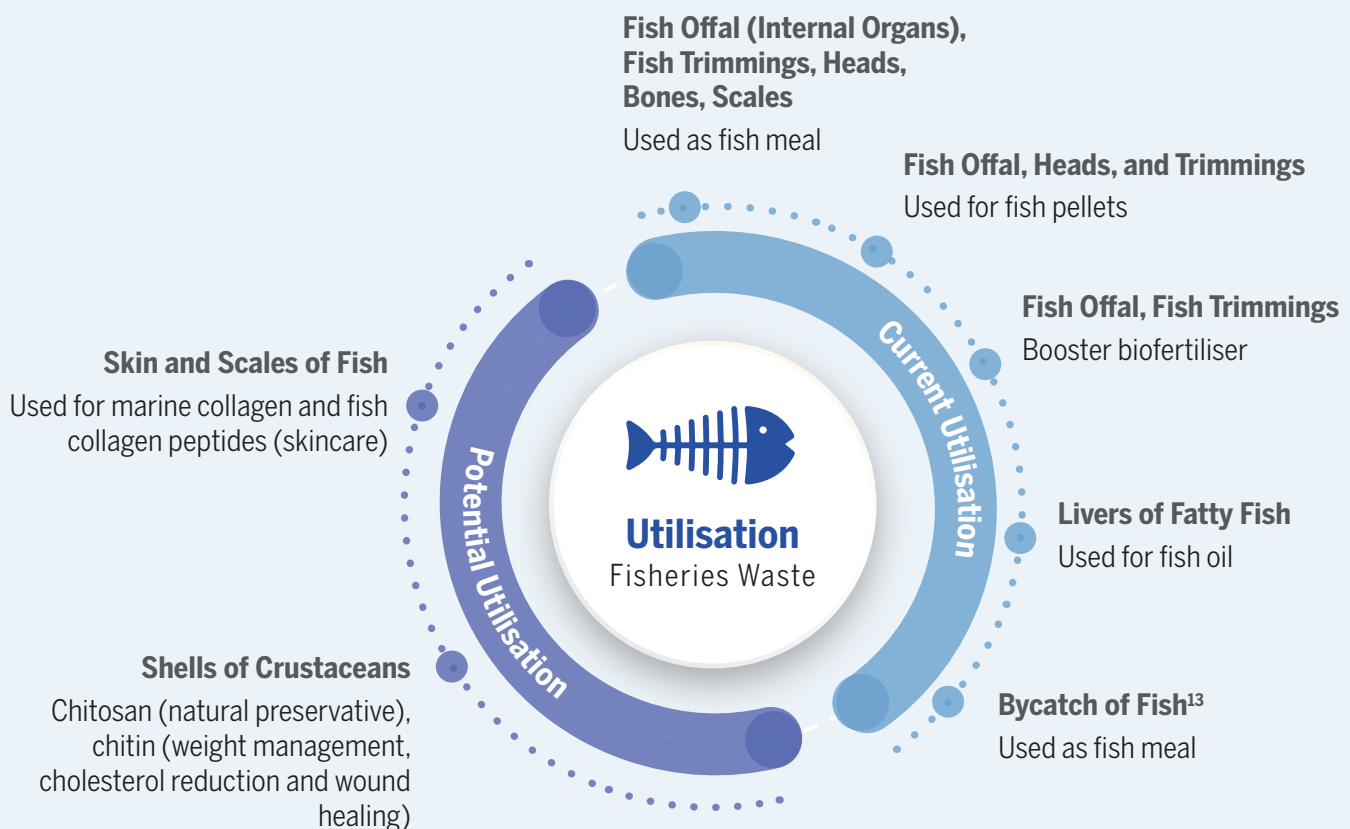
State Fisheries Industry Annual Production 2022 (Tonnes)

Sabah	550,827
Perak	374,168
Selangor	196,831
Kedah	173,111
Pahang	129,521
Sarawak	118,530
Pulau Pinang	92,280
Johor	84,160
Kelantan	62,374
Terengganu	39,505
Perlis	38,404
W.P. Labuan	18,414
Melaka	6,493
N. Sembilan	5,664
W.P. Kuala Lumpur	6

Source: Department of Fisheries (DOF)

Findings: Utilisation of Fish Waste

- Fish by-products, such as offal, heads, viscera, frame, skins, tails, fins, scales, mince and blood are collectively referred to as fish waste.
- Survey findings from fishery processing factories confirm the high demand for fish by-products, primarily for the production of fish meal. This fish meal is primarily processed for the local aquaculture industry, with premium-grade fish meal are also exported mainly to China. In 2022, Malaysia exported 28,835 tonnes of fish meal, generating revenue of RM156 million.¹²
- The consistently high demand for fish meals indicates the industry's significance and market viability. Most fish waste has been optimally utilised, and they undergo further processing to create nutrient supplements, pharmaceutical products and fertilisers.
- Additionally, there is a category of fish known as trash fish. These are smaller fish or bycatch that are unintentionally caught in fishing nets as non-target species. These smaller fish can be utilised for fish meal production, animal feed, fish sauce, or as an ingredient in various seafood products, thus reducing waste and maximising resource utilisation.
- The presence of bycatch highlights the need for sustainable fishing practices to minimise bycatch and promote responsible fishing methods.



¹² DOSM

¹³ Smaller fish or bycatch which are non-target species trapped at the fishing net

Chapter

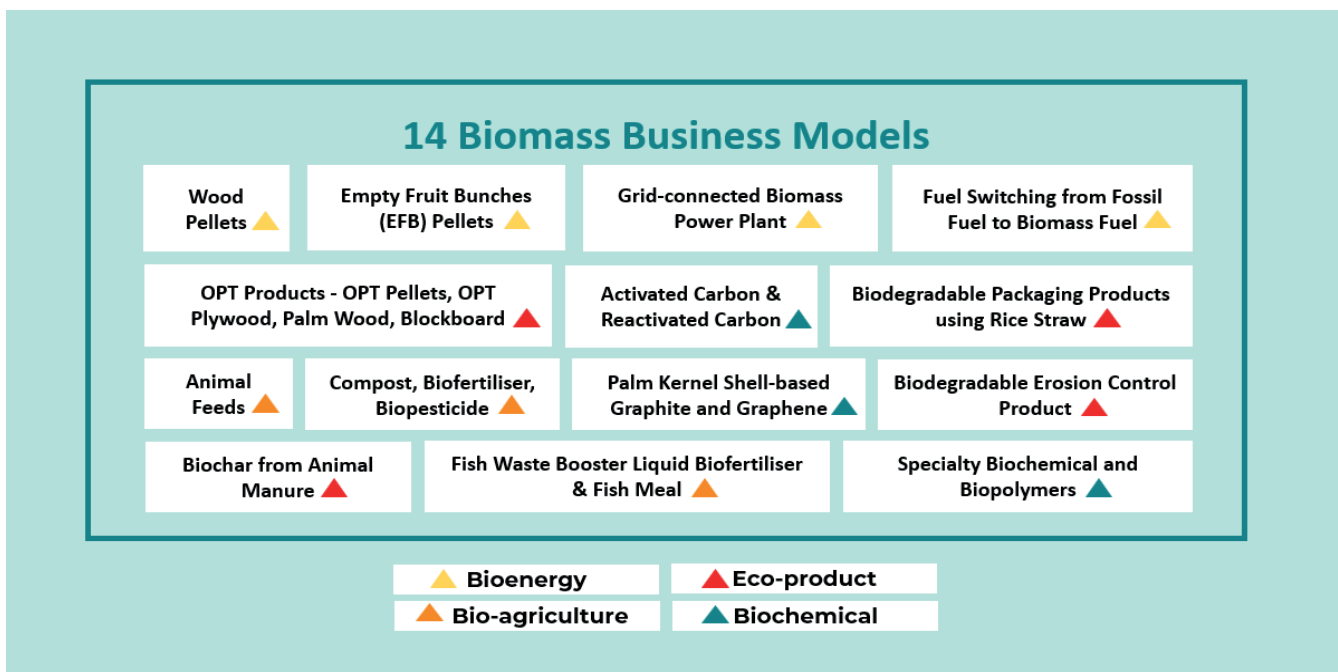
Review of Relevant Biomass Business Models

3

Introduction

This section highlights the 14 reviewed business models in this Action Plan.

The business models were selected through a rigorous approach – a triangulation of survey findings obtained from interviews with the various biomass stakeholders, FGD presentations and discussions with industry players, associations, stakeholder agencies and lastly the expertise of the subject matter consultants. The reviewed business models comprise the high value-added or the niche biomass sectors such as bioenergy, bio-agriculture, eco-products and biochemicals.



The key criteria used for the selection of the business models are market demand, technology availability, bankability, business model scalability and feedstock supply.

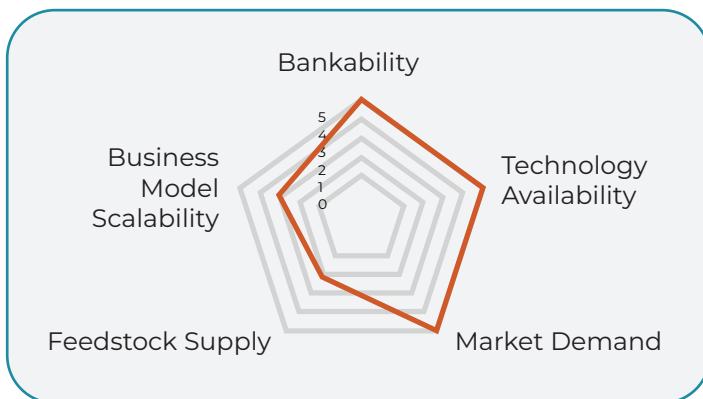
They are emerging business models with high-value propositions in high-growth markets compared to the competitive commoditised products such as wood pellets, fertiliser and activated carbon. Whereas graphite is an emerging business model with a high-value proposition, high demand, widespread application and high commercial viability.

The success of the business models hinges on several key enablers i.e. the prevailing economic situation, standards and certifications as well as government facilitation in the form of investment incentives, soft loans, R&D&C&I fundings, green procurement as well as regulatory affirmation.

WOOD PELLETS



Business Model	Type of Feedstock	Conversion Technology
Wood Pellets	Sawdust, Wood Shavings, Wood Chips	Hammering & Pelletisation Technology



Key Observations



Findings

- Currently, it is the most popular biomass commodity business model due to the global agenda to promote the usage of bioenergy from overseas such as Japan (feed-in-tariff), the Republic of Korea (renewable portfolio standard) etc. The wood pellets are being used as solid biofuel for industrial biomass boilers and biomass power plants.
- Many biomass SMEs have converted woody biomass from sawmill operations i.e. off-cuts and sawdust as wood pellets with ready market from both overseas and local market.
- Wood pellets producers can use the Sustainable Biomass Programme (SBP) certification scheme for the premium EU market. Whilst for Japan and Republic of Korea market, the popular certification schemes are Green Gold Label (GGL), Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification (PEFC) etc.

Key Factors



Technology Availability

- Mature and proven pelletisation technologies are available locally. Some wood pellets manufacturers opt to use pelleting machines from China and Europe.



Bankability

- Manufacturers investing in wood pellet machines can access financing facilities under machinery loan, conventional SME loan as well as Green Technology Financing Scheme (GTFS). Corporate venture capital has also supported the development of wood pellet companies.



Market Demand

- The global biomass pellets market has been growing as a result of government initiatives and stringent environmental regulations spurring the demand for renewable energy sources, especially as countries such as Japan and Republic of Korea have pledged to achieve net-zero emissions within the next few decades in line with the SDGs;¹⁴
- Both the Republic of Korea and Japan have imported 3.9 million tonnes and 4.4 million tonnes of wood pellets respectively in 2022. The imported volumes have been on the increasing trend between 2020 to 2022. Biomass pellets are foreseen to be in high demand in the coming years.¹⁵
- Malaysia's fuel wood / wood pellets industry export revenue has achieved RM958 million in 2022.¹⁶ To be specific, the wood pellets industry achieved RM556.8 million export revenue in 2022.



Feedstock Supply

- Woody biomass in the form of sawdust, off-cuts and woodchips from various timber processing companies and sawmills becomes the main source of feedstock supply.
- Due to the booming demand from overseas wood pellets market, woody biomass has become a highly sought-after commodity. New bidders need to offer competitive pricing in order to access woody biomass feedstock which is likely to have been locked in with their existing customers. An alternative strategy is to extract woody biomass from forest plantation scheme.



Business Model Scalability

- The scalability of the wood pellets industry is very much dependent on the availability of woody biomass feedstock. Recently there are new wood pellets producers have opted to extract woody biomass from forest plantation scheme in collaboration with State Government which will unlock woody biomass supply on sustainable basis.

Special Mention

- Blending woody biomass with other biomass such as bamboo biomass, oil palm trunk (OPT) which can also produce good grade wood pellets with calorific value of more than 3800 kcal / kg.
- Malaysian Green Technology and Climate Change Corporation (MGTC) in the newly-released Green Practices Guideline for Forest Operation has recommended post-logging forestry biomass in planted forest to be processed into woodchips in-situ.
- "Mill in Plantation" - Sarawak to introduce policy allowing mill in forest plantation to utilise forest remnants competitively.¹⁷



Government Facilitation

The Ministry of Plantation & Commodities (KPK) is proposed to further promote the Forest Plantation Scheme to encourage wood pellet producers to venture into forest plantation based on the soft loan provided by KPK.

¹⁴ MIDA

¹⁵ Argus Biomass Asia Conference 2023

¹⁶ MTIB

¹⁷ FGD - Feedstock Analysis of Biomass Data in Sarawak : Potential for Bioeconomy Development, Datu Haji Hashim Haji Bojet, Sarawak Timber Industry Development Corporation (STIDC) 2023

EMPTY FRUIT BUNCHES (EFB) PELLETS



Empty Fruit Bunches

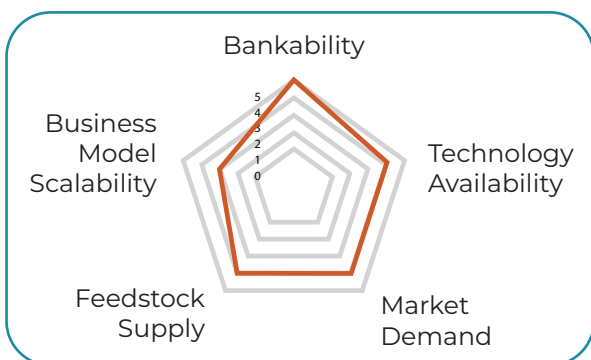


Palm Fibre



EFB Pellets

Business Model	Type of Feedstock	Conversion Technology
EFB Pellets	Empty Fruit Bunches (EFBs)	Pressing, Shredding, Drying and Pelletisation



Key Observations



Three Business Opportunities in the EFB Pellets Industry

- EFB pellets are used locally as fuel pellet for industrial boilers or served as animal feed as well as mushroom farming with business demand from China. The commercialisation of EFB pellets is championed jointly by IHI Japan, government-linked company as well as a few SMEs.
- EFB pellets serve as potential fuel pellet to be exported to overseas market (Japan) and Malaysian Sustainable Palm Oil (MSPO) Chain of Custody (COC) of Oil Palm Biomass, focusing on traceability requirement has been formulated by Malaysian Palm Oil Certification Council (MPOCC) due to anticipated increase in demand for power generation in Japan. The Ministry of Economy, Trade & Industry (METI) Japan has already approved MSPO-COC of Oil Palm Biomass certification scheme for palm pellets to be exported to Japan. Japanese Government has approved certified EFB pellets as the green fuel under its Feed-in Tariff (FIT) and Feed-in Premium (FIP) in 2023. Currently, Japan customers are using Green Gold Label (GGL) certification standard for EFB fuel pellets.
- As potential green fuel to be used as biomass co-firing by utility scale power plants such as Tenaga Nasional Bhd and Malakoff Corporation Bhd which have undertaken a feasibility study on using EFB fuel pellets in their coal-fired power plants (CFPP). Technically, EFB pellets can be used in the CFPP as confirmed by TNB Research which recommends to commence with lower ratio. For 1% biomass blending, a total of approximately 420,000 tonnes of EFB pellets are needed. It is estimated to save 112,800 tonnes of GHG emission subject to a full-scale report of life-cycle analysis.

Key Factors



Technology Availability

EFB pellets producers need to source the right machinery fabrication technical partners in order to avoid immature processing technology; The issue of washing the EFB to reduce the potassium needs to be addressed and meet the requirements of customers.



Bankability

Generally bankable business model includes venture capital financing. SMEs can apply Green Technology Financing Scheme (GTFS) and SME schemes promoted by BNM to access financing.



Market Demand

The EFB fuel pellets have yet to establish a large demand from overseas as wood pellets are still a preferred green fuel. Nevertheless, there is an increasing market demand from the Japanese customers due to construction of new biomass power plants with an estimated installed capacity of 711.8 MW.¹⁸ In Malaysia, EFB pellets are being used as green fuel for biomass boilers and CFPP.



Feedstock Supply

EFBs have an overall indicative utilisation rate of less than 50% as per MPOB's survey. EFBs are available, especially from private millers who do not have a plantation. Palm oil mills which are part of the larger plantation groups normally recycle the EFBs back to their plantations for the purpose of mulching serving as organic fertiliser. Hence, some listed plantation companies have achieved more than 90% utilisation rate of their EFBs. Potential new EFB pellets project developers from Malaysia or overseas can consult palm oil mills in the biomass clusters for feedstock procurement or to explore joint venture opportunity through incentives provided by the Malaysia Government.



Business Model Scalability

The EFB pellets industry is still in the infancy stage compared to the wood pellets industry. It is expected to scale up further in anticipation of overseas demand from Japan or biomass co-firing initiatives as outlined in the National Energy Transition Roadmap (NETR). From the ESG's perspective, EFB pellets appear to be an emerging commodity to the solid biofuel producers and users of green fuel as it can prevent or avoid the release of methane gas from unutilised EFB.

Special Mention

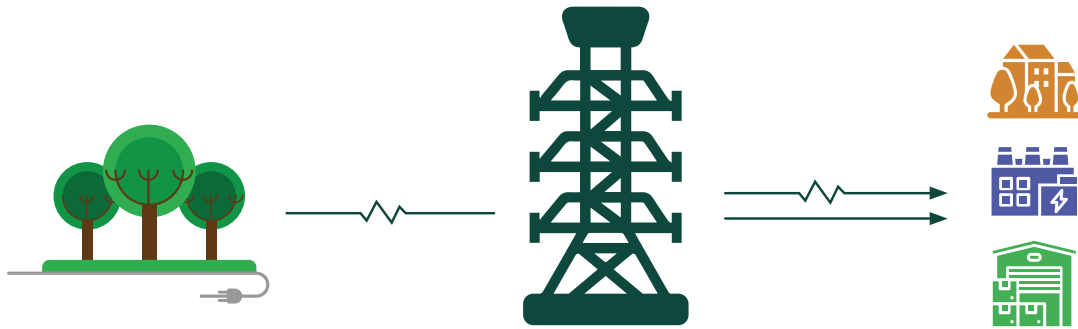
Mitigation Measure Dealing with Overseas Market Volatility

Malaysian companies targeting EFB pellets export market can leverage on the Market Development Grant of MATRADE to gather market intelligence via trade exhibition and business matching as well as engaging potential overseas customers by addressing certification requirement, confirmation of purchase order or setting up of joint venture company.



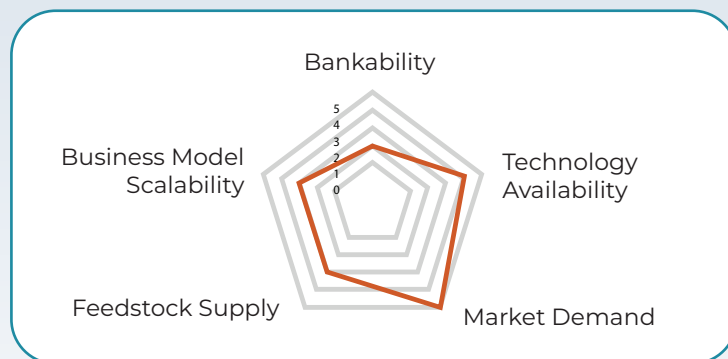
Government Facilitation

- KPK to coordinate with the Ministry of Economy and NRECC to conduct a study and assess the financing mechanism of biomass pellets under the national biomass co-firing initiatives.
- Proposed to formulate the policy by achieving 1% blending for biomass co-firing with a new financing mechanism enabled by the Malaysia Government by 2025.
- Relevant proactive investment promotion agencies such as MIDA to consider formulating new incentives for utility scale power plants to retrofit CFPP in the context of biomass co-firing initiatives.



GRID-CONNECTED BIOMASS POWER PLANT

Business Model	Type of Feedstock	Conversion Technology
Grid-connected Biomass Power Plant	EFB, Rice Husks, Wood Chips	Combustion



Key Observations



Findings

- This business model is empowered by the Renewable Energy Act 2011 to promote Feed-in-tariff (FIT) mechanism for grid-connected biomass power plants using various biomass feedstock.
- The successful biomass power plant bidder is eligible to sign a 21-year renewable energy power purchase agreement (REPPA) with Tenaga Nasional Bhd with a bidding price between RM0.23 kWh to RM0.3687 kWh.¹⁹
- As per SEDA Annual Report 2021, a total of 70.65 MW biomass power plants have been installed.

Key Factors



Technology Availability

Mature and proven technologies are available for biomass power plants especially dealing with woody biomass. Local engineering, procurement, construction and commissioning (EPCC) companies are available to support the development of biomass power plant. Nevertheless, biomass power plant using EFB as feedstock has encountered process conversion challenges due to EFB's intrinsic technical properties as compared to woody biomass. Thus, causing operational inefficiency and maintenance issues.



Bankability

Biomass power plant project developers need to convince the bankers on the availability of biomass fuel supply agreement and positive project cashflow which are linked to feedstock supply. Project developers with sound financial track records and ability to address feedstock supply issues are likely to have their loan applications approved. As outlined in the SEDA Annual Report 2021, access to project financing remains a challenge for biomass power plants.

¹⁹ <https://www.seda.gov.my/2022/05/result-of-feed-in-tariff-fit-quota-application-under-the-e-bidding-mechanism-for-biogas-biomass-and-small-hydropower-resources-for-the-year-2021/>



Market Demand

In 2023, a total of 40 MW FIT quota has been allocated for biomass power plant.



Feedstock Supply

- If the biomass power plant is championed by the big plantation group which has access to various oil palm biomass feedstock then the feedstock supply is a non-material issue.
- Feedstock supply may become a haunting issue when the biomass plant is operated by an independent biomass plant project developer who doesn't own feedstock and needs to buy from third parties. Biomass fuel supply strategies include feedstock procurement from multiple parties, joint venture with feedstock owners or owners of forest plantation.



Business Model Scalability

- Grid-connected biomass power plant scalability is largely dependent on 3 factors:-
 - (a) Biomass feedstock availability near the location of the biomass power plant
 - (b) Addressing technical issues of grid connectivity
 - (c) Capability of project developer to raise fund

Recently, a listed company has secured two biomass power plants' REPPA under FIT's e-bidding system. That shows that the business model is scalable if the above-mentioned pre-conditions are fulfilled.

Special Mention

Malaysia has achieved 1,063,528 (tCO₂) emission reduction based on the 1868 GWh renewable energy generated from the biomass power plants between the year 2012 – 2020.

Biomass			
Year	Cumulating RE Installed Capacity (MW)	RE Generated (GWh)	Annual GHG Emission Reduction (tCO ₂)
2012	52.3	104.54	57,852
2013	50.4	220.55	119,904
2014	55.9	200.16	109,413
2015	76.7	246.73	145,884
2016	87.90	248.48	137,636
2017	95.55	247.21	143,008
2018	70.65	226.09	131,313
2019	70.65	225.22	131,670
2020	70.65	149.32	86,848
Total		1868.30	1,063,528

Source: SEDA Malaysia



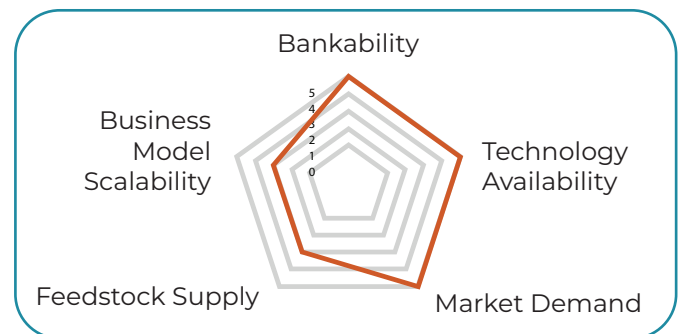
Government Facilitation

- It is also proposed that SEDA to conduct the feasibility study for palm oil mills with excess bioenergy capacity under existing co-generation practices to export to the national grid.

FUEL SWITCHING FROM FOSSIL FUEL TO BIOMASS FUEL



Business Model	Type of Feedstock	Conversion Technology
Fuel Switching from Fossil Fuel to Biomass Fuel using Biomass Boiler	Woodchips, Rice Husk, Mesocarp Fibre, EFBs / PKS, Wood Pellets	Combustion / Gasification



Key Observations



Findings

- This business model is suitable for manufacturing companies that are heavy energy users that require bioenergy for heating and steam generation such as cement companies, gloves manufacturing, food & beverage companies as well as palm oil mills which practise captive power model to utilise biomass fuel such as woodchips, rice husk, palm biomass and wood pellets for heating and steam generation.
- Similarly, palm oil mills have been investing in biomass boilers to utilise their excess biomass such as mesocarp fibre, palm kernel shell (PKS) as green fuel for co-generation in the mills.
- This bioenergy circular economy model complements as a measure to reduce reliance on fossil fuels, reduce GHG emission, increase ESG profile of the company and achieve energy efficiency through saving of energy cost between 20% to 30%.²⁰
- Currently, there are a total of off-grid 370 MW installed capacity of biomass boilers.²¹

²⁰ Subject to fluctuation of biomass feedstock pricing and energy price linked to surcharge of Imbalance Cost Pass Through (ICPT)

²¹ Energy Commission

Key Factors



Technology Availability

- Mature and proven technologies are available for heating and steam generation using local biomass feedstock (rice husk, woodchips, wood pellets, PKS, mesocarp fibre, EFB etc.).
- Locally manufactured biomass boiler technologies are readily available to support manufacturing companies to undertake fuel switching initiatives using biomass fuel.



Bankability

Manufacturers investing in industrial biomass boilers can access financing facilities under machinery loans or conventional SME loans.



Market Demand

- Viable business model by switching from fossil fuel to biomass fuel in light of current electricity charges in Malaysia.
- Good market demand from heavy energy users towards using biomass fuel to green the production as part of the ESG agenda as well as its proven cost saving solutions, which is even more competitive than natural gas.²²



Feedstock Supply

- Manufacturing companies with access to biomass especially palm oil mills can use mill-generated biomass i.e. mesocarp fibre, palm kernel shell or EFB for the purpose of co-generation.
- For manufacturing companies which need to procure biomass fuel to power their biomass boilers, biomass resources such as woodchips are only available with existing biomass boiler users through long term established business relationship. New investors in biomass boilers may face challenges to secure biomass fuel due to the increasing cost of biomass fuel such as PKS which has increased from RM300 to more than RM400 per tonne. Another option is to use shredded EFB which is cheaper than PKS and woodchips.



Business Model Scalability

- The successful implementation of fuel switching model is largely dependent on the biomass availability within the vicinity of the targeted site for the installed biomass boiler. Normally, a feasibility study will be conducted to assess the biomass resources availability before the commencement of the biomass boiler investment especially manufacturing industry which does not generate biomass as their industrial by-products. Thus, the scalability is on a case-to-case basis.

Special Mention

Rubber products manufacturers who are cess contributors to Malaysian Rubber Council (MRC) can apply to get matching grant from MRC's Automation & Green Technology Fund for biomass boilers investment to undertake fuel switching practice.

²² Data shared by Top Glove Corporation Bhd during FGD

OPT PRODUCTS - OPT PELLETS, OPT PLYWOOD, PALM WOOD, BLOCKBOARD



OnCore® Lumber Core



OnCore® Blockboard with Laminate

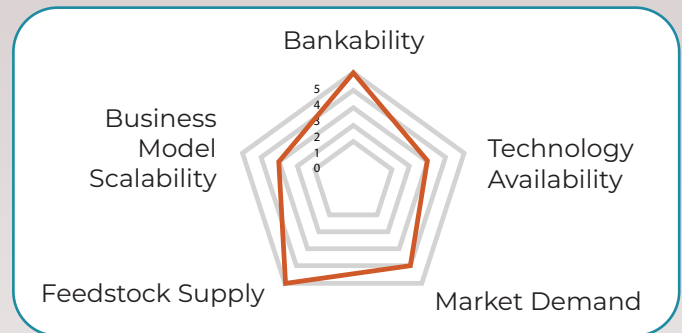


OnCore® Three-Layer Panel



OnCore® Glue Laminated Beams (Glulam)

Business Model	Type of Feedstock	Conversion Technology
OPT Pellets, OPT Plywood, Palm Wood, Blockboard	Oil Palm Trunk (OPT)	Palm Wood Panel Production Process; ²³ Pelletisation,



Key Observations



Findings

- Plywood manufactured from oil palm trunk (OPT) can be used as furniture components, building materials, interior fixtures, packaging materials and wooden pallets.
- The Japanese market has an emerging interest to buy OPT pellets as fuel pellets as the Ministry of Economy, Trade & Industry (METI) Japan has already approved OPT pellets as the green fuel for its FIT biomass power plant; also used as furniture boards catered for Japan's housing industry.
- OPTs can be processed as kiln-dried palm wood with compatible features as high-performance wood products, blockboard and panels for the furniture industry.
- SME Innovation : Verdastro Sdn Bhd is championing 100% OPT biodegradable drinking straw commercialisation in Malaysia.

Key Factors



Technology Availability

Local plantation company i.e. IOI Group has excelled in OPT conversion technology, producing blockboard, panel and kiln-dried palm wood.²⁴ Malaysian SME in collaboration with Japanese counterparts has also started a pilot plant to produce OPT pellets as fuel pellets and furniture boards for the Japanese market. Meanwhile, Fibre and Biocomposite Centre (FIDEC) under the purview of MTIB also provides technical assistance for OPT commercialisation such as OPT plywood.



Bankability

Generally, bankable business model based on the precedence of OPT plywood manufacturers. Biomass entrepreneurs can apply for SME schemes promoted by Bank Negara Malaysia to access financing.

²³ Proprietary technology of IOI Corporation Bhd

²⁴ Establish OPT Research and Development and Technology Transfer and scale-up business and establish a leading market position in OPT products (Source : Annual Report IOI Corporation Bhd 2022)



Market Demand

New OPT furniture products such as blockboard, panel or plywood are potential alternate wood products to complement the existing wood-based fibreboard and plywood which had already generated RM690 million and RM3.278 billion export revenue respectively in 2021. The OPT pellets product has established emerging buying interest from Japan.



Feedstock Supply

Malaysia generates recurring OPT resources of approximately 15 million trees – 20 million trees per annum. OPT products downstream processing companies and plantation owners are encouraged to work together as joint venture partners to access OPT feedstock. As highlighted in the annual reports of plantation companies, felled OPTs are mainly used for mulching serving as organic fertiliser, thus it may affect the supply of OPTs to the downstream industry. Hence, the joint venture approach is deemed as a better approach to secure feedstock. Nevertheless, accessing OPT feedstock is easier from smallholders compared to estate owners.²⁵



Business Model Scalability

Oil palm replantation activities located in remote and hilly areas may restrict the accessibility of OPTs due to high logistics and handling costs. Subject to the ultimate selling price of processed products such as OPT plywood which has a better selling price vis-à-vis to fuel pellet. Yet, OPT fuel pellet has a better market advantage due to the much higher volumes demanded by overseas customers. Hence, the business model scalability of different OPT products will be analysed on a case-to-case basis.

Special Mention

OPT : Climate Change Mitigation Business Model

Commercialisation of OPTs serves the following purposes :-

- (a) Repurpose biomass into bio-based fibre materials which capture carbon
- (b) Augment timber raw materials supply to reduce the dependency on the natural forests
- (c) Reduce carbon emissions by using bio-based renewable energy
- (d) Re-strategise on how to produce high value bio-based materials sustainably



Government Facilitation

- Proposed 10% - 30% of felled OPT to be reserved for the downstream industry built on BNM's Climate Change and Principle-based Taxonomy (CCPT)'s recommendation which called for financial institutions to ascertain loan applicants (estate owners) of new oil palm replantation scheme (more than 500 hectares) to systematically collect, accumulate and transfer OPT for processing by biofuel producer for the purpose of reducing GHG emissions.

²⁵ Feedback received from SME sourcing for OPT during FGD

ACTIVATED CARBON & REACTIVATED CARBON



Coconut Shell

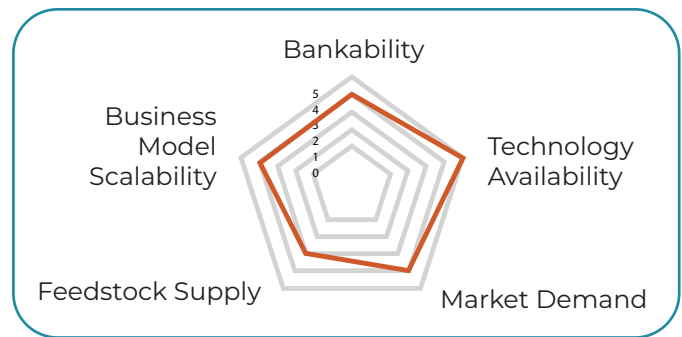


Palm Kernel Shell



Activated Carbon

Business Model	Type of Feedstock	Conversion Technology
Activated Carbon	Coconut Shell, Sawdust, Palm Kernel Shell (PKS)	Carbonisation and Activation Technology; Reactivation Technology



Key Observations



Findings

- Coconut shell, sawdust and palm kernel shell (PKS) can be converted to activated carbon serving as adsorption media due to its high surface area and porosity; it can effectively adsorb and remove various contaminants and impurities from gases and liquids solutions. Activated carbon is commonly used for treating industrial wastewater and river pollutions, purification of oleochemical products, bio-pharmaceutical solutions etc.
- Used PKS-based activated carbon can be repurposed and reused as re-activated carbon through carbon regeneration technology to restore its adsorption capability by increasing its iodine value. Conservatively, it can be reused 5 to 8 times depending on the quality of spent carbon.

Key Factors



Technology Availability

Mature and proven carbonisation and activation technologies are available locally. A new proprietary technology i.e. carbon regeneration or reactivation technology has been developed. The used bio-activated carbon can be repurposed through carbon reactivation technology to restore its adsorption capability. The reactivated carbon can have the same performance as virgin carbon which reduces the carbon footprint and promotes circular economy.



Bankability

The activated carbon business model is eligible to receive soft loans related to circular economy from the recently announced MOF's Budget 2024. For machinery loans, development financial institutions can offer competitive financing packages.



Market Demand

- The global activated carbon market size was valued at USD 5.7 billion in 2021 and is projected to reach USD 8.9 billion by 2026, growing at CAGR of 9.3% from 2021 to 2026. Bio-based activated carbon potentially serves to replace coal-based activated carbon. It has the potential to reduce carbon footprint and is qualified as carbon neutral products.
- Activated carbon has the potential to meet business demands as a premium product, catering to both overseas and domestic markets for a wide range of industrial applications.



Feedstock Supply

- The business model is subject to biomass feedstock availability especially coconut shell which is currently imported from Indonesia by activated carbon producers due to a shortage of coconut shells. A total of 1.25 million tonnes of PKS had been exported overseas in 2022 whilst the rest of the PKS were mainly used as green fuel in the palm oil mills.²⁶ Bamboo biomass and cocoa pod husks also present good technical properties to be converted to activated carbon based on R&D findings from the Forest Research Institute of Malaysia (FRIM) and Malaysian Cocoa Board (LKM).



Business Model Scalability

- The scalability of the PKS-based activated carbon is very much dependent on new enabling initiative introduced by the Malaysia Government i.e. using PKS activated carbon for treating POME to reduce chemical oxygen demand (COD) and biological oxygen demand (BOD) level. PKS-based activated carbon can serve as an alternative to imported coal-based activated carbon for water treatment projects or to reduce river pollution.
- Additionally, Malaysia imported 16,622 tonnes of activated carbon valued at RM153 million in 2022 and the total export was RM147 million.²⁷ Hence, newly developed PKS-activated carbon can also potentially address local demand and reduce imports as well as developing circular economy opportunities in Malaysia through reactivated carbon technology.

Special Mention

- PKS-based activated carbon is a high-value integrated circular economy model for palm oil industry which includes treating POME and purification of oleochemicals. It is recommended that palm oil mills to joint venture with activated carbon producer to manufacture activated carbon through tax incentive provided by Malaysia Government rather than selling raw PKS as fuel commodity.
- In average, the ex-factory selling price of coconut shell activated carbon is traded at RM8.50 / kg. In other words, PKS converted activated carbon can yield RM8500 per tonne compared to the same amount of raw PKS sold at RM4800, based on conversion ratio of 12 to 1.



Government Facilitation

- Ministry of Plantation and Commodities (KPK) and Malaysia Palm Oil Board (MPOB) to consider introducing and using palm kernel shell (PKS)-based activated carbon for treating POME to reduce its COD and BOD level. The used PKS-activated carbon can be reused again through carbon reactivation technology to restore its adsorption capability by increasing the iodine value.
- Reactivated carbon technology should be prioritised as a potential R&D&C&I biomass technology to promote the new circular economy model of PKS. It is proposed that MPOB and relevant industry partners to spearhead this biomass technology R&D&C&I.

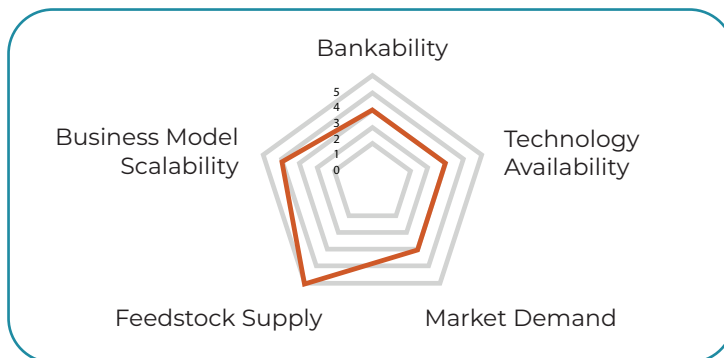
²⁶ MPOB Data 2022

²⁷ DOSM Data 2022

RICE STRAW BIODEGRADABLE PACKAGING PRODUCTS



Business Model	Type of Feedstock	Conversion Technology
Biodegradable Packaging Products	Rice Straw	Pulp Manufacturing Processes



Key Observations



Findings

- Innovative entrepreneurs convert rice straw into biodegradable food packaging products.
- A sustainable business model that can reduce the use of plastic and polystyrene for various food packaging products and industrial products. Corporations around the globe are moving towards reducing the consumption of such materials, which boost the demand of certified biodegradable products.
- The ESG-driven business model has encouraged farmers to supply the rice straw to bio-packaging products manufacturer rather than resort to open burning that successfully avoided CO₂ emission and haze. Additionally, the bio-based business model serves to replace single-use plastics with biodegradable and compostable products as currently massive volume of the Disposable Plastic & Paper (SUP) packaging products are made from petroleum (PE, PET & PC), virgin wood-pulp (kraft & eucalyptus) and recycled paper-pulp.

Key Factors



Technology Availability

Local SMEs have opted to develop their own R&D for their bio-conversion technology using rice straw. While another listed company has opted to use technology licensing service from a local research university to produce its EFB's nanocellulose-based bio-food packaging products.



Bankability

Bio-packaging products based on circular economy theme are eligible to apply various soft loan as recently announced in Budget Malaysia Madani 2024. Additionally, bio-packaging products companies awarded Bio-Nexus status are also qualified to enjoy financing scheme promoted by Bioeconomy Corporation.



Market Demand

- The global market value for biodegradable packing materials is between USD465 billion (2018) to USD703 billion (2028) as outlined by the Global Market Insights 2018 – 2028.
- The following sustainable certification schemes are used to penetrate the premium export market from the EU and US markets.
 - » EU Ecolabel
 - » Compostable EN13412 : 2000 Certification
 - » European Cradle-to-Cradle Certification
 - » ISO WD 59 010, ISO WD 59 020, SO WD 59004, ISO TR 59 031, ISO TR 59 032, ISO/TC 323
 - » Certified Cradle to Cradle



Feedstock Supply

Plenty of feedstock i.e. rice straw, a proven business model to work together with the farmers in the rice granary area.



Business Model Scalability

- In line with the global agenda to achieve SDGs pillared on various ESG-driven business models, there is an increasing demand from multi-national corporations switching to consumption of various bio-packaging products. Global demand will scale up the production of these high value bio-based products.
- Bioeconomy Corporation has a track record of nurturing enterprising SMEs for the development of bio-based packaging products using rice straw. For example, Free The Seed Sdn Bhd plans to scale up the production capacity from 18,000 tonnes of rice straw to 360,000 tonnes of rice straw.

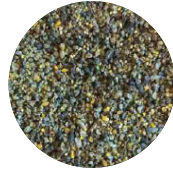
Special Mention

- Biodegradable products have the potential to be further scaled up based on the large amount of rice straw in the rice granary area.²⁸
- Biodegradable packaging industry is one sector that Bioeconomy Corporation is seeing with much potential of which Malaysian paddy farmers can get additional income by up to 20% through supplying the rice straw to the off-taker.

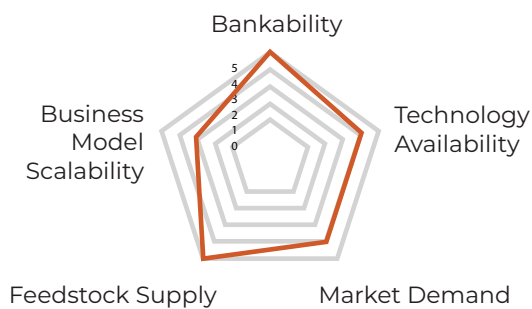


Government Facilitation

Bioeconomy Corporation is proposed to facilitate biopackaging product development to encourage paddy farmers to move up the value chain as producers of bio-based packaging products to unlock the potential of rice straw biomass.



ANIMAL FEED



Business Model	Type of Feedstock	Conversion Technology
Animal Feed	Fish Waste, Livestock Waste, Rice by-Products (Rice Husk, Rice Bran), Decanter Cake, Palm Kernel Cake (PKC), Oil Palm Frond (OPF)	Pelleting, Fermentation Technology, Aerobic Digestion, Black Soldier Fly etc.

Key Observations



Findings

- This bio-based business model involves converting the aforesaid biomass feedstock into high value animal feed such as fish feed, poultry feed and cattle feed and pet (cat) food. This involves proprietary bio-conversion technology and bio-based nutrient formulation developed by innovative biotechnology companies in Malaysia.
- Moreover, the high cost of imported animal feed had led to high selling cost of domestic meats and eggs. Factually, the cost of production of livestock keeps increasing and almost 60%-70% of the cost is contributed by feed cost. The above-mentioned issues can be progressively addressed through the development of a domestic animal feed supply chain made of biomass with high protein content.

Key Factors



Technology Availability

- Mature biotechnology is available locally for converting relevant biomass into processed animal feed. Some proven aerobic digestion technologies also can convert fish waste, decanter cake etc into animal feed within 48 hours. Nevertheless, the biotechnology that converts PKC into animal feed for layer and broiler chicken needs further accelerated R&D due to the high fibre content of PKC.



Bankability

- Soft loan schemes from Bank Negara Malaysia (BNM) and Agrobank can be tapped for animal feed production under the circular economy theme or food security theme.



Market Demand

- Malaysia's import of RM6 billion worth of animal feed solidifies the huge potential for locally developed animal feed using various biomass resources.
- Additionally, palm kernel cake can also be formulated as specialised feed additives of which the market size was USD\$37.8 billion in 2019 and is projected to grow at 3.8% CAGR from 2020 to 2027.²⁹
- In Malaysia, the feed consumption amounts to 250,000 tonnes for ruminant concentrate, 1.2 million tonnes for fodder and 5.9 million tonnes for compound feed essentially for both the broilers and layer chicken.



Feedstock Supply

- The ready-made feedstock for animal feed production i.e. PKC has been largely exported except for FGV which is championing the PKC/PKE-converted animal feed for Malaysia market.
- OPT and OPF are largely available in the plantation, especially during replantation activities. Nevertheless, its potentials to be developed as animal feed has yet to be commercialised at the industry level due to logistical challenges. Decanter cake from POME is still largely available and is suitable to be blended with other biomass.



Business Model Scalability

- Malaysia currently exports 98% of annually generated palm kernel cakes (PKC), with a total production of approximately 2.3 million tonnes annually.³⁰
- Competitive edge to have our own PKC animal feed production;-
 - (a) Animal feed needs to triple the production scale (for dairy and fish) and double the production scale (for poultry, swine, and beef) as compared to the current production rate.
 - (b) Dairy production is expected to rise by around 55%.
 - (c) FGV targets to supply 125,000 tonnes of processed PKC as animal feed for the domestic market with an estimated revenue of RM106.25 million by the year 2025.

Special Mention

- Production of PKC-based animal feed (cattle, goat and chicken) with local ingredients and development of complete animal nutrition solutions with an enhanced formulation has been championed by FGV.
- Malaysia exported 2.146 million tonnes of PKC in 2022 with export revenue of RM1.669 billion. The average exported price was RM777 / tonnes (2022). It is necessary to review such export policy in view of national food security issue. More attractive incentive may be formulated to turn PKC into animal feed for local market.
- Increased usage of 15% PKC as feeds for poultry chicken feed will potentially reduce 516,741 tonnes imported corn grain with saving of RM451 million annually.



Government Facilitation

It is proposed that Malaysia Government to consider further budgetary allocation for undertaking accelerated R&D by converting palm kernel cake into animal feed for layer and broiler chicken.

²⁹ The animal feed additives market is categorised into amino acids, vitamins, antibiotics, antioxidants, acidifiers, enzymes, and others; inputs shared by FGV Integrated Farming Holdings Sdn Bhd during FGD.

³⁰ MPOB 2022

COMPOST, BIOFERTILISER, BIOPESTICIDE

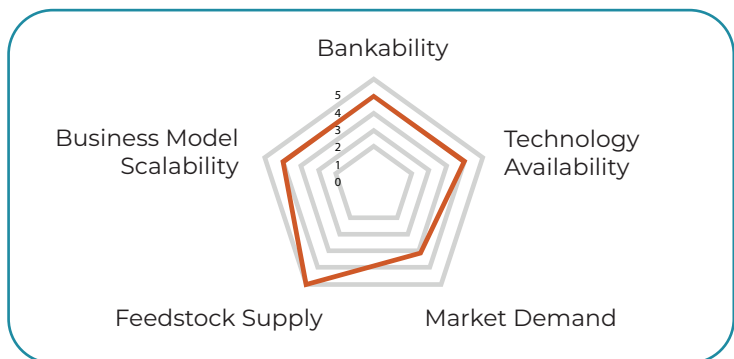


Key Observations



Findings

- There are two types of fertilisers i.e. organic (biofertiliser) and chemical (mineral) fertilisers. Fertiliser production in Malaysia is currently dominated by chemical fertilisers, representing about 85.5% of local fertiliser usage in 2020. Whereas organic fertilisers only have market penetration of about 14.5%.
- The consultation with stakeholders reveals a significant over supply in the biofertiliser, particularly in the case of chicken manure biofertiliser.
- Applying biofertiliser to plantation can contribute to soil rejuvenation coupled with the use of biochar which can be carbonised from various biomass such as EFB, PKS, etc.
- Wood vinegar, a by-product created during the pyrolysis process of biochar production; is a high value enzyme used as biopesticide to complement the usage of pesticide.
- Malaysia Standard on Organic Fertilisers i.e. MS 1517 is also in place.



Business Model	Type of Feedstock	Conversion Technology
Compost, Biofertiliser & Biopesticide Production.	Manure, Palm Biomass (EFB, POME, Palm Ash)	Composting, Anaerobic Digestion and Vermicomposting

Key Factors



Technology Availability

- Biofertiliser made of palm biomass and fish waste championed by innovative SMEs as well as the conversion technologies developed by leading plantation companies have yielded positive results.
- Genting Plantation Bhd through its flagship Yield Booster™ biofertiliser products has successfully delivered average yield increment of 16% coupled with a 25% reduction of inorganic fertiliser with application at more than 4200 hectares.³¹



Bankability

- Biofertiliser producers are eligible to apply for various soft loans promoted by Bank Negara Malaysia, Agrobank, Green Technology Financing Scheme (GTFS) and Bioeconomy Corporation.



Market Demand

- The fertiliser industry in Malaysia was valued at RM4.72 billion in 2021 and is projected to expand on a compounded annual growth rate ("CAGR") of 14.3% to reach RM9.20 billion in 2026.³²
- In 2021, Malaysia's total import value for nitrogen, phosphate and potassic was RM4.3 billion.
- The palm oil industry is the largest user of fertiliser with 5.2 million tonnes annually.³³
- Additionally, there is a great potential to encourage the use of biofertiliser and micronutrient in paddy plantations



Feedstock Supply

- There is plenty of feedstock i.e. EFB, POME, palm ash from boilers, chicken manure etc.
- Proven biofertiliser technology providers can propose innovative business models with potential palm oil mills integrating waste management of biomass (EFB, POME) and biofertiliser conversion technologies; Palm oil mills provide the biomass whilst the biotechnology companies provide the fertilisation know-how with palm oil mills off-take the produced biofertiliser.



Business Model Scalability

- If the biofertiliser industry is enabled by the government and linked to fertiliser subsidy scheme for agricommodity (oil palm), this will scale up the demand accordingly.
- Palm oil mills are likely to collaborate if there is potential for the off-take of produced biofertiliser using biomass generated from the mills. This, in turn, will lead to investment in waste management to address the environmental compliance issues related to POME with the Department of Environment (DOE)
- Assume the biofertiliser usage is further enabled by the government through legislative provision in future, it will generate a potential recurring circular economy value of RM378 million annually based on 420,000 tonnes of biofertiliser made of EFB and POME;³⁴ leading to 200 jobs creations and at the same time reducing the import of chemical fertiliser with potential forex saving of RM336 million per annum.³⁵



Government Facilitation

- It is proposed to legislate that all farming and plantation crops fertilisation to be replaced with a higher percentage of biofertiliser conforming to MS 1517 blending with chemical fertiliser as compound fertiliser. It is expected to avoid GHG emission reduction of an estimated 30 million tCO₂ annually based on the aforesaid scenario mobilising 420,000 tonnes of EFB biofertiliser.
- Review the existing fertiliser formulations and encourage the use of biofertiliser, biopesticide and micronutrient in paddy plantations for long term rice production and environmental sustainability.³⁶

³² Market Outlook on Malaysia Fertilisers, Hexstar Global Bhd's corporate announcement to Bursa Malaysia

³³ Between 2018 – 2020; MPOB Biology Unit

³⁴ Based on utilisation of 1 million tonnes of EFB.

³⁵ Engagement with 2 biofertiliser producers.

³⁶ Biopesticide is outlined as the Strategic Focus Area in Chemical Sector in the newly released New Investment Policy by MITI.

PALM KERNEL SHELL-BASED GRAPHITE AND GRAPHENE



Palm Kernel Shell (PKS)

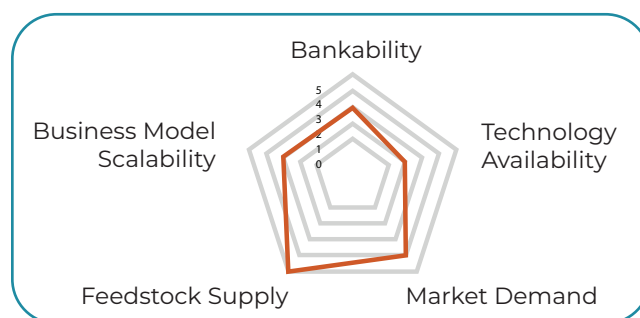


Palm-based Graphite



Palm-based Graphene

Business Model	Type of Feedstock	Conversion Technology
Bio-Graphite and Bio-Graphene	Palm Kernel Shells (PKS)	Advanced Carbonisation Technology



Key Observations



Findings

- Palm kernel shells (PKS) are used as the raw material for producing bio-graphite and bio-graphene. The PKS are dried and crushed to remove the water and oil to get the pure biomass form.
- Graphite is used for pencils, steel manufacturing and electronic such as smartphone. In application of lithium-ion battery, graphite ranks above lithium as the key ingredient. Graphite is the key raw material in the battery anode with almost all electric vehicle (EV) battery anodes comprising 100% graphite.
- Whilst, graphene has many different applications including lithium battery, energy storage, high frequency transistor, heat dissipation, paint, thin-film transistor, carbon based computer device, molecular detection and imagery, biochemical, rubber additives, nanofluids etc.³⁷
- Intense commercialisation of graphite and graphene technology are taking place now especially China which is the top export country of artificial graphite. There are three types of graphite as illustrated in the following table.

Graphite Source	Mineral	Artificial Graphite Coal / Petroleum based (Commodity)	PKS Graphite
Resource Type	Natural Resources (Limited Resources)	Artificially Made (Limited Resources)	Renewable (Circular Economy)
Pricing	Lower price than artificial graphite	USD1121 per tonne ³⁸	Competitive Pricing

37 Engaged with Nano Malaysia Bhd's Biomass Innovative Circular Economy Programme (BICEP) and FGD session with Graphjet Technology Sdn Bhd

38 Imported price in Malaysia for Year 2022

Key Factors



Technology Availability

- Malaysia has yet to establish a commercial scale manufacturing plant for PKS-converted bio-graphite and bio-graphene. Nano Malaysia Bhd is currently championing the development of graphite and graphene industry through its Biomass Innovation Circular Economy Programme (BICEP).



Bankability

- Turning PKS into bio-graphite and bio-graphene is a new technology and business model and this is a capital-intensive investment. Thus, project developer can refer to the Green Technology Financing Scheme (GTFS) IV. Alternatively, initial public offering (IPO) fund raising model such as Special Purpose Acquisition Company (SPAC) may be considered.



Market Demand

Graphene Market

The BICEP highlights that Lux Research UK has projected the graphene market will grow to around USD780 million by 2028.

Graphite Market

Graphite global trade has achieved more than USD4 billion in 2022 with Malaysia as the No. 1 importer in the world, representing 15.1% of world import of graphite.



Feedstock Supply

- Plenty of feedstock i.e palm kernel shell (PKS) which is mainly used as green fuel at boilers or exported to Japan and sold around RM400 – RM500 per tonne in 2022.³⁹ Bio-graphite and bio-graphene are higher value products with a better margin to offset the higher price of the feedstock.



Business Model Scalability

- Technology readiness level and access to financing are the key success factors for bio-graphite and bio-graphene. Malaysia imported artificial graphite valued at USD671 million (598,751 tonnes) in 2022 and USD384.22 million (480,101 tonnes) in 2021, making Malaysia the largest importer in the world.⁴⁰ Thus, Malaysia imported 1,078,852 tonnes of artificial graphite valued at USD1.05 billion between 2021 and 2022.⁴¹
- The above-mentioned trade data solidifies the fact that Malaysia has a strong market demand for artificial graphite. In other words, there is a potential transformational new commodity business model of PKS-converted bio-graphite.



Government Facilitation

- There is an emerging need for Malaysia to expedite the R&D&C&I of PKS-based bio-graphene and bio-graphite in light of the huge market demand globally and domestically. It is proposed that MPOB and relevant industry partners to undertake R&D&C&I for both bio-graphite and bio-graphene. A market study on bio-graphite should be conducted in view of its immediate commercialisation potential.

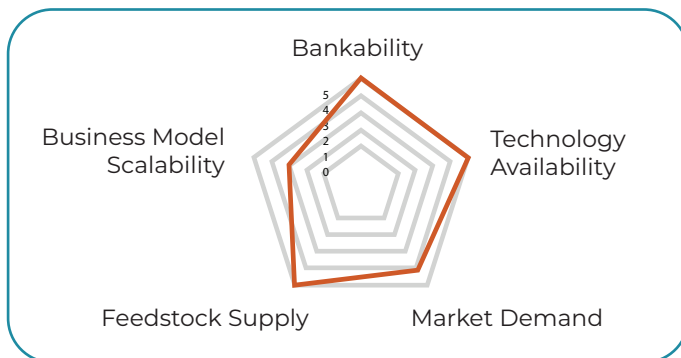
³⁹ PKS export price highly correlates with pricing of energy commodities.

⁴⁰ Approximately 3 tonnes of dried PKS is needed to convert into 1 tonne of bio-graphite based on inputs sharing from Graphjet Technology Sdn Bhd during FGD;

⁴¹ DOSM data

BIODEGRADABLE EROSION CONTROL PRODUCTS

Business Model	Type of Feedstock	Conversion Technology
Erosion Control Products	Rice Straw, Coconut Fibre, Palm Fibre	Biomass products are engineered into construction practice i.e. erosion control on the slope.



Key Factors



Technology Availability

Erosion control products are manufactured using: a) Biomass materials bundled with sand, soil and rock as bio-engineering products b) Synthetic materials c) A combination of biomass and synthetic materials; Biomass materials are generally biodegradable and will disintegrate to allow for vegetation growth along the ground. Vegetation increases the strength of the soil, therefore contributing to the soil stability. Whilst synthetic materials are generally used for soil protection and reinforcement to serve its engineering function. The value-added ratio of these bio-products has increased tremendously after it is upgraded as finished bio-engineering products. Mature and proven technologies are available locally.



Erosion Control Blankets



Turf Reinforcement Mattress



Erosion Control Blankets

Key Observations



Findings

- Innovative SMEs in Malaysia convert agricultural by-products i.e. rice straw, oil palm fibre and coconut fibre by turning these biomass into biodegradable erosion control products. These biomass resources have been repurposed in construction practice as high value bio-engineering products, decoupled from conventional biomass commodity business models.
- Erosion control products are used in a diverse range of infrastructure projects :-
 - (a) Land reclamation
 - (b) Road construction
 - (c) Railway construction
 - (d) Riverbank and coastal construction
 - (e) Soil stabilisation and landscaping



Bankability

Manufacturers of erosion control products generally have proven the bankability of the bio-engineering products including access to financing from the capital market. Two listed companies in Bursa Malaysia i.e. Fibromat (M) Bhd and Heng Huat Resources Bhd are championing this circular economy model.



Market Demand

- Erosion control products benefited immensely from government budget related to infrastructure development (highway construction, soil erosion etc)
- Sustainable business model to address natural disaster management such as landslides and erosion of riverbanks as a result of climate change such as heavy rain, flash flood etc.



Feedstock Supply

Currently, the main feedstock supply for this product is rice straw and coconut fibre. Both biomass feedstock prices range between RM200 to RM300 per tonne. Generally, feedstock pricing is not a material issue due to the high value-added ratio of erosion control products.



Business Model Scalability

The scalability of the erosion control industry correlates with the performance of the construction industry and the government annual budgetary allocation. The market size of the erosion control industry in Malaysia is in the region of RM450 – RM500 million based on an independent market report of a listed company during IPO corporate exercise.⁴² Thus, the scalability is on a case-to-case basis and is subject to specific project awards involved in tender selection process.

Special Mention

Business model linked to climate change and ESG-driven; increasing awareness on environmental issues drive demand of erosion control products.



Government Facilitation

Biodegradable erosion control products should be given priority for government procurement's consideration vis-à-vis synthetic engineering products.



⁴² Fibromat (M) Bhd

BIOCHAR FROM CHICKEN MANURE



Collection of Chicken Manure

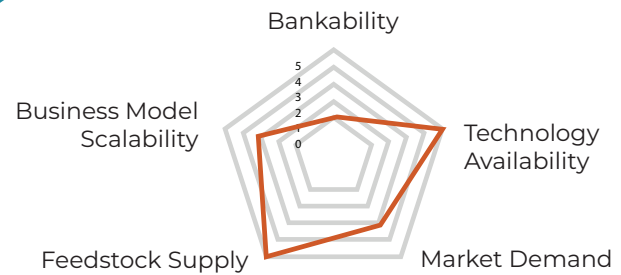


Chicken Manure



Biochar

Business Model	Type of Feedstock	Conversion Technology
Biochar	Chicken Manure	Carbonisation Technology



Key Observations



Findings

- Currently, the Malaysian poultry industry has undertaken various business initiatives in the context of resource recovery through recycling of poultry products and by-products :-
 - (a) Organic fertiliser from processed poultry manure/litter
 - (b) Sale of cooked poultry offal for feeding fish
 - (c) Processing of poultry by-products as pet food
 - (d) Rendering of inedible by-products in poultry slaughter (feather, offal and blood) to fish feed for aquaculture etc.
 - (e) Conversion of chicken manure into biochar
 - (f) Production of biogas
- New innovative business model should be formulated to further unlock the potential of chicken manure either as organic fertiliser certified with proper standard i.e. MS 1517 or biochar serving as soil enhancer to add value for biofertiliser application.

Key Factors



Technology Availability

Mature and proven conversion technologies are available locally for converting various livestock by-products as organic fertiliser, feather meal⁴³ and animal feed. While the conversion of chicken manure into biochar holds promises, the technological competency for large-scale commercialisation has not yet been proven due to the high capital expenditure involved.

⁴³ A SME has received technology funding from MTDC to produce feather meal serving as fish feed.



Bankability

MSMEs involved in livestock waste commercialisation are recommended to consult BNM's SME Schemes which fund circular economy projects as well as technology funding opportunities offered by Malaysian Technology Development Corporation (MTDC) i.e. Business Start-up Fund.



Market Demand

- At the moment, biochar has yet to establish mass market demand locally. Biochar, serving as soil enhancer is blended and sold as a premium grade biofertiliser which has gained market acceptance for durian farming in Malaysia.
- There is increasing business interest of biofertiliser manufacturers to off-take biochar produced by various biomass including chicken manure due to proven biofertiliser solutions blending with biochar, POME, EFB and relevant microbes.
- There is also investment interest from MNCs to convert chicken manure into bio-methanol.



Feedstock Supply

Plenty of biomass (chicken manure) is available based on telephone survey with poultry farms throughout Malaysia and direct engagement with top management of listed poultry companies. Similarly, chicken feathers, another potential livestock waste, are often discarded in landfills but can be upscaled for commercial use as fish feed.



Business Model Scalability

- Turning chicken manure into biochar remains a new circular economy model that has yet to be rolled out on a commercial basis. The new business model is likely to flourish if the national biofertiliser initiative is enabled which is expected to boost demand for biochar collectively.
- The biochar business model is potentially co-financed by carbon credit under the voluntary carbon market (VCM); Overseas carbon credit buyers are interested to buy carbon credits developed from biochar projects. Project developers need to incorporate additionality factors in the project design.



Government Facilitation

The chicken manure-turned-biochar project can be considered for a pilot demonstration plant to showcase its business and technical viability using R&D&C&I funding based on the theme of addressing national interest as newly announced in the recent Malaysia Madani Budget 2023 / 2024.



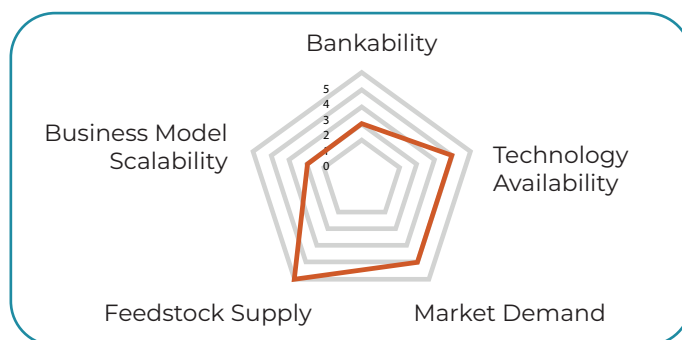
FISH WASTE COMMERCIALISATION – BOOSTER LIQUID BIOFERTILISER & FISH MEAL



Fish Waste

Fish Meal⁴⁴Booster Liquid Biofertiliser⁴⁵

Business Model	Type of Feedstock	Conversion Technology
Booster Liquid Biofertiliser	Fish Waste (Head, Tails, Stomach Etc)	Hydrolysate Process (Liquid Biofertiliser)



Key Observations



Findings

- Fish waste has been converted to aqua feed and animal feed which are already a mature business in Malaysia that supports the growth of the aquaculture industry.
- It also can be converted into high value booster liquid biofertiliser. Nevertheless, fish meal is highly in demand by aquaculture industry.
- Recently, a new business model has been proposed using booster liquid biofertiliser:-

Proposal to create a Farming Consortium by working together with like-minded farmers termed as "satellite farmers" with potential facilitation by relevant government authorities. The promoter will provide training, guidance in managing greenhouse farming projects and acts as the off-taker, purchasing the agricultural crops produced by satellite farmers who use booster liquid biofertiliser.

Key Factors



Technology Availability

- Proven conversion technologies are available locally for converting fish waste especially the fish head, tails, skin etc. into either fish meal or biofertiliser.
- Selective fish waste such as tuna which has a high content of amino acid, omega 3, natural NPK, etc are converted into booster liquid biofertiliser using hydrolysate fermentation process. It has been used for planting high value crops such as chili and Japanese's arus musk melon championed by an innovative SME. It possesses the relevant know-how to develop greenhouse-based agricultural projects using booster biofertiliser.

44. Mature business model in Malaysia

45. Focal Area of the Study



Bankability

The fish meal processing business is a mature business. MSMEs can approach Agrobank to explore financing opportunities. For MSMEs producing biofertiliser, they should apply for BioNexus status and apply Biotechnology Commercialisation Fund (BCF) provided by Bioeconomy Corporation.



Market Demand

Fish meal has a massive demand locally by the aquaculture industries. Importers from China also source fish meal in large quantities from Malaysia.

For booster liquid biofertiliser, it can be formulated as a new business model to address national food security by reducing imports of relevant agricultural commodities such as chili. It is proven that such booster biofertiliser can deliver high-yield / high-value crops such as Japanese arus musk melon based on a proven venture in Brunei.



Feedstock Supply

Most of the fish waste generated at fishery landing ports and seafood processing centres has been committed with existing buyers or off-takers which is sold between RM0.50 to RM2 per kg.⁴⁶ An alternative avenue is to source fish waste from wet markets.



Business Model Scalability

Malaysia's fish meal industry earned export revenue of RM156.6 million in 2022. Nevertheless, the scalability of the fish meal industry is very much subjected to feedstock availability.

An innovative business model has been formulated to work together with potential farmers using booster liquid biofertiliser which has proven its business viability in Brunei. New wealth is created for participating farmers with the promoter providing technical know-how and off-taking services. Participating satellite farmers are expected to earn RM10,000 per month. This new business model is scalable as the promoter plans to enlarge the production capacity for its booster biofertiliser.

Special Mention

Approximately 100,000 tonnes to 128,000 tonnes of fish waste are processed as fish feed annually.



Government Facilitation

The practices to convert fish waste into fish meal should be reviewed in view of sustainable fishing practices. The Department of Fisheries is recommended to assess the current practices of the deep sea fishing companies.

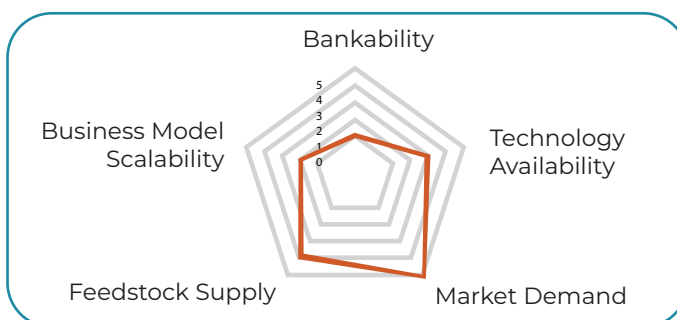
It is proposed for the Ministry of Agriculture & Food Security (KPKM) to conduct a study and to facilitate the satellite farmers business model using booster liquid biofertiliser.

46. Inputs from LKIM and off-taker of fish waste

SPECIALTY BIOCHEMICALS AND BIOPOLYMERS



Business Model	Type of Feedstock	Conversion Technology
Specialty Biochemicals & Biopolymers	Palm Biomass and Woody Biomass	Biochemical Fermentation Process



Key Observations



Findings

- Lignocellulosic biomass is abundant and sustainable feedstock available in Malaysia. These biomass feedstocks contain cellulose, hemicellulose, lignin etc. In general, these compounds are natural biopolymers. There are many potentials to convert these compounds to specialty biochemicals and biopolymers which includes biosurfactants, bioplasticisers, biolubricants, biopolymers - nanocellulose, polylactide acid (PLA/PHA) etc.
- Other application includes packaging, composites, films and coatings, biomedical applications and additives such as rheological modifiers.
- The advantages of specialty biochemicals and biopolymers compared to commodity biochemicals are:-
 - (a) High in products value;
 - (b) Require lesser of biomass feedstock;
 - (c) Potential of shorter payback period;
 - (d) Capex for investment is much lower;
 - (e) Business model risks are lower.

Key Factors



Technology Availability

In the local context, several universities and research institutes have engaged in developing these products with Technology Readiness Levels (TRL) 2 to 5. The biochemical industry has encountered technology conversion challenges to beat the production cost of petroleum-based chemicals.



Bankability

As the TRL varies from TRL 2 to 5. Thus, at this level, banks will be unlikely to offer any financial support. Nevertheless, MOSTI has offered 5 types of R&D&C&I grants i.e. Applied Innovation Fund (AIF), Technology Development Fund (TeD1 / TeD2), Bridging Fund (BGF) and Strategic Research Fund (SRF) for eligible proposals.



Market Demand

In the newly released New Investment Policy (NIP), the chemical sector contributed RM120 billion to GDP in 2021 which is equivalent to 8.7% of national GDP. Currently, most of the conventional specialty chemicals and polymers are petrochemical-based. Over the past decades, there has been strong interest in replacing conventional products with bio-based chemicals and polymers, driven by various environmental considerations. If we manage to convert 5% of the RM120 billion current chemicals market towards utilising biomass, indicating a potential business value of RM6 billion.

Globally, there are many companies actively involve in this focal area such as NatureWorks LLC (USA) - Ingeo™ biopolymers; Corbion (Netherlands) – lactides and biobased succinic acid; TotalEnergies (France) - biobased polypropylene (Bio-PP); Arkema (France) - Rilsan® biobased polyamide and Pebax® biobased elastomers; Mitsui Chemicals (Japan) - biobased polyethylene (Bio-PE) etc.



Feedstock Supply

Malaysia has generated abundant biomass from the plantation sector notably EFB. The requirement of biomass feedstock for specialty biochemicals and biopolymers are relatively low compared to the commodity biochemicals such as ethanol due to economic of scale with one or two mills' EFB is sufficient for a specialty chemicals or biopolymers pilot plant.



Business Model Scalability

The specialty biochemicals and biopolymers industry is still in the infancy stage in Malaysia. So far, we do not have any success stories to refer to locally. However, overseas companies have made good progress in this area. Recently, Petronas Chemicals Group (PCG) has been involved in new bio-based monoethylene glycol (MEG) R & D which is the raw materials for polyethylene terephthalate (PET) production, a widely used resin in packaging industries with prominence in bottle manufacturing.

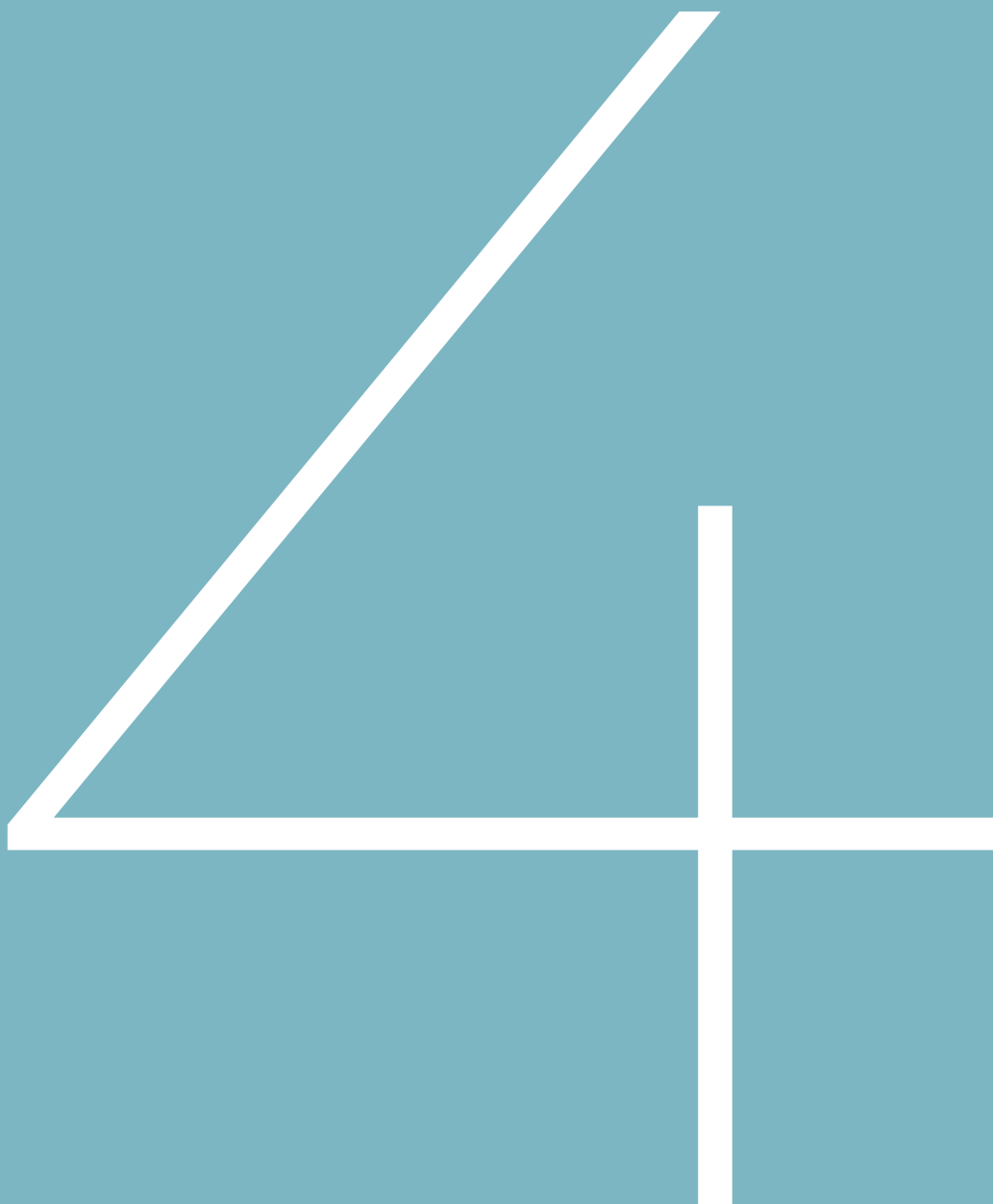


Government Facilitation

It is proposed for the Malaysia Government to allocate a special grant related to specialty biochemicals as well as biopolymers. Additionally, compilation of a comprehensive list of available biochemicals and biopolymers in local universities and all research institutes in Malaysia with proper grading of TRLs is required.

Chapter

Financing Mechanism and Investment Incentives



Financing Mechanism & Investment Incentives

Current Scenario

Access to financing remains a challenge for biomass MSMEs who are not familiar with the financing eco-system in Malaysia. The issues have been highlighted in the National Agri-commodity Policy (DAKN) 2021 – 2030, the annual report of Sustainable Energy Development Authority (SEDA)⁴⁷ as well as Malaysian Palm Oil Board (MPOB). This chapter serves to identify the financing framework to guide biomass companies especially MSMEs to access financing offered by various financial institutions such as development financial institutions (DFIs), Bank Negara Malaysia (BNM), commercial banks, Islamic banks; government grants related to marketing promotion, alternative financing avenues promoted by the Securities Commission i.e. equity crowdfunding (ECF), venture capital and private equity, initial public offering (IPO) - LEAP Market, ACE Market & Main Market at Bursa Market as well as carbon credit.

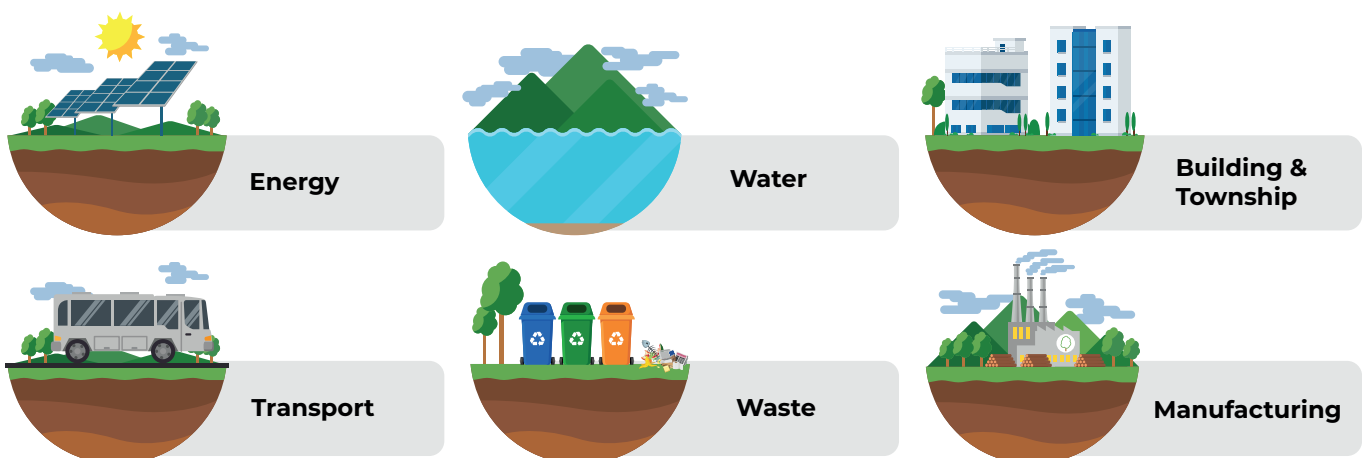
For this report, the focus will be on potential financing schemes that can be tapped by biomass MSMEs from banking institutions⁴⁸ as well as relevant investment incentives.

Relevant Financing Schemes for Biomass Sector Offered from Banking Institutions

(i) Green Technology Financing Scheme (GTFS) IV

The Green Technology Financing Scheme (GTFS) IV (www.gtfs.my) was established to address the financing gap, thus closing knowledge gaps and technical capacity in evaluating new technologies, while de-risking these investments for financial institutions.⁴⁹ The Malaysia Madani Budget 2023 has recently announced the RM3 billion GTFS 4.0 which is the popular financing scheme for green technology project producers and users in Malaysia. The guarantee for the waste sector will be increased to 80%.

What Sector Can Be Funded?



⁴⁷ Dealing with project financing of grid-connected biomass power plants.

⁴⁸ As per the scope in the TOR of the study

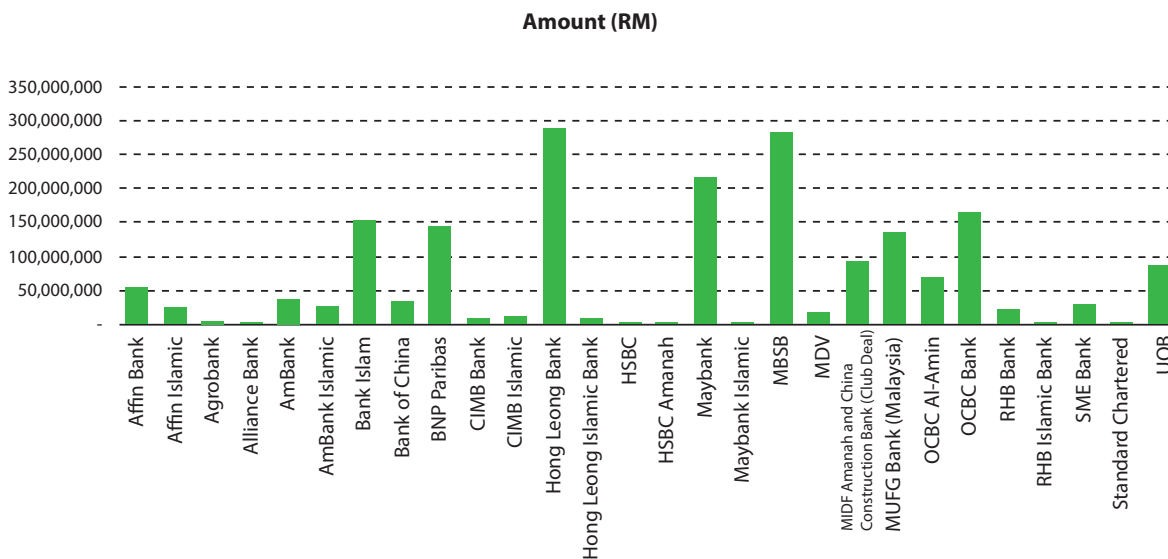
⁴⁹ Unleashing Sustainable Finance in South East Asia, The World Bank (2022)

Table 4.1: Criteria of Green Technology Financing Scheme 4.0

Features	Producer of Green Technology	User of Green Technology	Energy Service Company
Purpose	To finance investment for the production of green products	To finance investment for the utilisation of green technology	To finance investment or assets related to energy efficient projects and/ or energy performance contracting
Eligibility	Legally registered Malaysian Companies with 60% Malaysian Shareholding		
Financing Size	Maximum: RM100 Million	Maximum: RM50 Million	Maximum: RM25 Million
Financing Tenure	Up to 15 years	Up to 10 years	Up to 10 years
Incentive Period	First 7 Years		
Government Incentives	60%-80% Government Guarantee and 1.5% Rebate on Interest Rate; MGTC has recommended to the Government that the waste sector is eligible to receive 80% government guarantee for the bank loan.		

Source: MGTC

The following table outlines the green banks that are more aggressive and loan-friendly in the context of approving GTFS projects. It can serve as a guide to relevant biomass MSMEs seeking financing through GTFS. As illustrated in the diagram, OCBC Bank and its Islamic bank i.e. OCBC Al-Amin Bank have been ranked No.1 as GTFS 2.0's PFI followed by MBSB Bank and Hong Leong Bank.

Figure 4.1: Participating Financial Institutions (PFIs) of GTFS 2.0 (Dec 2020)



Source : MGTC

(ii) Development Financial Institutions (DFIs)

Leverage on the financing facilities provided by Development Financial Institutions (DFIs) of which their key result indicators are developmental-oriented to better reflect the socio-economic impacts of DFIs' operations. These indicators include financing amount approved to first time borrowers, new jobs creation from financed projects, funding for underserved or new growth segments.⁵⁰ DFIs as public institutions are positioned to continue to improve how DFIs contribute to socio-economic development. Biomass entrepreneurs across different business models can tap into the credit facilities provided by DFIs. Financing by DFIs complements government's efforts to facilitate greater market efficiency for financing mechanism and serves as a good alternative avenue for funding biomass projects. Different DFIs have different funding preferences and risk appetites such as Bank Pembangunan Malaysia Bhd which has higher risk profile and prefers development projects with national interest and involves minimum funding of RM20 million.


Example of DFIs linked to potential biomass themes project financing:

Table 4.2: Agrobank and SME Bank Financing Scheme related to Biomass Theme

Features	 AGRO BANK Financing for Food Production Projects	 SME BANK SME Technology Transformation Fund
Key Terms	Financing Scheme	Financing Scheme
Financing Limit	RM10,000 to RM10 million	RM100,000 to RM3 million
Profit rate	3.75% profit rate p.a. for total financing up to RM5 million 5.00% profit rate p.a. for financing exceeding RM5 million up to RM10 million	4.0% p.a (inclusive of guarantee fee)
Financing Scopes	For production of all food commodities either for the purpose of production, processing, cold storage, marketing or distribution services. Processed food products are allowed provided that these products use more than 50% local raw materials. For local and export marketing (local marketing must be at least 30% of production value)	Equipment and/or machinery; Technology support services; and Other intangible assets to enhance productivity and efficiency.
Tenure	Up to 10 years	Up to 10 years
Collateral	Subject to Agrobank's current policy	Up to 80% guarantee cover from Syarikat Jaminan Pembiayaan Perniagaan (SJPP); Personal guarantees/ joint and several guarantees/ corporate guarantees.

50 Financial Sector Blueprint 2022 – 2026, Bank Negara Malaysia (2022)

Table 4.3: BPMB's Sustainable Development Financing Scheme

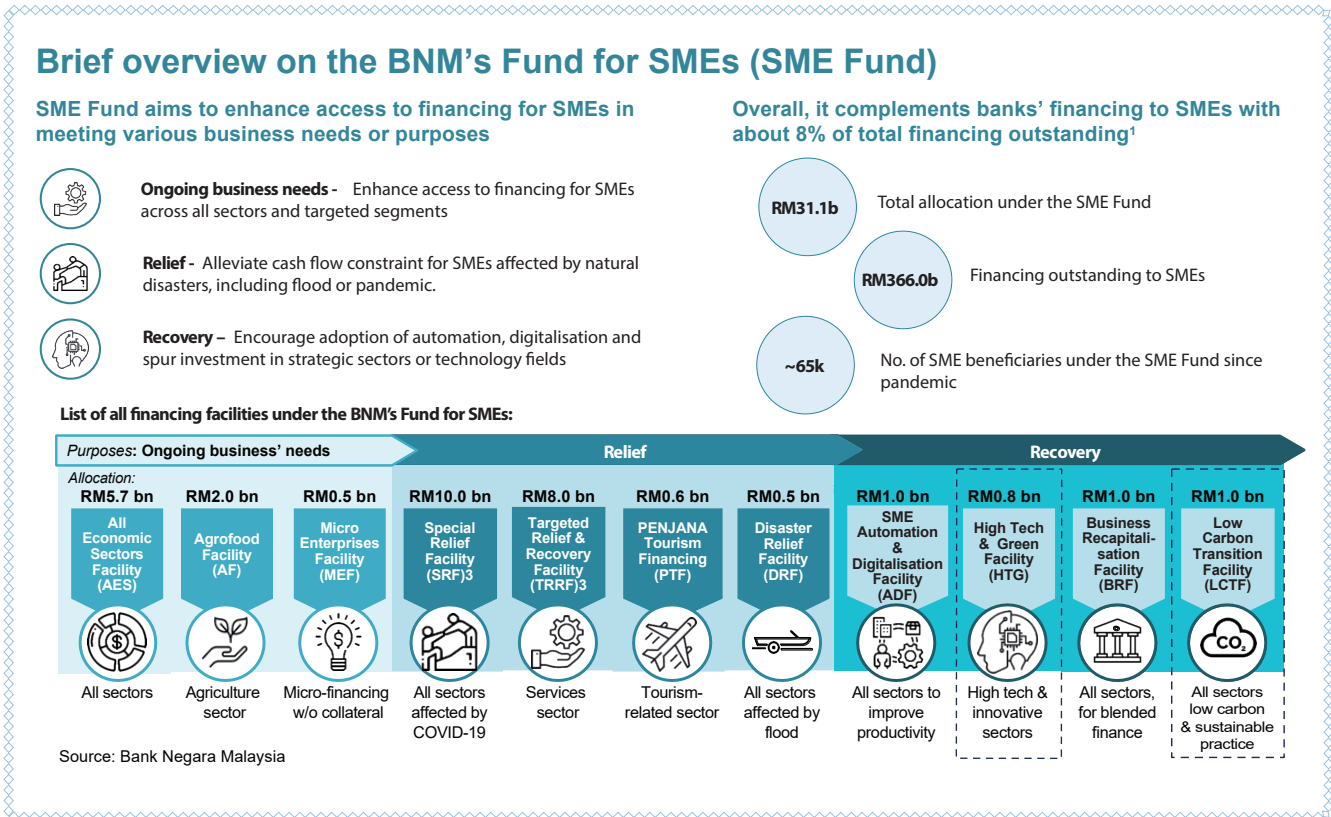
 Bank Pembangunan Malaysia Bhd: Sustainable Development Financing Scheme	
Key Terms	Financing Scheme
Fund Size	RM 1.0 billion
Availability	1 Jan 2021 – 31 Dec 2025
Financing Facility Offered	Term Financing Revolving Facility (for working capital financing only) Syndication / Club Deals
Financing Purpose and Tenure	CAPEX: Up to 15 years OPEX: Up to 5 years
Margin of Financing	Up to 80%
Pricing	COF / BFR + Margin (Up to 2% p.a.) – Subsidy of 1.5%
Financing Limit	Asset acquisition : Up to RM100 million Development of infrastructure : Up to RM200 million
Eligible Applicant	Partnership, Private Limited, Public Company and Co-operatives; Majority ownership of 51% by Malaysian; Registered and incorporated in Malaysia and involved in any of the UNDP 17 Sustainable Development Goals (SDG) initiatives; Able to demonstrate measurable and continuous contribution to any of the UNDP's 17 SDG to BPMB's satisfaction; Minimum funding requirement is RM20 million.


SUSTAINABLE DEVELOPMENT GOALS


(iii) Bank Negara Malaysia (BNM)'s Fund for SMEs

BNM's Fund for SMEs serves to provide access to financing at a reasonable cost for SMEs in all sectors. Recently, BNM has launched **RM800 million High Tech & Green Facility (HTG)** and **RM 1 billion Low Carbon Transition Facility (LCTF)**. MSMEs involved in biomass circular business models are eligible to apply these soft loan schemes. For further details please visit <https://www.bnm.gov.my/funds4sme>.

Figure 4.2: Overview on BNM's Fund for SMEs





All Economic Sectors Facility (AES)

This facility is to enhance access to financing for SMEs in all economic sectors to support growth. The financing covers capital expenditure and working capital.

Agrofood Facility (AF)

The facility is to increase food production for Malaysia and for export purposes. Following the Budget 2023 announcement, the allocation of the Agrofood Facility has been increased by RM500 million, resulting in a total allocation of RM2.5 billion.

Micro Enterprises Facility (MEF)

This RM500 million facility is aimed at supporting microenterprises including gig workers on digital platforms and the self-employed. The facility is for working capital and capital expenditure.

High Tech & Green Facility (HTG)

The RM1.1 billion facility is designed to help SMEs and innovative start-ups to grow their businesses and invest in strategic sectors and technology fields (digital tech, green tech and biotech) for a sustainable and entrenched economic recovery. A financing rate of up to 3.5% per annum is offered for financing without guarantee or up to 5% per annum, inclusive of guaranteed fee (with guaranteed coverage by Credit Guarantee Corporation Malaysia Berhad (CGC) or Syarikat Jaminan Pembiayaan Perniagaan Berhad (SJPP)).

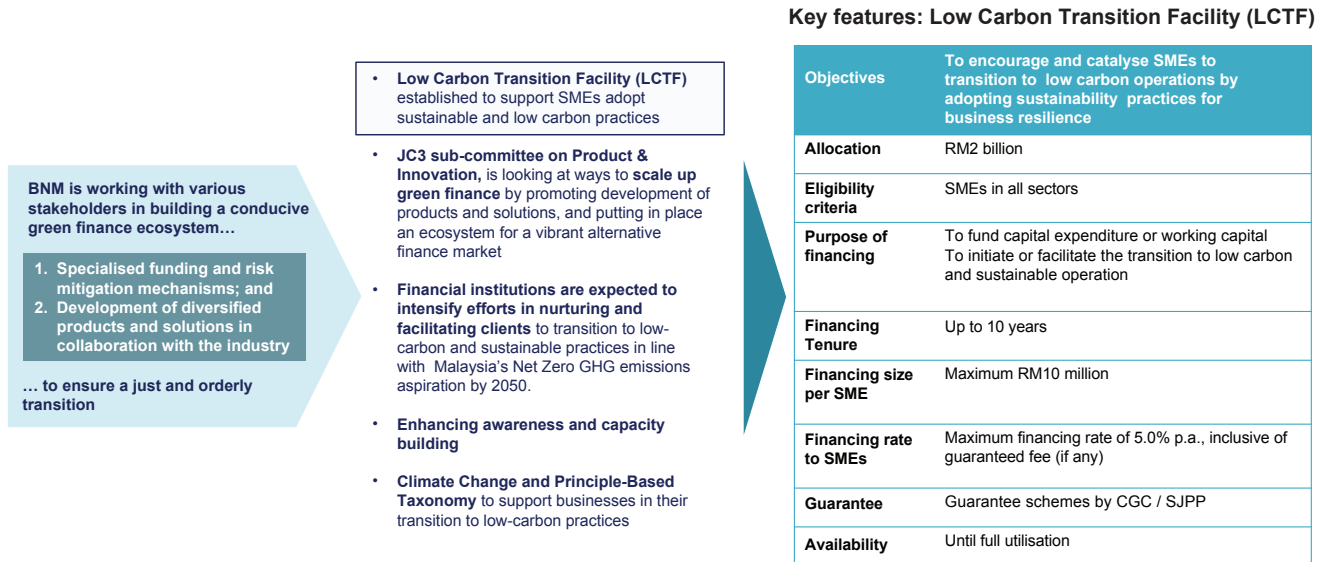
Low Carbon Transition Facility (LCTF)

A RM1 billion facility established on a matching basis with participating financial institutions to help SMEs embrace sustainable and low carbon practices in their business operations. This includes increasing the usage of sustainable raw materials and renewable energy and also improving energy efficiency of buildings or machinery. This facility is in line with the Government's target for Malaysia to be a net-zero emission economy by 2050.

Bank Negara Malaysia (BNM)'s Fund for SMEs (Cont.)

Figure 4.3: Low Carbon Transition Facility (LCTF)

LCTF is one of BNM's initiatives to scale up green finance, designed to support and encourage SMEs to adopt sustainable and low carbon practices



Source: Bank Negara Malaysia

Figure 4.4: High Tech & Green Facility (HTG)

HTG aims to support eligible SMEs to invest in strategic sectors or technology solutions, including renewable energy using biomass

Key features: High Tech & Green Facility (HTG)

Objectives	Help SMEs and innovative start-ups to grow their businesses and invest in strategic sectors and technology fields (digital tech, green tech and biotech) for a sustainable and entrenched economic recovery.
Allocation	RM800 million
Eligibility criteria	<ul style="list-style-type: none"> • SMEs involved in selected manufacturing & services sectors; or • SMEs involved in providing technology solutions²; or • SMEs and start-ups involved in Government programmes.
Purpose of financing	Working capital and/or capital expenditure (CAPEX)
Financing Tenure	Up to 10 years
Financing size per SME	Maximum RM10 million
Financing rate to SMEs	<ul style="list-style-type: none"> • Up to 3.5% p.a., for financing without guarantee; or • Up to 5% p.a., inclusive of guaranteed fee
Guarantee	Guarantee schemes by CGC / SJPP3
Availability	Until 31 Dec 2023

SMEs involved in providing 3 key technology solutions below are eligible for HTG up to RM10 million

IR4.0 and Digital Technology
<ul style="list-style-type: none"> • Automation solutions (<i>smart manufacturing, robotics</i>) • Connectivity and distributed infrastructure (<i>5G, cloud computing</i>) • AI applications and software development (<i>digital healthcare, mobility solutions</i>)
Green Technology
<ul style="list-style-type: none"> • Renewable energy (<i>solar, biomass, wind, energy-as-a-service, hydrogen, waste-to-energy</i>) • Electrification (<i>EV, smart grids, fuel cells</i>) • Circular economy • AgriTech (<i>vertical farming hydroponic, drones, big data</i>) • Low carbon technologies (<i>CCUS, manufacturing</i>)
Biotechnology (<i>strategic national priorities in food security and health</i>)
<ul style="list-style-type: none"> • Biochemical (<i>biofuel</i>) • Biosciences/ Biomedical (<i>crop improvements, vaccines, alternative meats, precision medicine</i>)

(Non-exhaustive examples shared in brackets)

Source: Bank Negara Malaysia

Both LCTF and HTG are distributed by participating financial institutions (PFI). Total allocation for LCTF is RM2 billion i.e. RM1 billion allocation from Bank Negara Malaysia + RM1 billion from participating financial institutions on a matching basis.

List of Participating Financial Institutions (PFIs) for LCTF

- Affin Bank Berhad / Affin Islamic Bank
- Alliance Bank Malaysia Berhad / Alliance Islamic Bank Berhad
- Al Rajhi Banking & Investment Corporation (Malaysia) Berhad
- AmBank / AmBank Islamic Berhad
- Bangkok Bank Berhad
- Bank Islam Malaysia Berhad
- Bank Kerjasama Rakyat Malaysia Berhad
- Bank Muamalat Malaysia Berhad
- Bank of China (Malaysia) Berhad
- Bank Pembangunan Malaysia Berhad
- Bank Pertanian Malaysia Berhad (Agrobank)
- Bank Simpanan Nasional
- CIMB Bank Berhad / CIMB Islamic Bank
- Export-Import Bank of Malaysia Berhad (EXIM Bank)
- HSBC Bank Malaysia Berhad / HSBC Amanah Malaysia Berhad
- Hong Leong Bank Berhad / Hong Leong Islamic Bank Berhad
- Maybank Islamic Berhad
- MBSB Bank Berhad
- OCBC Bank (Malaysia) Berhad / OCBC Al-Amin Bank Berhad
- Public Bank Berhad / Public Islamic Bank
- RHB Bank Berhad / RHB Islamic Bank
- SME Bank
- Standard Chartered Bank Malaysia Berhad / Standard Chartered Saadiq Berhad
- United Overseas Bank (Malaysia) Bhd

Special Mention

BNM's Business Recapitalisation Facility (BRF) (Blended Finance initiative introduced by BNM)

The Facility is established to provide financing which helps to lower the indebtedness of SMEs who wish to undertake capital expenditure.

Objective

- To support SMEs to recover and grow, while managing their level of indebtedness through innovative financing solutions.
- This refers to improvements in the capital structure of a SME, particularly those who wish to undertake capital expenditure, facilitating a more manageable debt-to-equity (D/E) ratio for the SME after tapping on the BRF.
- SMEs including micro-enterprises can either obtain:
 - Equity financing through issuance of preference shares, common shares, or any suitable equity-like instruments; or
 - A mix of debt financing from participating financial institutions (PFIs) and equity financing through third party equity financiers (blended finance).
- The maximum effective rate is up 5.0% p.a., inclusive of guaranteed fee or 3.5% p.a. without guarantee; no cap on return for equity investment
- Maximum loan size per SME is RM5 million with tenure up to 10 years.

(iv) Financing Scheme for Bumiputra

Working Capital Guarantee Scheme – Bumiputera Start Up (WCGS-SU)

The scope includes working capital and capital expenditure. This guaranteed scheme cannot be used to refinance existing facilities granted by the same or other participating Financial Institutions

Financing Amount: Minimum: RM50,000; Maximum: RM500,000 only

Tenure of Financing:

Up to 15 years or until 31 December 2035, whichever is earlier

Working Capital Guarantee Scheme - Bumiputera (WCGS-B)

The scope includes working capital and capital expenditure. This guarantee scheme cannot be used to refinance existing facilities granted by the same or other participating financial institutions

Financing Amount: Minimum: RM100,000; Maximum: RM3 million only

Tenure of Financing:

Up to 15 years or until 31 December 2035, whichever is earlier

Guarantee Fee:

0.75% per annum payable upfront

Interest/ Profit Rate:

Determined by participating financial institutions

Bumiputera Prosperity Fund

The Bumiputera Prosperity Fund (DKB) under TERAJU was established as a tipping point for new private sector investment initiatives. This funding is up to 10% of the eligible project cost or RM2 million (whichever is lower), channelled on a reimbursement basis to the company.

The objectives of DKB are:

- Support in the form of a “tipping point” or strategic catalyst for qualified Bumiputera companies to explore new investments in strategic sectors.
- Creating more job opportunities at all levels of employment among Bumiputera.
- Achieving sustainable economic growth through business development programmes.

The priority sectors under this DKB Programme involve manufacturing, digital economy, Malay reserve land/wakaf land/customary land (Sabah & Sarawak), engineering services, agriculture & bio-industry and other selected sectors.

(v) Loan for Micro Enterprises

TEKUN Niaga Financing Scheme

Financing Amount:

- Small financing: RM10,000 – RM50,000 (up to 5 years)
- Medium financing: RM50,000 – RM100,000 (up to 10 years)

Profit rate: 4% per annum

BSN Micro/i

Financing Amount: Up to RM50,000

- Financing / Loan Tenure: Up to 5.5 years including a moratorium period of 6 months

Profit / Interest rate: 4.00% per annum and no profit / interest charged during the 6 months moratorium period.

(vi) Alternative Financing Opportunities from Bursa Malaysia

Voluntary Carbon Market (VCM) & Bursa Carbon Exchange (BCX)

Voluntary carbon market allows carbon emitters to offset their emissions by purchasing carbon credits generated from eligible biomass projects that remove or reduce GHG from the atmosphere. Bursa Carbon Exchange (BCX) is Malaysia's VCM and also the world's first Shariah-compliant carbon exchange. Trading of carbon credits can be used as a co-financing instrument to enable eligible biomass projects. The Malaysia Government has developed initiatives for the carbon market by designating a fund amounting to RM10 million to launch the carbon credits in Malaysia and target Sarawak to lead in generating additional income in carbon credits. Expenditure related to development of carbon projects incurred by carbon credit trading companies is allowed for income tax deduction. In Budget 2024, it is proposed further tax deduction up to RM300,000 be given to companies for costs incurred on the Development and Measurement, Reporting & Verification (MRV) related to development of carbon projects. Such expenditure must be certified by the Malaysian Green Technology & Climate Change Corporation (MGTC).

New Debt Fundraising Platform

Bursa Malaysia Berhad and RAM Holdings Berhad have established a joint venture entity i.e. Bursa Malaysia RAM Capital Sdn Bhd which had on 2 June 2023 received approval in principle from the Securities Commission Malaysia (SC) in relation to the application to be registered as a Recognised Market Operator under the SC's Guidelines on Recognised Markets, to manage and operate a new debt fundraising platform.



Source: Bursa Malaysia

(vii) Financing Opportunities from Equity Investors

Venture Capital and Private Equity

Venture capital and private equity firms serve as strategic equity partners to grow technology SMEs⁵¹ and mid-tier companies (MTCs)⁵² which are defined as Malaysian companies with annual revenues between RM50 million to RM500 million in the manufacturing sector and between RM20 million to RM500 million in other sectors. MTCs are potential targeted investee companies for private equity firms.

Recently, Pembangunan Ekuiti Sdn Bhd, a registered venture capital company with the Securities Commission (SC) has invested in a start-up Bioeconomy company with RM25 million series A investment. Any ambitious bio-based companies with a foreseeable exit route for the venture capital (VC) or private equity (PE) companies either through an initial public offering (IPO) or corporate mergers & acquisitions (M&A) can target VC/PE companies as their strategic equity investment partners.

An EFB pellets producer has managed to attract RM10 million investment in the form of preference shares from a government-owned venture capital company. Typically, VC or PE companies aim to achieve extraordinary ROI in high-risk, high-return venture investments. The exit strategies range from trade sales, IPOs, reversed take over (RTO), assets sales, mergers or acquisitions (M&A) and put options or redemption. Lists of registered venture capital and private equity companies registered with SC are accessible at the website of the Securities Commission.

Meanwhile, Malaysian Technology Development Corporation (MTDC) also offers various thematic funding opportunities for deserving technology MSMEs which are tabulated as per the following diagram: -

Table 4.4: Funding Opportunities Offered by MTDC

Business Start-Up Fund	Business Growth Fund	National Technology & Innovation Sandbox Fund (NTIS)
<p>Serve to fund early stage technology-based companies. The fund also aims to nurture scalable and viable technology-based early stage companies.</p> <p>https://www.mtdc.com.my/bsf/</p>	<p>Focus on growing the company not only on its production output and reach, but also on internal preparedness towards professionalism, corporate governance and all the necessary tools to drive the company to the next level.</p> <p>https://www.mtdc.com.my/bgf/</p>	<p>The NTIS is a national initiative which serves as a 'safe place' to allow innovators to test their products, services, business models and delivery mechanisms in a 'live' environment with relaxations on all or specific processes and/or regulatory requirements.</p> <p>https://www.mtdc.com.my/sandb/</p>

51 Funded by venture capital industries; Preferred industries include ICT, fintech, biotech and waste management.

52 MATRADE champions the Mid-Tier Companies Development Programme (MTCDP).

Special Mention

Khazanah Nasional Bhd recently launched the **Future Malaysia Programme** which aims to support the local start-up ecosystem of entrepreneurs, start-ups, venture capital and corporate venture programmes. The programme is an initiative under its Dana Impak mandate — a RM6 billion commitment over five years, seeking to invest across six themes based on issues and challenges facing the nation including food and energy security, Khazanah Nasional Bhd has invested into 2 companies related to waste management and biomass/biogas i.e. Cenviro Sdn Bhd and Cenergi SEA Bhd.

(viii) Equity Crowd Funding (ECF)

Equity crowdfunding (ECF) is an innovative form of alternative fundraising that allows small businesses to raise capital from the public, using online platforms regulated by the Securities Commission Malaysia (SC). A total of 10 ECF platform service providers have been registered with the SC. ECF allows MSMEs to offer equity in their companies to investors, who in turn invest in the concept they see potential in the future. MSMEs use ECF approach normally opt for IPO within 5 years' timeframe and offer such exit route to their equity investors.

A few biomass SMEs involved in biofertiliser production and biogas plant project developers have used ECF platforms for fund raising. Average fund-raising amount for biomass company is RM3 million and is offered to retail investors, angel investors, sophisticated investors (high net worth individuals) or corporate investors. Upon successful fund raising, the ECF platform will charge 5% - 7% success fees to the MSMEs. ECF platforms have been posting steady growth. Since its inception, ECF helped raise **RM420.9 million of funds for 248 issuers as at end-December 2021.**

(ix) Forest Plantation Development Programme

Ministry of Plantation & Commodities (KPK) through Forest Plantation Development Sdn Bhd provides loan facility to companies that are eligible to participate in the forest plantation programme.

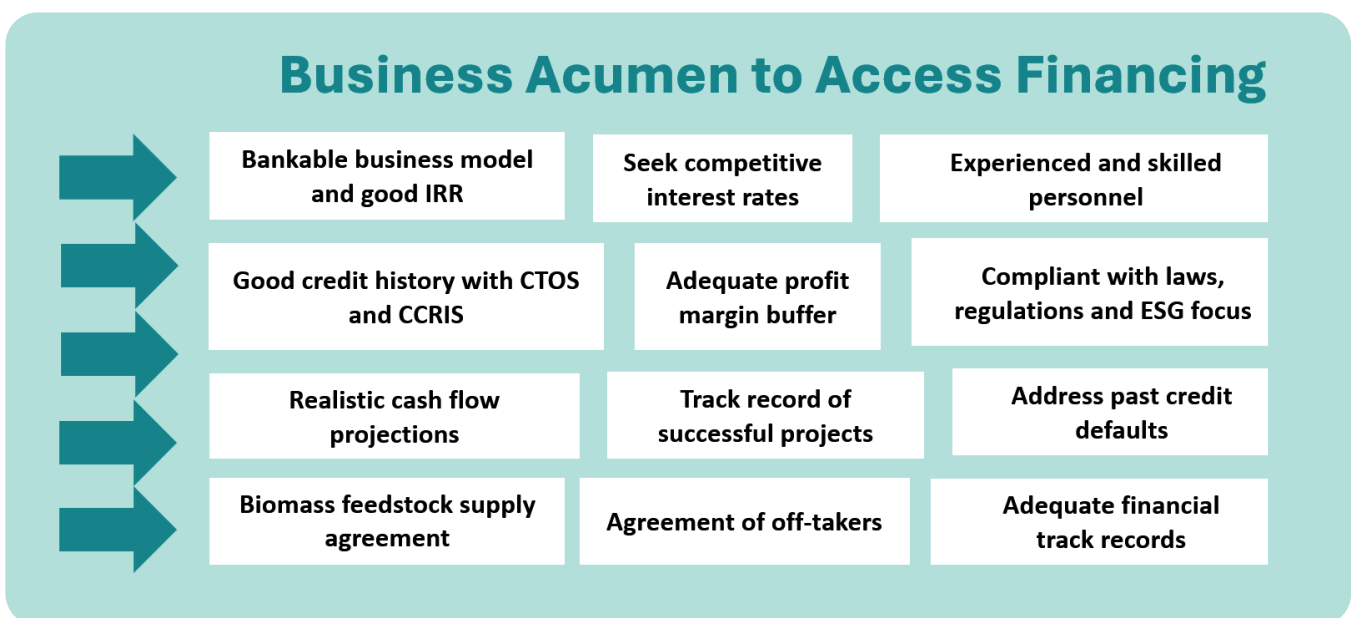
- The quantum of loan given to a successful applicant is as follows:
 - Rubberwood : RM10,000 / hectare (Peninsular), RM13,000 / hectare (Sabah & Sarawak)
 - Forest species and Eucalyptus : RM8,000 / hectare (Peninsular, Sabah & Sarawak)
 - Bamboo and Paulownia : RM10,000 /hectare (Peninsular, Sabah & Sarawak)
- The terms and conditions of the PPLH 2.0 are as follows:
 - Islamic financing
 - Profit rate of 5.0% + 1.0% (Administration charge fees)
 - Loan period: Rubberwood (13 years), Forest species (13 years), Bamboo, Paulownia & Eucalyptus (12 years)
 - Grace period (with yearly deferred profit rate) : Rubberwood (8 years), Forest species (8 years), Bamboo, Paulownia & Eucalyptus (7 years)
 - Repayment period of five years on monthly basis begins immediately after the end of grace period (with monthly deferred profit rate)



Navigating Financing Opportunities Enabling Growth for Biomass Companies

Malaysia offers a comprehensive financing framework for eligible biomass companies such as MSMEs, mid-tier companies or big corporations to access financing from multiple sources. In general, mid-tier companies and big corporations due to their stronger balance sheets and track records are likely to access financing from banking institutions, capital market as well as the bond market. MSMEs always face challenges in the context of project financing or fund-raising. Fortunately, Malaysia Government through its annual Budget has also allocated various soft loans for eligible MSMEs such as the Green Technology Financing Scheme 4.0, the BNM's Fund for SMEs, thematic financing schemes offered by development financing institutions (DFIs) and government agencies such as Bioeconomy Corporation etc.

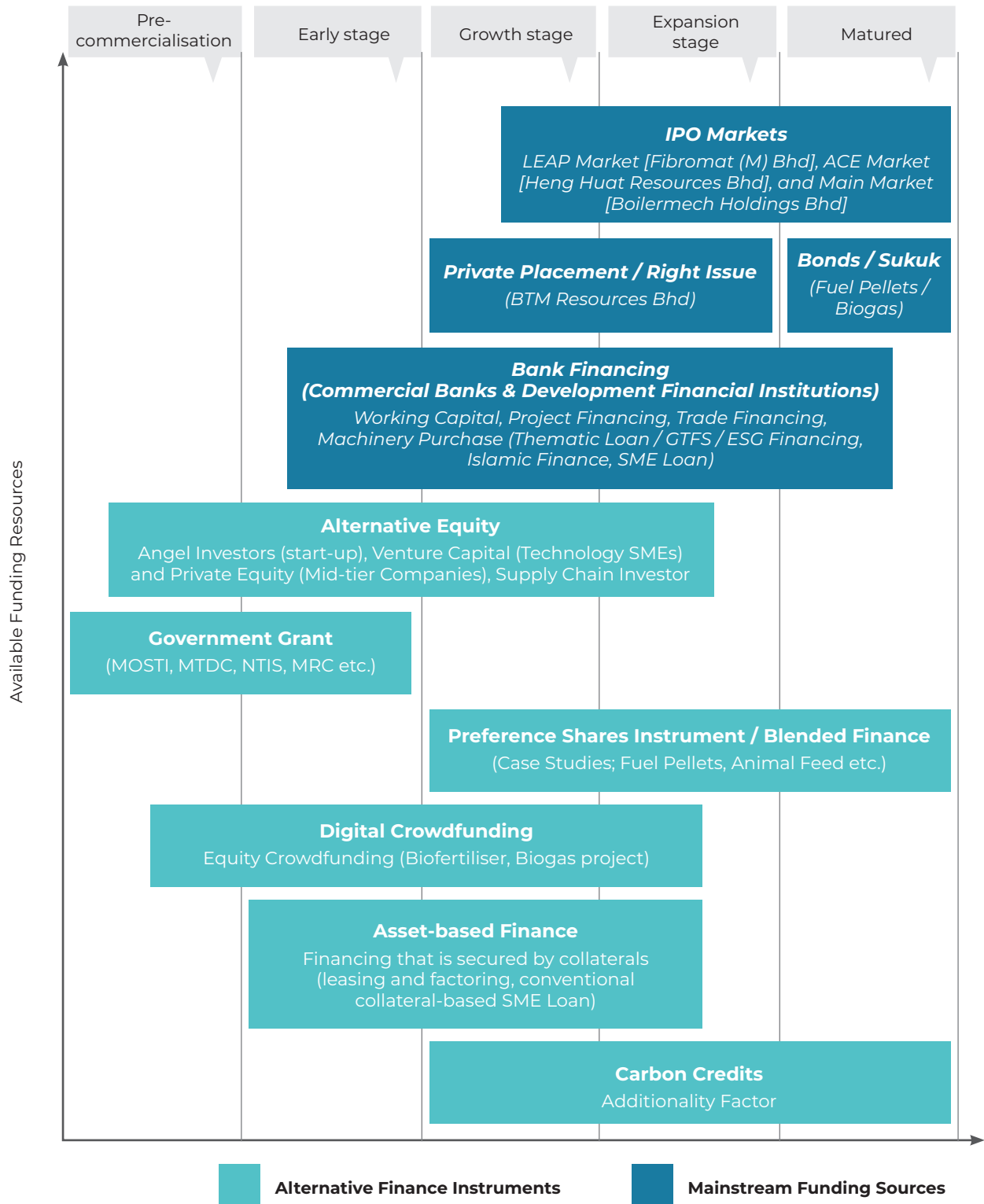
The biomass project promoter needs to ensure the funding requirements dealing with various financial institutions, government funding agencies or equity investors are addressed accordingly. In Malaysia, majority of the MSMEs mainly depend on banking institutions as the primary source of funding as highlighted by the MSMEs Insights Report Malaysia 2021. Hence, relevant biomass MSMEs should equip themselves with business acumen for dealing with banking institutions.



It is proposed that the Ministry of Plantation and Commodities to work together with Malaysia Biomass Industries Confederation (MBIC) to organise seminars and training programmes to build the management capacities of MSMEs to access financing. At the same time, to engage relevant financial institutions, especially Bank Negara Malaysia (BNM) and participating financial institutions of GTFS to be familiarised with various business models of biomass industries.

Greater access to a more diversified range of financing instruments will be of strategic important to various biomass companies to remain financially competitive and resilient. Alternative financing instruments which include debt and equity-based instruments should be used as blended financing tools to enable fund raising based on the business life cycle of biomass company. The comprehensive financing instruments are further outlined in the following diagram.

Figure 4.6: Financing Mechanism for Biomass Projects in Malaysia



Source: Bank Negara Malaysia & Research of Uni-Link Smart Venture Sdn Bhd

Relevant Investment Incentives for the Biomass Industries

Biomass technology companies owned by Malaysian or foreign investors can refer to Malaysian Investment Development Authority (MIDA) or Bioeconomy Corporation to access and apply various relevant investment incentives for their manufacturing-based activities or bioeconomy-driven business models.

Alternatively, biomass technology companies can also refer to respective Malaysia economic corridor promotion agencies i.e. Northern Corridor Economic Region (NCER), East Coast Economic Region Development Council (ECERDC), Iskandar Regional Development Authority (IRDA), Sabah Development Corridor – Sabah Economic Development and Investment Authority (SEDIA) and Sarawak Corridor of Renewable Energy (SCORE) – Regional Corridor Development Authority (RECODA) to structure similar and more competitive investment and tax incentives.

Biomass companies can access this portal which provides comprehensive information on investment incentives at <https://investmalaysia.mida.gov.my/incentives/>

MIDA
MALAYSIAN INVESTMENT DEVELOPMENT AUTHORITY

Welcome to
i-Incentives
Investment Incentives Portal

i-Incentives is a portal that provides the information on investment incentives offered by the Federal Government of Malaysia. Incentives Coordination and Collaboration Office (ICCO) established under the Malaysian Investment Development Authority (MIDA) has been tasked as a central coordinator for all investments incentives to meet the national investment agenda. ICCO will be a one-stop centre to advice and coordinate businesses on incentive offerings and provide cross-agency visibility. The incentives coverage will be a dynamic one, whereby the list of incentives offered by all Ministries and agencies will be updated from time to time.

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Investment Incentive on Biomass Offered by MIDA

The following diagram highlights relevant biomass projects such as energy pellets, bioplastics, bio-CNG, etc. to be processed by respective divisions i.e. Food Technology & Resource-based Industries Division, Life Sciences Division and Chemical & Advanced Materials Division at MIDA.

Figure 4.7: MIDA Investment Incentive for Oil Palm Biomass vs Other Biomass

MIDA Incentives

Utilisation of Oil Palm Biomass to Produce Value-Added Products:

Projects	Processing Division	Incentives for new investment and reinvestment*	
		Pioneer Status	Investment Tax Allowance
1. Biogas 2. EFB Processing 3. Bio Chemicals 4. Biofuel (biodiesel, SAF) 5. Bioethanol 6. Food additives	Chemical & Advanced Material Division		
7. Wood product from Oil palm trunk 8. Animal Feed – PKC, decanter cake 9. Bio composite 10. Pulp & paper 11. Energy pellet 12. Biochar/activated carbon 13. Bio fertiliser	Food Technology & Resource-based Industries Division	Income tax exemption between 70%-100% of statutory income for a period of 5-10 years*	Between 60%-100% of qualifying capital expenditure incurred within a period of 5 years
14. Bioplastics 15. Biosugar 16. Other enzymatic processes of palm biomass product	Life Sciences & Medical Technology Division		

Other Incentives for Biomass

Projects	Processing Division <i>Depending on end product</i>	Incentives for new investment and reinvestment*	
		Pioneer Status**	Investment Tax Allowance**
Agricultural Waste or Agricultural by-products : <ul style="list-style-type: none"> • Rice husk • Forestry Waste • Animal waste* • Etc.* 	Food Technology & Resource-based Industries Division	Income tax exemption of 70% of statutory income for a period of 5 years	An allowance of 60% of qualifying capital expenditure incurred within a period of 5 years. The allowance is offset against 70% of statutory income for each assessment year
*Case to case basis			

** Company needs to fulfill the criteria, please contact MIDA for more information

Source: MIDA

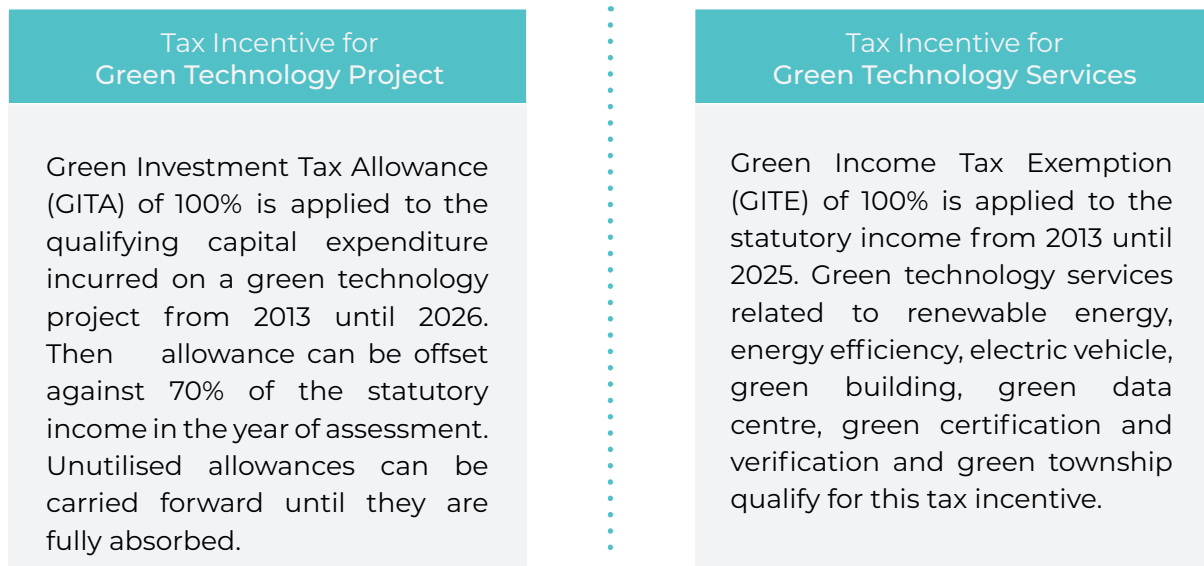
Future Incentives for ESG

MIDA is working in progress to formulate relevant incentives for ESG:-

- Increase awareness of ESG opportunities
- Develop ESG reporting standards aligned with industry and international requirement
- Establish ESG criteria for investment incentives
- Develop ESG capacity building requirements
- Promote ESG market mechanisms i.e. carbon trading & carbon pricing
- Increase funding/financing and incentives for ESG transition

Incentives for Green Technology Administered by MGTC & MIDA

Figure 4.8: Green Investment Tax Allowance (GITA) and Green Income Tax Exemption (GITE)



The above diagram highlights the concept of GITA and GITE jointly promoted by MGTC and MIDA. The latest Malaysia Madani Budget 2024 proposes to extend the period to apply for the GITA to Dec 31, 2026. It also proposes to extend the tax allowance and exemptions from three years to five years.

Incentives for BioNexus Status Companies

Biomass companies undertaking bio-conversion technologies such as biofuel, bioenergy, biomaterials and bioremediation from various sectors, i.e. plantation, agriculture, livestock and aquaculture are eligible to apply for investment incentives under BioNexus Status granted by Malaysian Bioeconomy Development Corporation (Bioeconomy Corporation).

INCENTIVE PACKAGE

Privileges of BioNexus Status Company

BioNexus Status

A recognition awarded by the Malaysia Government through Bioeconomy Corporation



TAX EXEMPTION



ACCESSIBILITY



FREEDOM

SUPPORT

Source: Malaysian Bioeconomy Development Corporation

Figure 4.9: Funding Opportunities Provided by the Bioeconomy Corporation

BCF

Biotechnology Commercialisation Fund

For the second half of 2023, Bioeconomy Corporation will be relaunching an enhanced version of the Biotechnology Commercialisation Fund with a more attractive borrowing package for pricing, principal grace period and repayment tenure. Additionally, the utilisation of financing proceeds will be relaxed to accommodate a broader application of debt financing requirements.

These include:

- Viable initial commercialisation initiatives
- Working capital financing for existing operations
- Capital expansion requirements to purchase used machinery and business properties.

This debt financing programme will be available for both locally-controlled companies, as well as foreign-controlled companies.

AGVF

Agriculture Venture Fund

An Equity Funding Programme developed to address the funding needs of eligible Early Stage Companies, SMEs and Pre-Initial Public Offering Exercises.

Funding Quantum:

Early stage : RM500,000 – RM1,000,000

SMEs : RM1,000,000 – RM5,000,000

Pre-IPO/ Mezzanine : RM1,000,000 – RM10,000,000

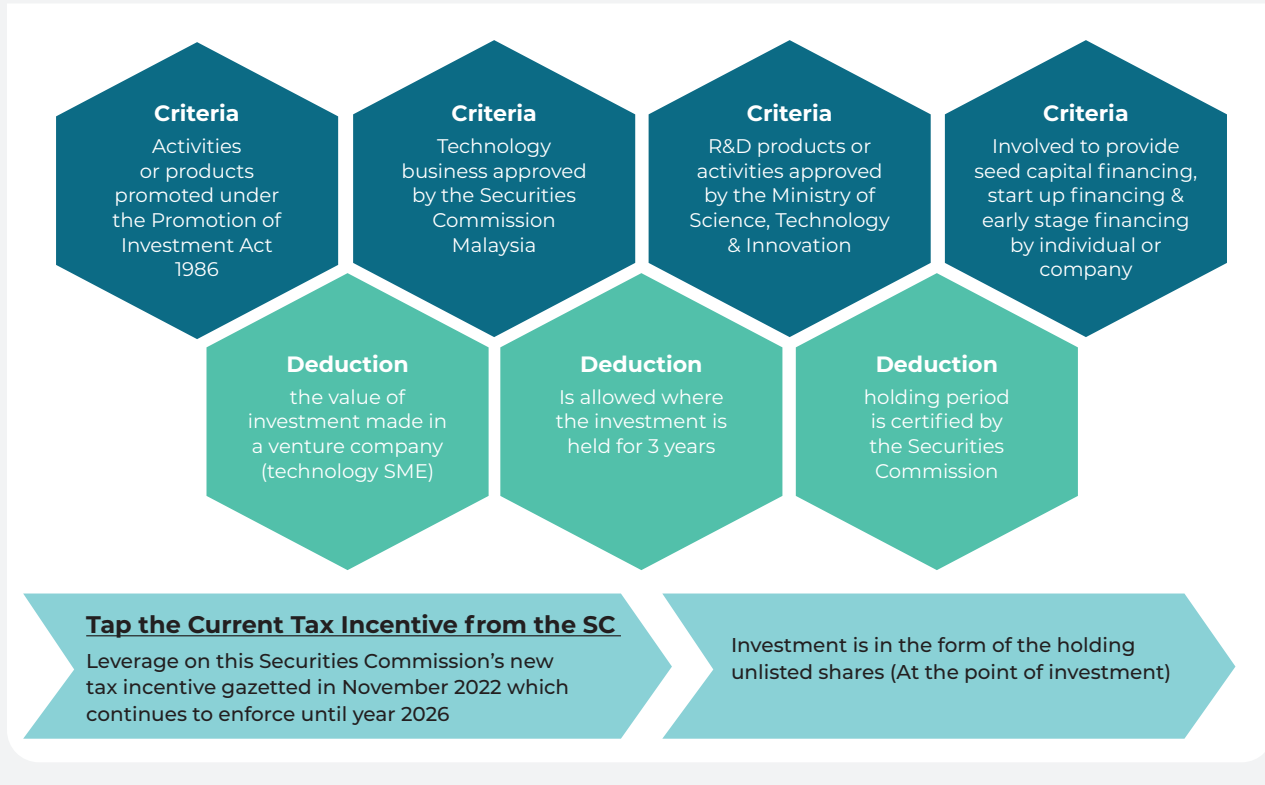
The instrument : RCCPS

Investment tenure : 2 – 7 years

Purpose:

- To invest, assist & support agricultural, bio-based & agritech activities of eligible companies
- To finance working capital, expansion capital, acquisition capital or to recapitalise (refinance debt)

Special Mention

Securities Commission's Venture Capital Tax Incentive :Tax Deduction for Direct Investment into Venture Company⁵³**Table 4.5: Promoted Area Related to Biomass Technology**

➤ Genetic engineering / Genetically-engineered organisms	➤ Biodiagnostics
➤ Cell cultures	➤ Waste, waste minimisation and waste treatment
➤ Biopolymers	➤ Waste optimisation/utilisation
➤ Metabolites	➤ Waste remediation
➤ Food and food supplements	➤ Bioconversion processes
➤ Fine chemicals	➤ Energy – Renewable energy, hybrid energy technology & energy efficiency method

However, eligible activities under the incentive are not limited to the above categories. Start ups in the biomass value chain (or other industries) may qualify under other categories as defined by this new tax incentive.

This tax incentive is suitable to encourage biomass feedstock owners predominantly oil palm biomass sector to invest in a biomass technology venture (such as energy pellets, animal feed, biofertiliser, biochemical etc). Biomass feedstock owners will be able to claim tax deduction from such investment for technology-based activities as outlined in this tax incentive. Consult the Securities Commission for further information.

⁵³ Means Investee Company as defined by the Securities Commission's Venture Capital (VC) Tax Incentive which undertakes technology-based activities; SC-GL/ VC TAX-2001 (R3-2022)

Business Accelerator Programme (BAP 3.0) – Matching Grant

The scope includes :-

- i. Certification and quality management system
- ii. Packaging
- iii. Branding development and promotion
- iv. Productivity and automation
- v. Online applications, e-commerce and ICT applications.

Financing amount:

- 50% of total approved cost (amount of financing to be determined by SME Corp)
- Maximum amount of RM400,000.
- Reimbursement basis

Biomass companies can tap this facility to co-fund the cost of relevant certification and quality management systems as part of the strategy to be integrated with various green supply chain opportunities locally or globally. Kindly consult SME Corp for the availability of this matching grant.

INDUSTRY4WRD Intervention Fund

Financial support facility for Malaysian Small and Medium Enterprises (SMEs) in the manufacturing and related services sectors to embrace Industry 4.0. Its objective serves to improve the productivity of the company; accelerate business growth through the adoption of Industry 4.0 technologies and processes and improve the current level of scoring based on the Industry4WRD's Readiness Assessment (RA) undertaken.

It is a matching grant (70% : 30%) on a reimbursable basis based on eligible expenditures, up to a maximum grant of RM500,000. Other conditions include :-

- SMEs in the manufacturing and related services sectors who have completed the government funded Industry4WRD's Readiness Assessment (RA) programme.
- Any expenditure incurred prior to the approval letter issued by MIDA will not be covered or reimbursed.
- Companies which have been approved by the Smart Automation Grant (SAG) from MIDA or Malaysia Digital Economy Corporation (MDEC) are not eligible to apply for this grant.

Automation Capital Allowance

Automation Capital Allowance of 200% on the first RM4 million expenditure incurred within 8 years of assessment from 2015 to 2023, which has been extended to 2027.

- Manufacturing companies incorporated under the Companies Act, 1965 / 2016 and resident in Malaysia
- Possess a valid business license from local authority and manufacturing license from MITI or a confirmation letter for exempted from manufacturing license from MIDA (whichever is applicable).
- Companies have been in operation for at least 36 months
- Expanded to include the agriculture sector

Note:

Automation machine / equipment is used directly in the manufacturing activity. Automation machine/equipment should enhance productivity such as reducing man hours, reducing workers and increasing the volume of output to be verified by SIRIM.

Automation machine / equipment adopts technology that is more advanced than the technology that is currently used by the company and it has to be verified by SIRIM. The machine should be used at least one (1) month after installation / commissioning. For new products, the machine should be in operation for at least three (3) months after the production of the first batch of that new products.

Market Development Grant

The Market Development Grant (MDG) is a support initiative in the form of a reimbursable grant promoted by MATRADE. MDG was introduced in 2002 with the objective of assisting exporters in their efforts to promote Malaysian made products or services globally. The lifetime limit of MDG is RM300,000 and it is specifically formulated for Malaysian SMEs, Professional Service Providers, Trade and Industry Associations, Chambers of Commerce, Professional Bodies and Co-operatives. Eligible activities include :

- Participation in international trade fairs or exhibitions held in Malaysia / overseas
- Participation in trade & investment missions (TIM) or export acceleration missions (EAM)
- Participation in international conferences held overseas, listing fees for made in Malaysia products in supermarkets or hypermarkets or retail centres or boutique outlets located overseas
- Participation In business to business (B2B) meetings related to virtual trade investment missions and export acceleration mission

Tax Incentives for Carbon Capture and Storage (CCS)

Companies undertaking CCS in-house activity will be eligible for an investment tax allowance of 100% for 10 years to be set off against 100% of statutory income. They are also eligible for full import duty and sales tax exemption on equipment for CCS technology from 1 January 2023 until 31 December 2027.

Chapter

**Private Sector
Participation in Biomass
Research & Development,
Commercialisation & Innovation**

5

Private Sector Participation in Biomass Research & Development, Commercialisation & Innovation (R&D&C&I)

Introduction

Challenges in Awareness and Access to R&D Grants in Biomass Sector

R&D&C&I is a crucial driver of innovation and sustainable development, particularly in the biomass sector in Malaysia. The Ministry of Science, Technology and Innovation (MOSTI) plays a vital role in the R&D&C&I funding ecosystem, including the biomass sector. Mission-oriented government research institutions like the Malaysian Palm Oil Board (MPOB) and the Forest Research Institute of Malaysia (FRIM) spearhead R&D initiatives in oil palm and forestry biomass. Additionally, other research institutions and universities contribute significantly to biomass R&D in areas such as biofuel, biofertiliser, bioenergy, biomaterials, and bio-chemicals. Despite the government's efforts to promote R&D through initiatives such as the MOSTI's R&D&C&I grant, there remains a significant lack of awareness among potential beneficiaries regarding the availability of such grants.

Findings

Findings from Focus Group Discussion and National Survey on R&D Incentives

The findings from the engagement results of the Focus Group Discussion (FGD) conducted for the National Biomass Action Plan 2023-2030 revealed that many engaged biomass stakeholders cited several challenges related to biomass R&D&C&I. These challenges include a lack of guidance to access biomass R&D&C&I inventory, difficulties in searching for relevant biomass R&D&C&I information and insufficient R&D&C&I grants or incentives. These findings are in alignment with the latest National Survey on Research & Development (R&D) published by MOSTI. According to the survey, the top three R&D incentives received by the private sector are R&D&C&I grants / matching grants, pioneer status and income tax exemption. However, the private sector has highlighted three key issues that they faced, i.e. lack of information and accessibility on R&D&C&I incentives, unclear definitions of these incentives and unclear application procedures or complicated processes.

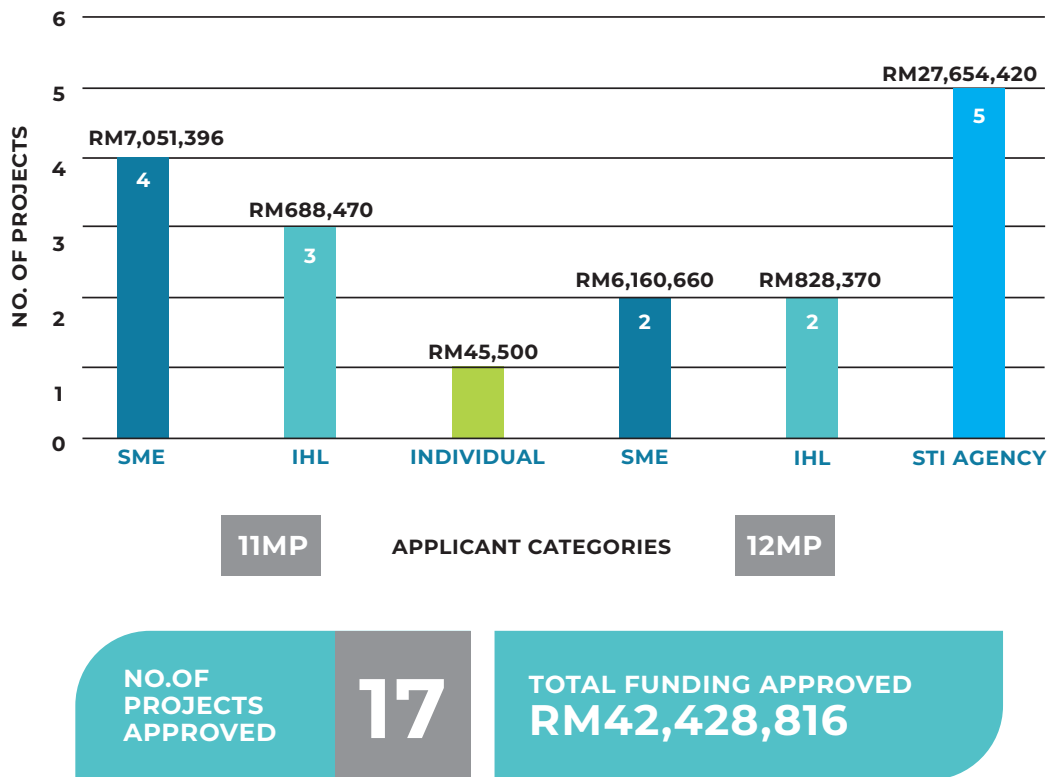
Therefore, it is essential to promote and disseminate information on pertinent R&D&C&I funding opportunities and incentives, aiming to encourage greater private sector involvement in biomass R&D&C&I.

R&D&C&I Funding from MOSTI

General

In 11MP and 12MP, a total of at least 17 biomass projects received RM42 million R&D&C&I funding from MOSTI under the Strategic Technology Driver Fund Program (PEMACU) which aims to develop a R&D&C&I ecosystem.⁵⁴ Utilising R&D&C&I funding from the government can be instrumental in scaling up biomass technology products. This serves to address the challenges of the 'valley of death' and move towards successful commercialisation.

Figure 5.1: Biomass R&D&C&I Projects Approved by MOSTI



Source: MOSTI

⁵⁴ This is not the exhaustive list on biomass R&D&C&I. Interested stakeholders can conduct further search at the R&D bank with different key words such as EFBs, rice husk etc at www.krste.my

Five Types of Funding from MOSTI

MOSTI currently provides five types of R&D&C&I funding opportunities for Science, Technology and Innovation (STI) based projects including biomass technology projects which have the potential for commercialisation.

Figure 5.2: R&D&C&I Funding Offered by MOSTI



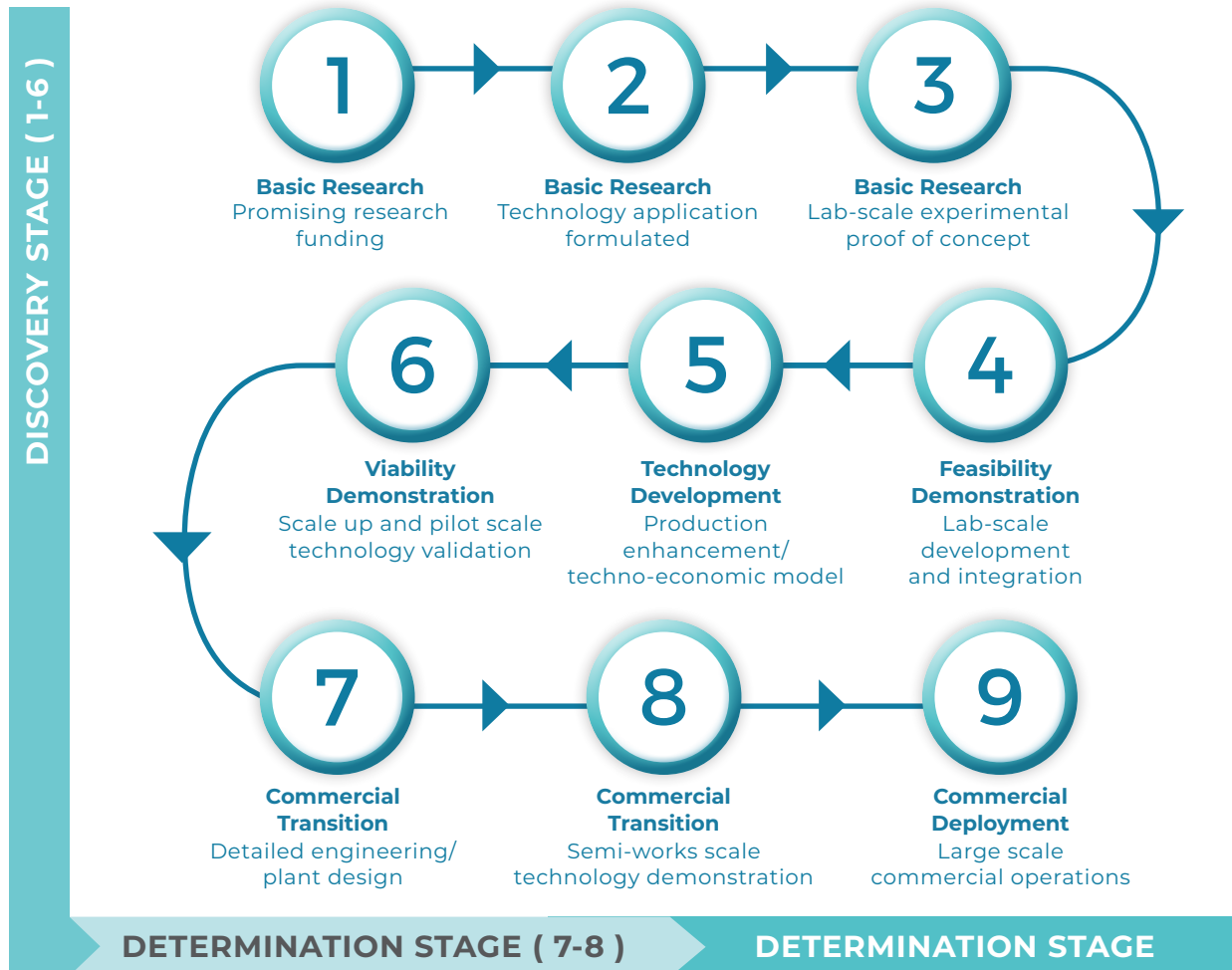
Source: MOSTI

The Applied Innovation Fund (AIF), Technology Development Fund (TeD)1, Technology Development Fund (TeD)2 Bridging Fund (BGF) are the bottom-up funds. The objective of the respective funds and the technology readiness level (TRL) are summarised in the diagram Figure 5.2 and Figure 5.3. On the other hand, the **Strategic Research Fund (SRF)** is a **top-down fund** with pre-condition that the company needs to work hand-in-hand with the government agency in MOSTI as an Implementation and Monitoring Agency (APP) to jointly execute the national interest of R&D&C&I project.⁵⁵

Bottom-up Fund			
AIF	TeD1	TeD2	BGF
Up to RM500,000 for duration of 12 to 18 months	Up to RM1 million for duration up to 24 months	Up to RM3 million for duration of 36 months	Ready product from R&D&C&I. Need marketing assistance for penetration. RM4 million for a duration of 36 months

55 Agensi Pelaksana & Pemantau (APP)

Figure 5.3: Technology Readiness Level



Source: MOSTI

Additionally, private sector biomass stakeholders can always access the following website: www.krste.my; **System Knowledge Resource for Science and Technology Excellence**, a knowledge bank on various R&D&C&I projects funded by MOSTI. The website provides instant search results to access various R&D&C&I projects inclusive of various biomass technologies for potential R&D&C&I with relevant research universities. This portal serves to facilitate potential biomass R&D&C&I collaboration between the industry and the government research institutions.



R&D&C&I Funding from Agencies Under MOSTI

The following diagram highlights the funding agencies under the purview of MOSTI, which provide various alternative funding opportunities in term of R&D&C&I fund, venture capital, venture debt and preference shares for qualified technology companies which meet the funding requirements.

Figure 5.4: Funding Agencies under MOSTI



Special Mention

Malaysian Technology Development Corporation (MTDC)

MTDC has created a commendable track record on the successful rate of technology commercialisation as highlighted in the following table.

Table 5.5: Commercialisation Rate of R&D&C&I Projects Nurtured by MTDC

PERIODS	2006 2010	2011 2016	2017 2020
Total Sales Generated (RM Million)	1,390	316	540
Total Amount Invested (RM Million)	230	120	133
Rate of Commercialisation	84% (129 out of 154 projects)	56% (58 out of 103 projects)	41% (43 out of 105 projects)
Private Sector Investment (RM Million)	418.00	96.32	39.90

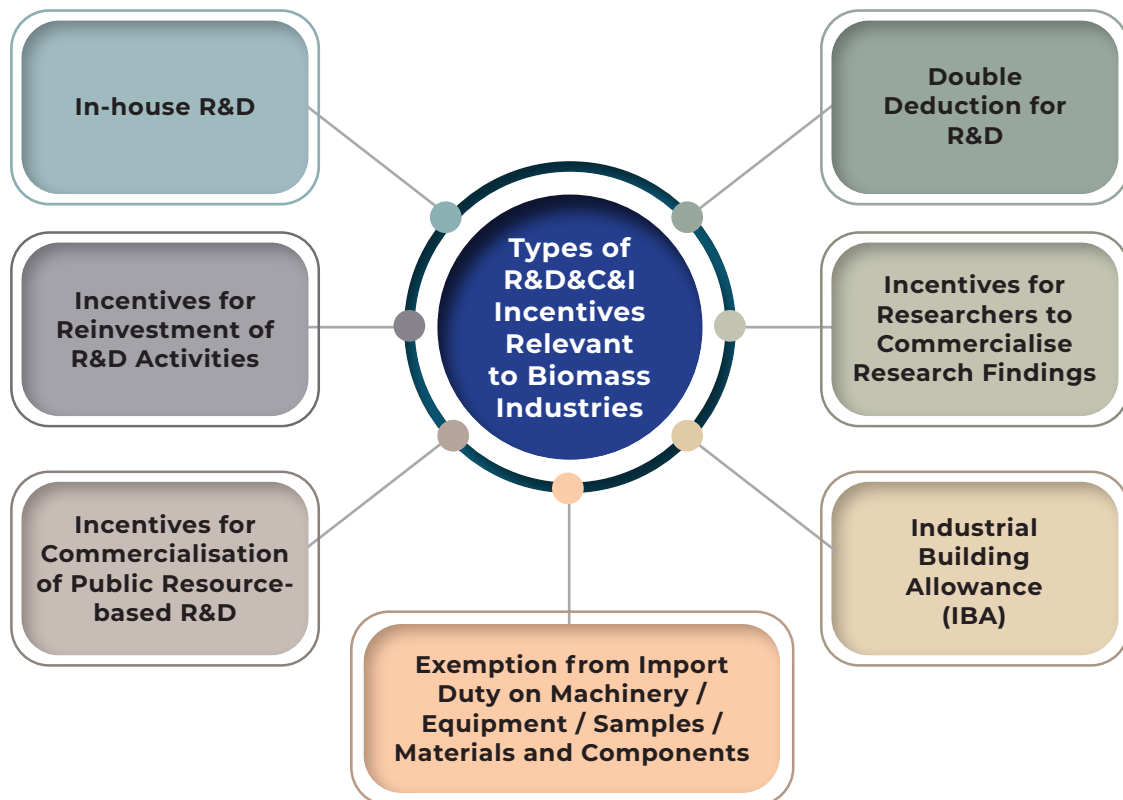
Source: MTDC, 2020

Biomass companies championing the R&D&C&I commercialisation should link up with technology nurturing opportunities provided by MTDC, given their historical track records in upscaling commercialisation path of MSMEs. MTDC has financed a few biomass MSMEs linked to bioeconomy and conversion of chicken feather as fish feed etc.

R&D&C&I Incentive Relevant to Biomass Industries

The following diagram provides a helicopter view on various R&D&C&I incentives relevant to biomass industries.

Figure 5.5: Types of R&D&C&I Incentives Relevant to Biomass Industries



In-house R&D⁵⁶

A company that undertakes in-house R&D to develop further its business can apply for an Investment Tax Allowance (ITA) of 50% of the qualifying capital expenditure incurred within 10 years. The company can offset the allowance against 70% (100% for promoted areas) of its statutory income for each year of tax assessment. Any unutilised allowances can be carried forward to subsequent years until they fully utilised.

Incentives in Reinvestment of R&D Activities

Biomass companies undertaking R&D activities are eligible for a second round of Pioneer Status for another 5 years, or ITA for a further 10 years, where applicable.

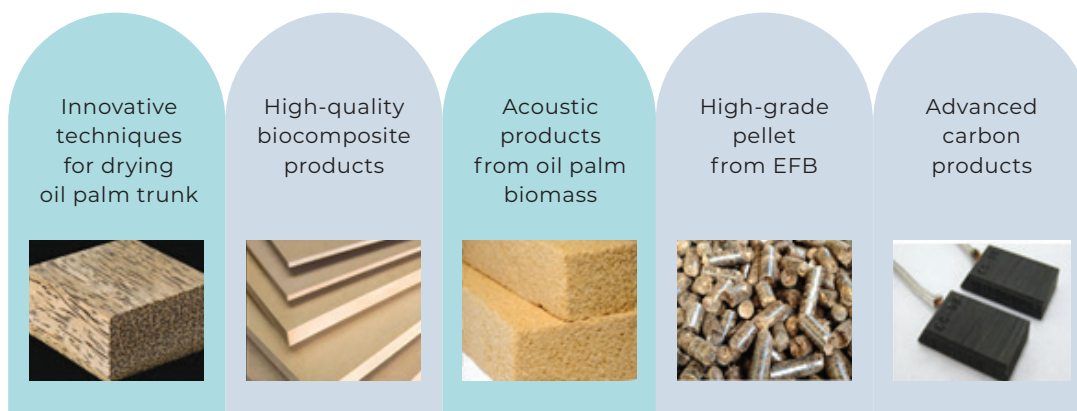
⁵⁶ In-house R&D is a common practice undertaken by Malaysian biomass companies especially MSMEs.

Incentives for Commercialisation of Public Resource-based R&D⁵⁷

To encourage the commercialisation of resource-based R&D findings of public research institutes, the following incentives are given:

- A company that invests in its subsidiary company which is engaged in the commercialisation of the R&D findings is eligible for a tax deduction equivalent to the amount of investment made in the subsidiary company;
- The subsidiary company that undertakes the commercialisation of R&D findings is eligible for Pioneer Status with income tax exemption of 100% of statutory income for a period of 5 or 10 years.
- Resource-based R&D findings cover the following sectors:
 - ✓ Agriculture;
 - ✓ Agriculture and food processing;
 - ✓ Oil palm products;
 - ✓ Wood and wood-based products;
 - ✓ Rubber-based products;
 - ✓ Non-metallic mineral products;
 - ✓ Natural products which include pharmaceuticals; and
 - ✓ Natural resources such as water, air, lightning and solar.

As an example, Malaysian Palm Oil Board (MPOB) offers the following 5 types of biomass technologies for R&D&C&I with the private sector which have high TRLs and prospects for commercialisation.



Special Mention

Further accelerated R&D&C&I can be undertaken to address and remove the high potassium content in EFB pellets, it may create greater market opportunities for EFB pellets in overseas as well as used locally as green fuel in the context of national biomass co-firing initiative. EFB pellets are observed to be positioned in TRL 8 – commercial transition; should be further enabled by accelerated R&D&C&I funding to scale up commercialisation. It is economically viable to consider biomass R&D&C&I with higher TRLs for R&D&C&I funding consideration by Malaysia Government.

⁵⁷ Refer IRB Public Ruling No. 12/2022 and Public Ruling 13/2022 for further explanation.

Double Deduction for R&D

- A company can enjoy a double deduction on its revenue (non-capital) expenditure for research which is directly undertaken and approved by the Minister of Finance and the Ministry of Science, Technology and Innovation (MOSTI);
- Double deduction can also be claimed for cash contributions or donations to approved research institutes and payments for the use of the services of approved research institutes, approved research companies, R&D companies or contract R&D companies;
- Approved R&D expenditure incurred during the tax relief period for companies granted Pioneer Status can be accumulated and deducted after the tax relief period; and
- Expenditure on R&D activities undertaken overseas, including the training of Malaysian staff, will be considered for double deduction on a case-by-case basis.
- Claims should be submitted to the Inland Revenue Board (IRB).

Incentives for Researchers to Commercialise Research Findings

Researchers who undertake research that focuses on value creation will be given a 50% tax exemption for 5 years on the income that they receive from the commercialisation of their research findings. Claims should be submitted to the Inland Revenue Board (IRB).

Industrial Building Allowance (IBA)

An Industrial Building Allowance (IBA) is granted to companies incurring capital expenditure on the construction or purchase of a building that is used for R&D purposes. Such a company is eligible for an initial allowance of 10% and an annual allowance of 3%. Such expenditure can be written off in 30 years. Claims should be submitted to the Inland Revenue Board (IRB).

Exemption from Import Duty on Machinery / Equipment / Samples / Materials and Components

It is the policy of the government not to impose taxes on machinery / equipment / samples / materials and components used directly in the R&D activities and are not produced locally. Most categories of machinery and equipment are, therefore, not subject to import duties. In cases where the imported goods are taxable but are not available locally, full exemption is given on import duty. Applications should be submitted to MIDA.

Enhancing Private Sector's R&D&C&I Participation

Figure 5.6: Six Ways to Enhance Private Sector's R&D&C&I Participation



R&D&C&I Synergy Pillared on Quadrilateral Collaboration Model

The collaboration model between the government and biomass companies with potential off takers from overseas as well as research institutions / universities that are established under the quadrilateral collaboration model will be enhanced to further improve productivity at the national, sectoral and enterprise levels, thus boosting R&D&C&I performance.

Figure 5.7: Quadrilateral Collaboration Model on Biomass R&D&C&I



Success Story on Quadrilateral Collaboration Model

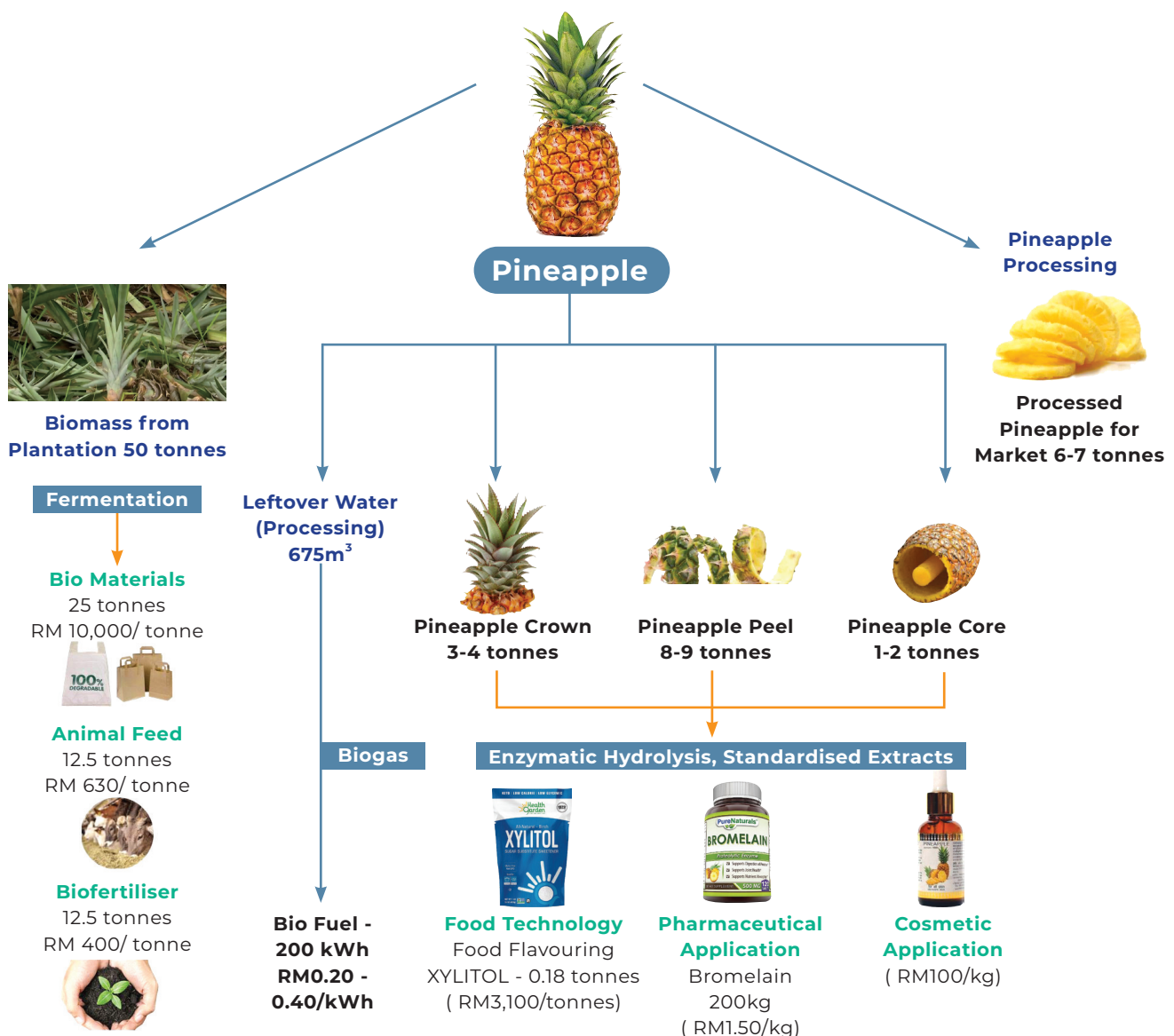
In 2019, a local bio-based product manufacturer signed a licensing agreement with a government research university that obtained a technology licensing from the public university with a pilot R&D&C&I grant of more than RM3 million allocated by MOSTI. The licensing agreement started in August 2019 and has a duration of 30 months. The agreement involves a licensing fee of more than RM500,000 and a royalty fee of 2.5% on the grss profit sales generated which are to be paid by the biomass product manufacturer to the university. The technology is for the production of nanocellulose based materials i.e. bio-based food packaging products using oil palm biomass targeting off-taker from overseas. This is a proven quadrilateral model for biomass R&D&C&I on palm biomass commercialisation between biomass industry, public university and overseas off-taker enabled by government R&D fundings. Another SME that convert chicken feathers into fish feed has also achieved commercialisation based on the quadrilateral collaboration model.

Communication Awareness for Development of High Value Bio-based Products

Communication and creating awareness play a crucial role in promoting biomass R&D&C&I initiatives. Various stakeholders such as researchers, industry experts and policymakers help to promote the understanding and benefits of biomass R&D&C&I with focus on high value bio-based products. These campaigns may include workshops, seminars, webinars and public awareness which help to disseminate information about biomass R&D&C&I value creation potential. Apart from these, collaboration with media partners and various communication channels such as websites, social media, newsletters and scientific publications also help to share updates, research findings and success stories related to biomass innovation.

Highlighting the economic viability, job creation potential and carbon footprint reduction which are achieved through biomass technologies can inspire further interest and investment. These approaches are also more effective in spurring the participation of the private sector. The following diagram highlights high value products made of pineapple biomass.

Figure 5.8: Bromelain - High Value Creation Product from Pineapple Biomass



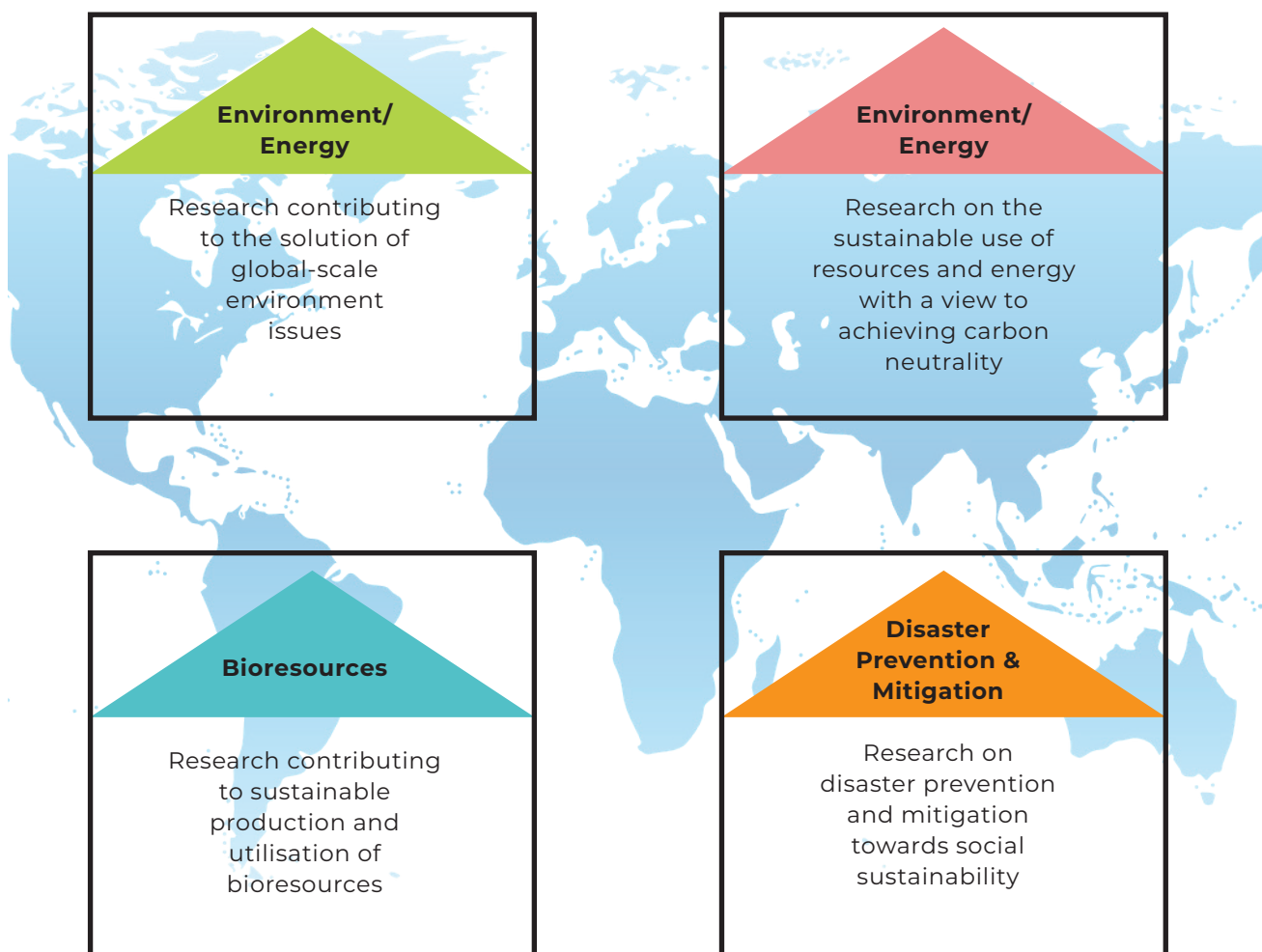
Source: Bioeconomy Corporation

Access International R&D Funding Opportunities From Japan

Japan Science and Technology Agency (JST) in collaboration with Japan International Collaboration Agency (JICA) has called for proposals of **Science and Technology Research Partnership for Sustainable Development (SATREPS)**.

SATREPS is targeted at researchers from research institutions / universities in Japan. Researchers in other countries (e.g. Malaysia) should consult their national-level government agency responsible for Overseas Technical Assistance (ODA) cooperation i.e. the Embassy of Japan or JICA offices in their respective resident countries. The indicative funding quantum is approximately Japanese Yen 60 million (about RM1.98 million per annum).

Figure 5.9: Research Areas Funded by Japan



The SATREPS provides opportunities for Malaysian biomass companies especially MSMEs to address biomass technology conversion issues for development of value-added bio-based products. One of the commendable successful cases in Malaysia is development of OPT pellets enabled by Japanese funding to address production efficiency as well as linking up with green supply chain opportunities from Japan.

Develop Human Capital for Biomass Industries

Malaysia has a competitive advantage in R&D&C&I due to its competitive costing of conducting R&D&C&I. Nevertheless, there are some issues in terms of the availability of talents. For this reason, building up human capital capabilities and knowledge within the sector are crucial steps that need to be taken for the nation. The focus on providing training and courses on potential biomass R&D&C&I technologies remains relevant, especially through synergistic collaboration with research universities such as UTP, UNITEN, USM, UPM, etc. The private sector can also leverage on R&D&C&I personnel, advanced lab equipment and testing facilities provided by the research universities to accelerate R&D&C&I objectives. It is timely to develop the National Occupational Skills Standard (NOSS) for biomass industries under the Department of Skills Development (DSD).

Furthermore, talent upskilling has been outlined in the 12MP to increase the level of innovation outcomes as below: -



Foster Biomass Innovation Platform

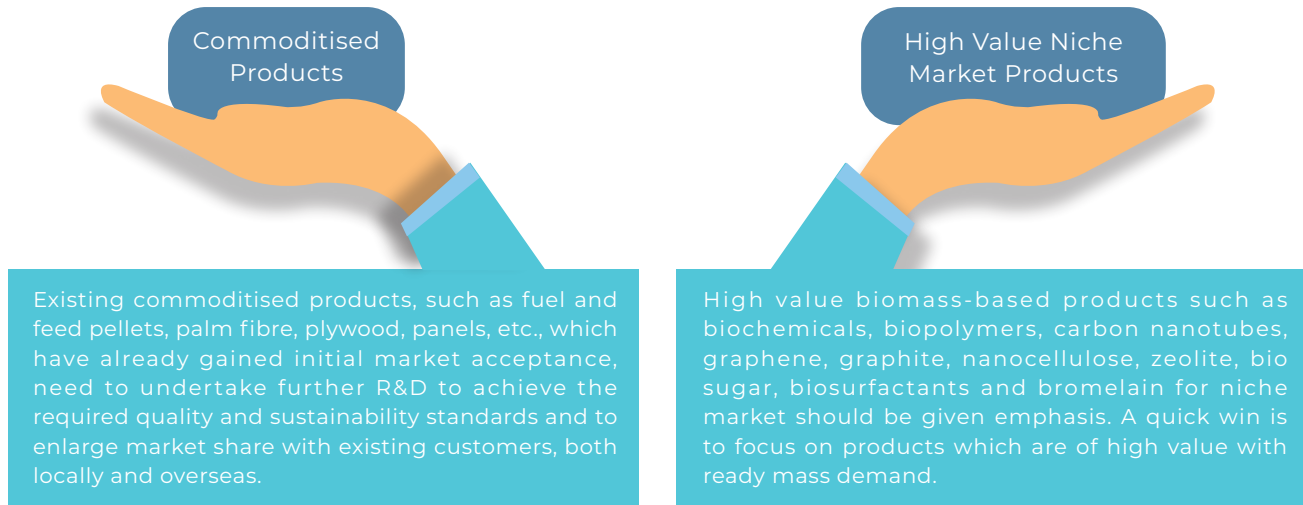
To encourage innovation, the government in collaboration with industry associations can establish innovation hubs that bring together researchers, entrepreneurs, investors, feedstock owners and venture capitalists to create a Biomass Innovation Platform based on multi-stakeholders' approach. The government can also provide more supports for early stage start-ups through incubation programs and mentorship as well as to facilitate MNCs to invest in the private sector and public universities' R&D&C&I linking to their green supply chain.

Research and Development Linked to Government Green Procurement

The government can create conducive green market access opportunities for biomass products by providing green lanes through government green procurement (GGP) for the use of biomass-derived products. A growing green market demand can attract private companies to invest in relevant biomass R&D&C&I with potential quick win opportunities. Currently, there are four biomass-themed products listed in GGP i.e. paper, packaging products, furniture and organic fertiliser. The list may be further expanded to spur biomass R&D&C&I product development.

The Way Forward

The potential of the biomass industry to leverage on circular economy opportunities and contributes to the reduction of greenhouse gas (GHG) emissions. The R&D&C&I of biomass-based products need to focus on 2 business models.



The following recommendations are outlined for future implementation.

- Various R&D&C&I funding schemes and tax incentive benefits need to be strategically communicated to the target groups.
- More intervention is needed to facilitate the R&D&C&I towards industrial-driven or demand-driven R&D&C&I rather than purely academic R&D&C&I, leading towards a quick win commercialisation driven by global trend and market demand.
- A thematic grant should be allocated for biomass under the purview of MOSTI.
- The government can provide support for the commercialisation of biomass technologies developed by the private sector's in-house R&D&C&I. This can include funding for pilot projects, assistance in obtaining patents and intellectual property rights and support in scaling up biomass technologies from lab to market.
- Focus on biomass R&D&C&I that have the potential to be integrated with global green supply chain opportunities especially high value commodities (bio-graphite, bio-graphene, bromelain, reactivated carbon, palm kernel expeller fermentation R&D etc.)
- Highlight success story based on quadrilateral collaboration model to facilitate private sector participation in biomass R&D&C&I.

Inclusiveness Approach for Biomass-related Industry

Engage with circular economy or biomass related associations on specific industrial issues that needs further accelerated R&D&C&I to expedite the commercialisation path of potential products such as PKE / PKC animal feed for layer and broiler chicken. Such inputs can be incorporated in the Specific Call for Proposal based on the earlier consultative approach on realistic problem statement which will attract the private sector to participate in the R&D&C&I call initiated by the government.

In a nutshell, the government can implement CEPA activities on the potential benefits of biomass R&D&C&I through targeted campaigns, seminars, websites and social media channels.

Chapter

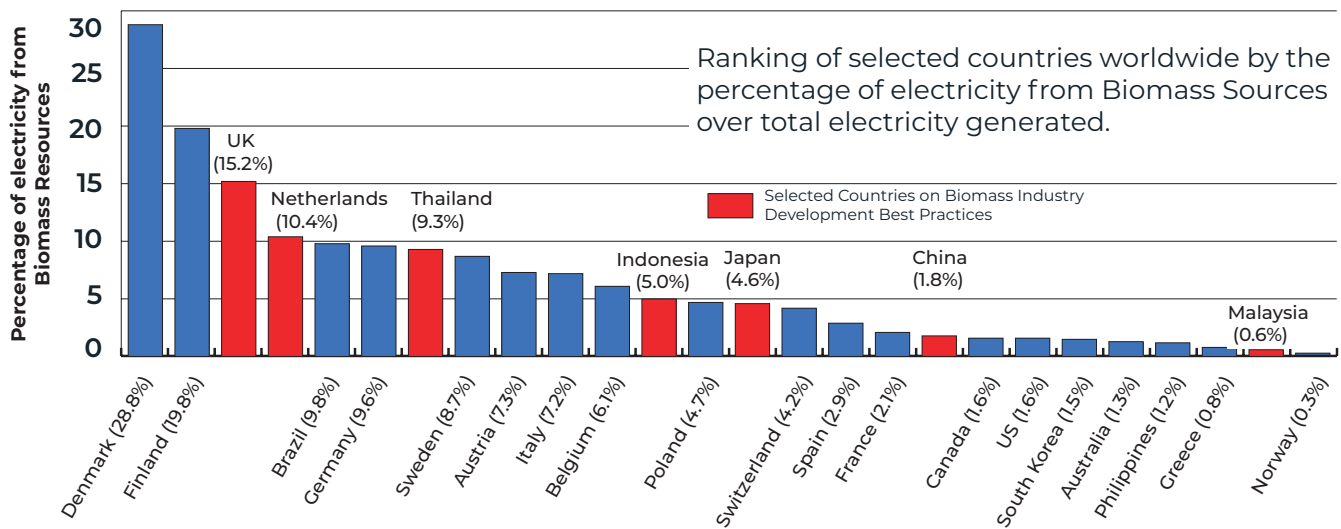
**International
Best Practices
on Biomass Policies**



International Best Practices on Biomass Policies








Six countries are selected based on similar utilisation of biomass across varying ambition levels of aspirations and percentage of electricity generated from biomass sources. These countries are spread across the Asia Pacific region i.e. Thailand, Indonesia, China, Japan, United Kingdom and a Member State of the European Union i.e. The Netherlands. Key insights that Malaysia can learn from and use to enhance local implementation include best practices from their journey and an understanding of the current state in the biomass landscape resulting from the policies undertaken.

Figure 6.1: Ranking of Selected Countries by the Percentage of Electricity from Biomass Sources



Source: IEA

Table 6.1: Summary of Key Statistics for the Selected Countries

	 Malaysia	 Thailand	 Japan	 China	 Indonesia	 United Kingdom	 The Netherlands
Population (2021)	33.57 million	71.6 million	125.7 million	1.412 billion	273.7 million	67.33 million	17.53 million
GDP per capita (2021)	USD 11,109	USD 7,066	USD 39,312	USD 12,556	USD 4,333	USD 46,510	USD 57,767
GDP (2021)	USD 373 million	USD 505.9 million	USD 4.941 trillion	USD 17.73 trillion	USD 1.187 million	USD 3.133 trillion	USD 1.013 trillion
Percentage of agricultural land (2020)	26%	45%	12%	56%	33%	71%	54%
Percentage of electricity from biomass (2021)	0.6%	9.3%	4.6%	1.8%	14.7%	15.2%	10.4%
RE Target mix	31% by 2025	30% by 2037	36-38% by 2030	25% by 2030	23% by 2023	50% by 2030	16% by 2023

Source:

World Bank, IEA, NRECC, Thailand AEDP, Japan METI, UK Committee Climate Change, Ministry of Economic Affairs and Climate Policy (The Netherlands), National Energy Administration (NEA) China

Thailand

Thailand's biomass supply chain and its utilisation in the energy sector are a result of the country's supportive policy environment and regulatory framework.

The key contributing initiatives, policies and plans to develop the biomass industry are:



Thailand 4.0 Policy - Investment Promotion and Tax Incentive

Thailand 4.0 policy aims to promote innovation, technology adoption and collaboration with international partners to achieve sustainable development in various sectors, including the biomass industry. Under this policy, Thailand Board of Investment (BOI) provides various incentives to encourage foreign investors in this industry. Up to 8 years of tax holiday is applicable for projects using waste to produce electricity or steam and production of biofuel from agricultural products and by-products. Exemption of import duty for industry-specific machinery are also available. Tax exemption of corporate income tax of up to 13 years can be applied for biotechnology development, advanced materials technology development and nanotechnology development, among other promoted business activities.



Twenty-Year Agriculture and Co-operative Strategy (2017-2036)

The Twenty-Year Agriculture and Co-operative Strategy (2017-2036) and the Five-Year Agriculture Development Plan recognise the importance of providing technical assistance and training to farmers to promote sustainable agriculture practices. By providing farmers with the knowledge and skills to produce and use biofertilisers effectively, the strategy aims to increase the adoption of sustainable agriculture practices. The strategy successfully reduced the import value of chemical fertilisers in 2015 to 60,557 million baht (RM7.87 million), an average reduction of 10.73% per year from 85,135 million baht (RM 11.06 million) in 2012.



Alternative Energy Development Plan (AEDP 2015)

The AEDP 2015 aimed to promote the use of biomass as one of the alternative energy sources. A major milestone was achieved in 2018 with 3.372 MW bioenergy generated for own energy consumption by the industry generator under the captive power model. This has achieved substantial energy cost savings and a smaller share was exported to the electricity grid. As of 2021, biomass energy sources accounted for approximately 3% of Thailand's total energy consumption, with the majority from biogas and biomass power plants.



New Theory Farming Project

The project was initiated by the late King Bhumibol Adulyadej in 1994. Under the New Theory Farming project, the Thai Government established demonstration farms and research centres across the country to showcase the effectiveness of organic farming practices and to provide training and education to farmers. The project also promotes the use of locally available resources, such as biofertilisers made from animal waste, plant residues and microorganisms, to reduce reliance on chemical fertilisers. This initiative was highly successful in promoting sustainable agriculture practices and has received international recognition for its contribution to sustainable development.

Insights for Malaysia

**Capture Bioenergy Data under the Captive Power Model**

The Malaysia Government i.e. Ministry of Natural Resources, Environment Climate Change (NRECC) through Energy Commission (ST) could capture further bioenergy data used/achieved in Malaysia. Malaysia bioenergy (self-generation, co-generation and FIT) achieved 552 MW in 2018 and 440 MW in 2019 respectively.

**Offer Competitive Investment Incentives for Biomass Projects**

BOI Thailand and Malaysia (MIDA/ Bioeconomy Corporation) offer competitive / compatible investment incentives for biomass projects. Thailand's tax holidays for biomass ranges from 5 years (pellets), 8 years (fuel switching, biomass plant) to 13 years (biotechnology) whereas MIDA and Bioeconomy Corporation offer tax holiday between 5 years to 10 years for various palm biomass / non-palm biomass projects.

**Lessons Learnt to Reduce Import of Chemical Fertiliser**

Thailand's Strategy to reduce usage of chemical fertiliser is commendable. It is timely for Malaysia Government to consider major campaign on biofertiliser since Budget Malaysia Madani 2023 has already allocated RM5 million for a pilot project to use biofertiliser.



Addressing Feedstock Management with Recommendations from IRENA

IRENA's recommendations on biomass feedstock procurement between sellers and buyers

FEEDSTOCK MANAGEMENT CHALLENGES IN THAILAND

- Establishing a fair and reasonable pricing mechanism for biomass collection, handling and storage;
- Development of the biomass supply chains needed to ensure the collection and storage of a large amount of biomass residues from dispersed areas; and
- Coordination of planning practices with the Ministry of Agriculture and the Ministry of Natural Resources and Environment, in respect of land use and the certainty of demand for biomass used for energy purposes.

Pricing Mechanism

Establish a fair and reasonable market environment with a clear pricing mechanism for biomass that can offer long-term purchase guarantees, based on projected demand and mitigate the seasonal variation in feedstock yield as much as possible.

Market Price

Market pricing for biomass should also factor out the commodity price volatility of the international markets. This would help minimise the negative impact of oil price volatility on farmers' finances, and in return enhance their confidence in investments in energy crops.

Regulatory Framework

A fair and sound regulatory framework should be put in place to ensure a fair distribution of the benefits between farmers and energy producers, particularly when trade is conducted through collection and processing companies (including agricultural cooperatives that are operating as a collector in some places), processing mills and other involved businesses.

Contractual Agreement

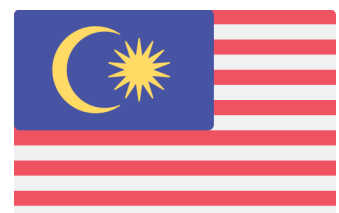
A regulated contractual agreement for biomass feedstock sales and purchase.

Insights for Malaysia

1 Clear pricing mechanism for biomass that can offer long term purchase guarantee is currently absent in Malaysia as the current market practice for sourcing biomass feedstock is purely based on arm's length negotiation between biomass feedstock owners, biomass users, project developers; open tender, joint venture, business relationship based biomass procurement.

2 Similar to Ministry of Local Government Development (KPKT) Malaysia's regulatory approach on the sales and purchase agreement of residential properties, Malaysia Government may consider implementing same measures for biomass feedstock sales and purchase agreement (SPA).

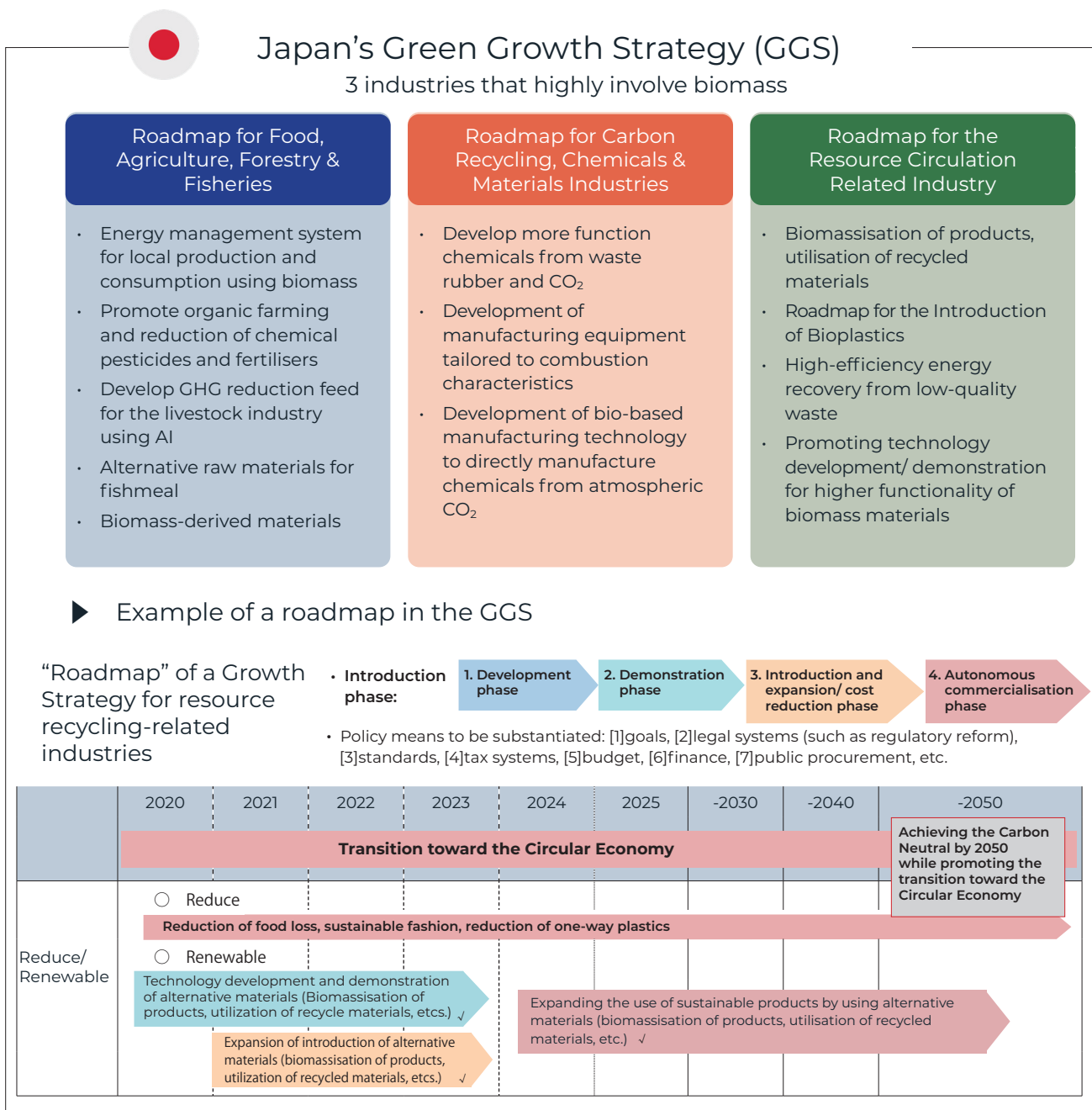
3 Tribunal dealing with feedstock procurement disputes between buyers and sellers may be considered mirrored on the KPKT's Housing Tribunal model.



Japan

Recognising that the biomass industry does not operate in isolation, Japan developed the cross-cutting Green Growth Strategy towards realisation of Carbon Neutrality by 2050. A whole-of-government approach and synergy with corporations are employed to ensure participation from all relevant stakeholders towards a mutual goal.

The Green Growth Strategy (GGS) identified 14 most promising industries in three groups i.e. energy-related, transport / manufacturing and home / office related that are expected to accelerate efforts towards carbon neutrality. A roadmap that outlines a realistic growth pathway for each field has been developed to provide a clear direction for all stakeholders.



Insights for Malaysia

1 Japan GGS has provided insights to formulate various biomass sectoral short term, mid-term and long-term enabling policy ecosystem to develop technological driven business models and R&D pillared on green growth agenda.



Good insights for future planning of 5 year Malaysia Plan

2 GGS has identified the roadmap to reuse / repurpose biomass for various high value bio-based products such as biochar, cellulose nanofibre (CNF), bioplastics, development of low GHG feed, encourage circularities of biomass products, functional chemicals production from waste rubber, development of biomanufacturing of green chemicals from atmospheric CO₂ through R&D, products demonstration.

3 More synergy with Japanese corporations for biomass investment, trading, R&D such as IHI Japan, Itochu, Idemitsu, Marubeni, Nagase, Panasonic, ENEOS Corporation etc.



Regulatory intervention contributed to the rapid increase in demand for biomass demand in renewable energy and agriculture sectors.

The Renewable Energy Law

The feed-in-tariff (FIT) initiative which was introduced in 2012, has resulted in the mushrooming development of biomass power plants with 4.4 million tonnes of imported wood pellets; Malaysia exported wood pellets to Japan in 2022 was 227,615 tonnes.

Livestock Manure Utilisation Promotion Act

Provides a framework to promote the utilisation of livestock manure for various purposes, such as the production of biofuels and compost. Key provisions include:

Obligations of livestock farmers

Requires livestock farmers to properly manage and utilise their manure, including measures to prevent the release of harmful substances into the environment.

Support measures for livestock farmers

Provides financial and technical support for livestock farmers to implement manure utilisation projects. This includes subsidies for the installation of equipment and facilities for manure treatment and utilisation as well as technical guidance and training.

Promotion of manure utilisation projects

Encourages the development and promotion of manure utilisation projects, such as the production of biogas and compost. The government is also required to conduct research and development on manure utilisation technologies and promote their adoption.

Monitoring and reporting

Requires livestock farmers and businesses to monitor and report on their manure management and utilisation activities and to maintain records for at least five years.

China

Modernisation of agriculture through internet of things (IoT)



Modern Agriculture Platform (MAP)

The Chinese Government has been promoting the development and adoption of biofertilisers as part of its MAP initiative, which aims to modernise and enhance the productivity of China's agricultural sector. This modernisation effort involves application of IoT as part of a bigger scheme i.e. Internet Plus Agriculture initiative. The MAP platform provides farmers with recommendations for the optimal types and amounts of fertilisers and pesticides to use based on factors such as crop varieties, soil conditions and weather patterns. Other key outputs of MAP include research and development efforts to improve the efficiency and effectiveness of fertiliser and pesticide use in agriculture.

Best Practices in Addressing Feedstock Issues

As the demand for biomass feedstock has increased rapidly in recent years due to the government's push for renewable energy. This has led to competition for limited feedstock resources and gaps in quality control. To address these challenges, the Chinese Government has implemented a range of policies and regulations to promote the development of the biomass industry and ensure a stable and affordable supply of biomass feedstock.

To address quality challenges, the Chinese Government is taking a multi-faceted approach with policies aimed at improving the quality of the feedstock, setting quality standards and promoting the development of new technologies to upgrade low-quality feedstock e.g. pyrolysis or gasification.

Biomass Energy Price Policy

- Sets the upper and lower limits for the price of biomass feedstock based on market conditions, transportation costs.
- Aims to prevent biomass feedstock prices from becoming too high or too low, ensuring that biomass power plants can obtain feedstock at a fair price.
- Certification system for environmentally friendly and socially responsible manner.

Guidelines for the Collection, Transportation and Storage of Crop Straws

- Provides guidance on how to properly collect, transport and store crop straws to address the issues arisen from impurities and moisture.
- Foundation for downstream economic activities that use biomass feedstock e.g. bioenergy.

National Plan for the Development of Biofertilisers (2017 - 2020)

- Six industry standards and regulations for biofertilisers.
- The first standard, "General Requirements for Biofertiliser Products" (NY/T 1480-2017) - specifies that biofertilisers can be produced from a variety of organic materials, including livestock manure, crop straw and other plant residues. It also sets standards for the physical chemical and biological properties of biofertilisers, as well as requirements for labelling and packaging.
- The third standard, "Technical Requirements for Production of Bio organic Fertiliser" (NY/T 706-2017) - provides detailed guidance on the production of biofertilisers from livestock manure and other organic materials.

Industrial clusters focused on biotechnology and bio-based industries



Qingdao International Bioenergy and Bioproducts Demonstration Zone

This project is part of a broader national strategy to promote the development of clean energy and reduce dependence on fossil fuels. It is aligned with China's broader goals of transitioning to a more sustainable and low-carbon economy. In a nutshell, the project is...

- Initiated by the Chinese Government in 2009 with the aim of promoting the development of the bioenergy and bioproducts industries in China.
- A specific initiative that includes the establishment of a bio-industry park in Qingdao, Shandong Province. Other supporting measures include research and development funding, regulatory support and international cooperation agreements.
- Planned to build a new biorefinery plant with an annual output of 200,000 tons of biochemical products, highlighting its continued commitment to promote technological innovation and commercialisation in the bioenergy and bioproducts industries.

Insights for Malaysia



- 1** Absence of the Biomass Energy Price Policy
- 2** Potential to create biomass industrial clusters
- 3** National Biofertiliser Policy for Malaysia
- 4** Upgrading low quality biomass feedstock, such as using pyrolysis or gasification
- 5** Malaysia is progressing towards using precision agriculture, agritech digital technology, IR 4 (Internet of things, Big Data Analytics, Artificial Intelligence etc.) enabled by government grants, tax incentives and soft loans provided by MIDA, MDEC, Agrobank etc.



Success of Blended Finance Using Equity Investment and Government Grant

British Business Bank (BBB) is a government-owned economic development bank and supports access to finance for smaller businesses to drive sustainable growth and prosperity across the UK, and also to enable the transition to a net zero economy.

The BBB has supported a bio-based SME i.e Nova Pangaea which has a patented technology for converting woody and agricultural residues into high value sustainable products that will be used to produce sustainable aviation fuel for British Airways. Successive funding from the BBB's Northern Powerhouse Investment Fund and grant funding support from the Department for Transport have enabled Nova Pangaea to build a demonstration plant and proved the capability of its process.



British Business Bank (BBB)

BBB is providing blended finance services to biomass related business.

The BBB offers financing support in the form of loan, guarantee and equities.

BBB supported £505 million of equities investment in clean technology companies.

Has supported a bio-based SME for converting woody and agricultural residues into sustainable fuel for British Airways.



UK Biomass Feedstock Innovation Programme

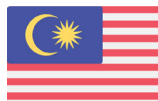
The UK Biomass Feedstock Innovation Program is specifically designed to address the feedstock issue by supporting the development of a sustainable and cost-effective biomass supply chain in the UK.

A total of £62 million (Phase 1 £30 million and Phase 2 £32 million) of funding was awarded for the project demonstration stage of the UK Biomass Feedstocks Innovation Programme. The funding enabled more than 20 organisations, including SMEs to deliver commercially viable innovations in biomass production.

The Department for Business, Energy and Industrial Strategy (BEIS) has provided more than £32 million (Phase 2) in funding to support innovation in the production of sustainable domestic biomass. Various innovative biomass technologies such as :

- Geospatial Data Systems to Upscale National Forestry-based Biomass Production
- Offshore Marine Algae Production
- Perennial Energy Crops Decision Support System
- Mobile Pelleting Machines for Converting Agri-Residues In-situ
- Biomass Connect: Innovation and Information Sharing Platform etc.

Insights for Malaysia



- 1** Timely to review the government grant ecosystem in the future by focusing both on vertical theme and horizontal theme. The present approach by MOSTI is adopting the horizontal approach across all promoted or emerging technology sectors.
- 2** A vertical approach purely focused on biomass theme for government grant may be necessary parked under the Ministry of Science, Technology & Innovation (MOSTI).
- 3** Bank Negara Malaysia and SME Bank Malaysia have already introduced blended finance between RM 5 million to RM 10 million as equity investment for eligible SMEs.

The Netherlands

The success of technology adoption by private sectors in emission reduction can be attributed to the government's subsidy scheme for greenhouse gas (GHG) reduction. With the rate of €300 per tCO₂e through the budget set in SDE++ 2022, it is considered as of the highest in the world.



Stimulation of Sustainable Energy Production and Climate Transition (SDE++)

The Stimulation of Sustainable Energy Production and Climate Transition (SDE++) scheme focuses on the large-scale roll-out of technologies for renewable energy production and other technologies that reduce CO₂ emissions.

The scheme details the different categories of technology for renewable energy production including the relevant biomass technologies and technologies that reduce CO₂ emission. Promoters are eligible to receive subsidy incentive based on the achieved CO₂ reduction.

The SDE++ applications are divided into 5 phases by the categories of technology. The first and second phases mainly consisted of applications from CCUS and solar (large solar-PV systems on rooftops) and the third phase consisted mainly of applications for CCUS, solar PV projects and e-boilers. As for the fourth and fifth phases, the applicants were from the geothermal, biomass and fermentation, carbon capture & storage (CCS), carbon capture & utilisation (CCU) and electric boilers.

▼ SDE++ categories

Main category	Subcategory
Renewable energy	Osmosis Hydropower Wind Solar PV
Renewable heat (CHP)	Biomass fermentation Biomass combustion Composting Geothermal energy Solar thermal
Renewable gas	Biomass fermentation Biomass gasification
Low-carbon heat	Aquathermal Daylight greenhouses Solar PVT panels with a heat pump Geothermal(shallow) Use of waste heat Industrial heat pump
Low Carbon Production	CO ₂ capture and storage (CCS) CO ₂ capture and USE (CCU) Advanced renewable fuels Electrolytic hydrogen production

▼ Results of SDE++ 2021

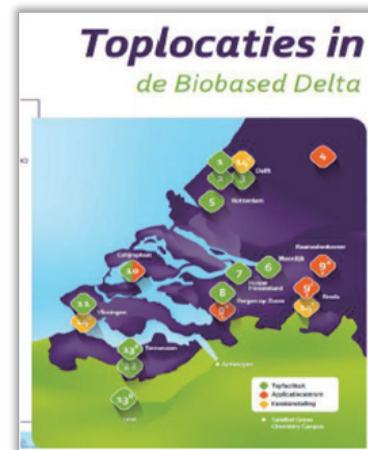
Category	No. of Applications	Requested Budget (€ min.)	Requested Capacity (MW)	Annual CO ₂ Reduction (Mton CO ₂ /p.a.)	Average Subsidy Intensity (€/CO ₂)
Renewable electricity	3,921	2,276	4,161	0.84	82
Solar PV on rooftops	3,747	1,315	2,224	0.43	71
Solar PV on field or water	168	928	1,908	0.39	94
Wind energy	6	33	29	0.02	78
Renewable heat (CHP)	51	917	310	0.34	162
Biomass heat and CHP	30	150	59	0.09	96
Geothermal	10	763	243	0.24	180
Solar thermal	10	3	7	0.00	149
Composting	1	2	1	0.00	68
Renewable gas (Biomass gas)	38	710	151	0.22	230
Low CO ₂ ,heat	56	751	528	0.41	92
Electric boiler	21	499	352	0.24	109
Industrial heat pump	19	82	54	0.06	80



Biobased Delta – A Biobased Economy Cluster Initiative

Biobased Delta was initiated in 2009 by a group of organisations in the southwest Netherlands, including companies, universities, research centres and governmental bodies to promote the development of a sustainable and biobased economy in the region. It covers an area of approximately 8,000 km². It also aims to develop biobased solutions that replace fossil fuels and chemicals with renewable alternatives.

Biobased Delta created a governance structure, including a steering committee and working groups, to oversee the initiative and coordinate the efforts of stakeholders. It also established a physical location, the Biobased Delta House, to serve as a hub for collaboration and innovation.



Over 100 organisations have formed the cluster. This initiative has created a new platform for business opportunities, stimulate innovation and entrepreneurship and growth of a sustainable and circular economy in the region.



Fertilisers Act (Meststoffenwet)

Under the Dutch Fertilisers Act (Meststoffenwet), reducing the use of synthetic fertiliser which can be a major source of nutrient pollution in waterways and can contribute to environmental problems such as eutrophication.

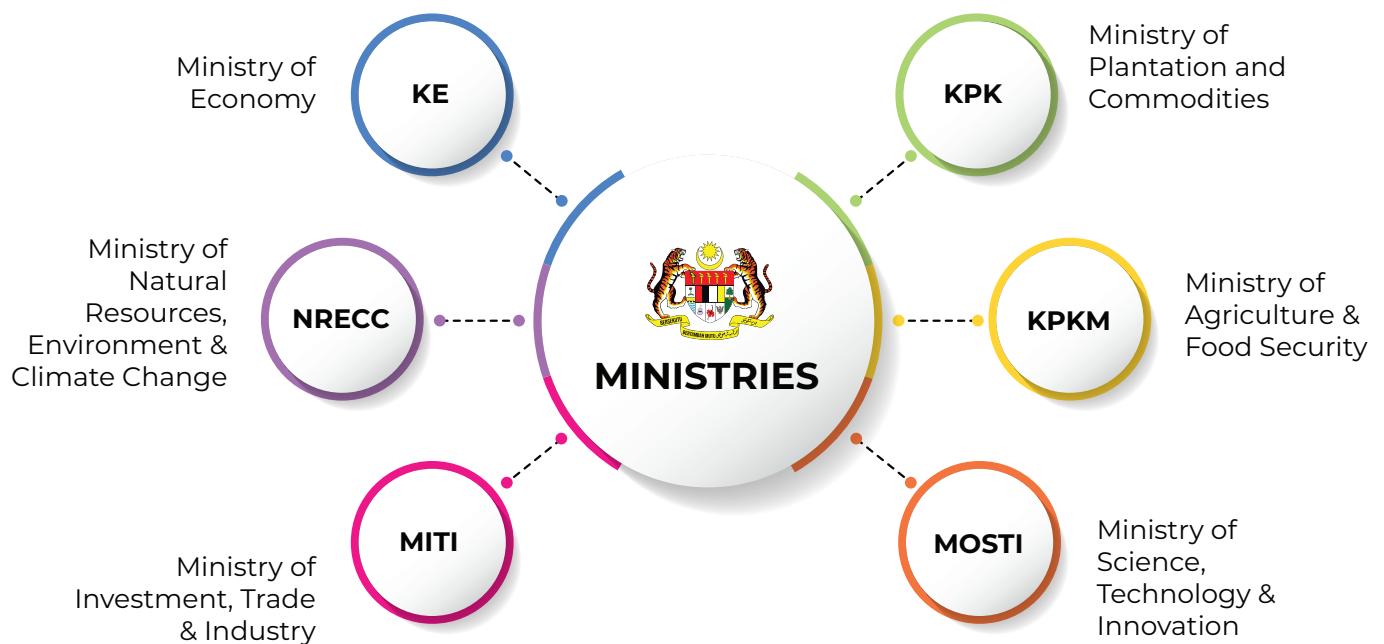
The importance of nutrient management is emphasised in The Netherlands with regulatory framework which requires farmers to develop and implement a Nutrient Management Plan (NMP) including keeping records of their fertiliser utilisation.

This approach not only raises awareness among farmers about the importance of nutrient management and the environmental impact of fertilisers, but it also promotes accountability and transparency in the use of fertilisers, which can help to reduce nutrient pollution in the environment.

The Dutch Government has set a target to reduce the use of synthetic fertilisers by 50% by 2030 as part of broader goal to transition to more sustainable and circular economy.

Insights for Malaysia

The comprehensive climate change driven approach by the Dutch Government provides a planning insight for Malaysia Government with reference to the following ministries to formulate climate change mitigation incentives by linking to GHG emission reduction based on the application of various low carbon technologies. It is also timely for Malaysia to adopt the application of biofertiliser and progressively reduce the usage of chemical fertilisers.



INDONESIA

Indonesia, the world's largest producer of palm oil, generates abundant biomass from its plantations, forestry and agriculture sectors. Its plentiful biomass feedstocks have continued to attract huge investments and enabled bioenergy and bio-based projects aligned with the nation's policies such as feed-in tariffs and tax incentives.



Foreign Direct Investment (FDI) Tax Holidays

The Indonesia Government offers tax incentives for eligible firms in pioneer industries. Capital investments including those in the biomass sector from IDR 500 billion (RM155 million) may be eligible for 5 - 20 years tax holidays and a 50% reduction in corporate income tax (CIT) for two years.

Investments ranging from IDR 100 billion (RM31 million) to less than IDR 500 billion (RM155 million) may obtain a 50% CIT reduction for five years and a further 25% reduction for two years. The incentives aim to support industries with high strategic value, emerging technologies and externalities.

Insights for Malaysia

The incentives offered are very attractive, especially to the MNCs, to invest in its biomass sector. Indonesia provides a relatively cheap labour force. Hence, it is timely for Malaysia to reinforce its value proposition in the biomass sector with more appealing incentives, business models, technological innovations, etc. to ensure its competitiveness in the biomass sector remains on par with Indonesia.



Biomass Co-firing Power Stations Phasing Out Coal Power Plants

Indonesia aims to gradually blend biomass with fossil fuel power plants. Co-firing plays a significant role in greening energy production. Implementing a plan to make biomass co-firing mandatory in power stations will eventually phase out coal power plants and promote biomass as a renewable energy in Indonesia.

As of May 2022, Indonesia has successfully implemented co-firing in 32 of its coal-fired power plants, generating 487 MWh of electricity. This transition has led to a significant reduction of around 184,000 tonnes of CO₂ and GHG emissions. Indonesia has targeted 114 existing plants by 2024 constituting 60% of the total number of plants for biomass blending.

Insights for Malaysia

Indonesia has moved ahead of Malaysia to operationalise the national biomass co-firing initiative with Perusahaan Listrik Negara (PLN) spearheading the initiative. The Indonesia Government's political will to implement the climate change mitigation initiative which complements its net zero emission target is highly commendable. Hence, it is timely for the Malaysia Government to formulate a National Biomass Co-firing Initiative using EFB pellets to decarbonise our electricity supply. In the newly released National Energy Transition Roadmap (NETR), biomass co-firing has been outlined as a key initiative. Further intervention is needed from Malaysia Government to harness the bioenergy potential from oil palm biomass in view of the potential competition from Japan for importing palm pellets.

Special Mention

Indonesia – The Republic of Korea Forestry Collaboration

Indonesia's state-owned forestry company, Perhutani is collaborating with the Korea Forest Service (KFS) and Korea Green Promotion Agency (KGMA) to accelerate biomass plantation and wood pellets production. Around 3,300 trees have been planted in the Bogor Forest Management Unit (FMU) as well as extended cultivation on a 1,500-ha gamal (*gliricidia sepium*) forest in the Semarang FMU. Other fast-growing species i.e., calliandra (*Calliandra calothyrsus*), albizia (*Paraserianthes falcataria*) and acacia have also been planted.

KFS's forest biomass business focuses on growing Gliricidia trees which serves to increase woody biomass feedstock supply for the Republic of Korea's Renewable Portfolio Standard. KFS plans to expand the overseas reforestation area to 1 million hectares.

Insights for Malaysia

The Malaysia Government, especially Sarawak and Sabah Governments can venture into forest plantation for accelerating the wood pellets industry with potential Korean counterparts since the certified wood pellets have huge market demand from overseas. Global demand for bioenergy will continue to drive the development of the wood pellets industry. Enterprising wood pellet producers can work in partnership with Sarawak and Sabah Governments to convert forestry land into sustainable wood pellet projects based on soft loans provided by KPK.

Chapter

**Setting Up Biomass Hub
In Malaysia**



Setting up Biomass Hub In Malaysia

Concept of Biomass Hub

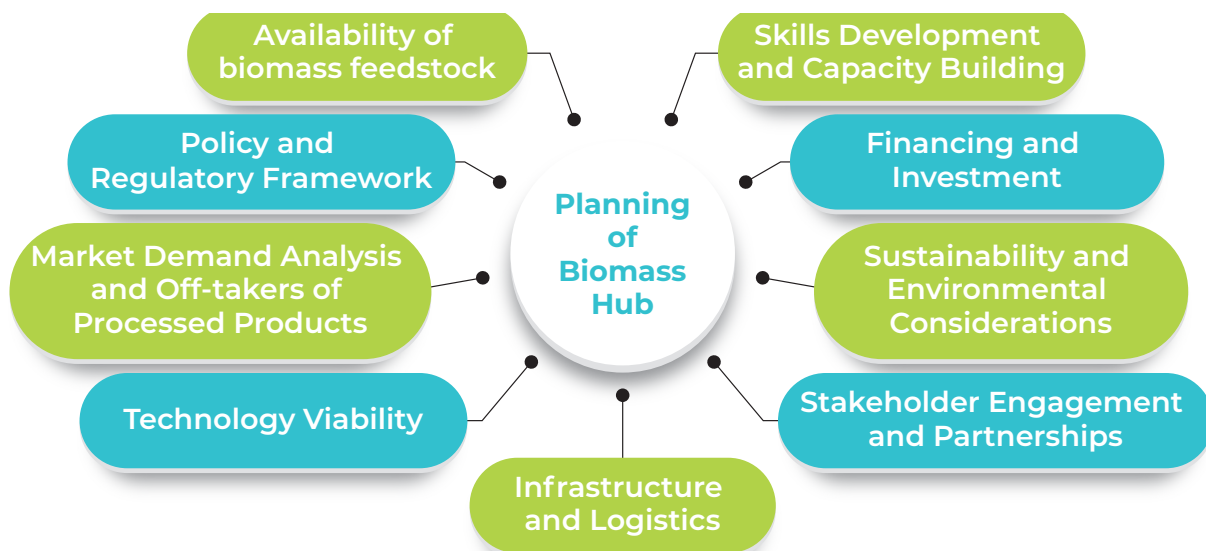
A biomass hub is a centralised location where biomass feedstocks are collected, processed and distributed for use in various applications such as biofertiliser, animal feed, energy production, biochemicals, pulp and paper and other value-added products. Biomass hub serves as an effective role to facilitate green supply chain for converting biomass into bioenergy and biomaterials due to the economic of scale it achieves and its unique business models.

Typically, a biomass hub incorporates facilities for biomass collection, storage, processing and distribution. The collection facility includes harvesting equipment, logistics infrastructure and a collection point for biomass resources. The storage facility includes silos, warehouses or other storage structures catered to the large quantities of biomass.

Planning of Biomass Hub

When planning to set up a biomass hub in Malaysia, several key considerations should be taken into account. These factors will help to ensure the successful establishment and operation of the biomass hub as outlined in the National Agri-commodity Policy (DAKN) 2021 – 2030. The Ministry of Plantation & Commodities and Malaysian Palm Oil Board have explored the feasibility of setting up a biomass hub with a preference to the industry sector to spearhead the initiative. Below are some important considerations and best practices:

Figure 7.1: Key Considerations of Setting Up Biomass Hub



- ▶ **Availability of Biomass Feedstock:** Conduct a comprehensive assessment of biomass feedstock in the targeted biomass cluster, ascertaining actual biomass availability in the targeted location. In the context of Malaysia, it is specifically referring to oil palm biomass due to its large quantities and concentration of palm oil mills and estates in dedicated areas such as Pahang, Johor, Perak, Sarawak and Sabah. This assessment should identify the quantity, quality and availability of biomass feedstock, with the view of determining the potential biomass hub locations and the potential business models that enable the viability of the biomass hub.
- ▶ **Policy and Regulatory Framework:** Understand the existing policy and regulatory framework in Malaysia that is related to biomass utilisation and renewable energy. These include incentives for the development of a biomass hub,⁵⁸ feed-in tariffs, tax benefits and sustainability requirements. Aligning the biomass hub's plans with government policies and regulations will facilitate the smooth operations and to ensure compliance.
- ▶ **Market Demand Analysis and Off-takers of Processed Products:** Conduct a thorough market analysis to identify potential biomass product opportunities and target markets with commitment from off-takers of manufactured products. Assess the demand for solid biofuels and bio-based products both domestically and internationally. Engage with potential buyers, industries and end-users to understand their requirements and tailor the biomass hub's offerings accordingly.
- ▶ **Technology Viability:** Explore international best practices in biomass conversion technologies and identify the most suitable ones for Malaysia's biomass resources. Assess technologies such as pyrolysis, gasification, anaerobic digestion or pelletisation. Evaluate the scalability, proven technology efficiency and sustainability certification requirement for the overseas premium market.
- ▶ **Infrastructure and Logistics:** Determine the required infrastructure such as storage facilities, processing units and transportation networks based on the biomass hub's scale and location. Ensure that the infrastructure can accommodate the expected biomass feedstock volumes and handle the conversion process efficiently. Develop an optimised logistics plan to minimise transportation costs and ensure a smooth supply chain as biomass economics is highly sensitive to logistics costs particularly lower value commodity products.
- ▶ **Stakeholder Engagement and Partnerships:** Engage with relevant stakeholders, that include biomass feedstock suppliers, logistic partners, technology providers, government research institutions, financial institutions and government agencies. Establish strong partnership models with multi-stakeholders to ensure a successful delivery of biomass hub.
- ▶ **Sustainability and Environmental Considerations:** Emphasise sustainability in the biomass hub's operations including responsible biomass sourcing focusing on traceability such as MSPO Chain of Custody (COC) for Oil Palm Biomass, waste management and emissions reduction. Consider international sustainability standards such as certifications for sustainable biomass production. Implement environmental monitoring and reporting mechanisms to ensure compliance with regulations and enhance the hub's environmental performance.
- ▶ **Financing and Investment:** Develop a comprehensive business plan and financial model to attract investments and secure funding for the biomass hub. Explore financing options such as Green Technology Financing Scheme (GTFS), green sukuk, public-private partnerships or international funding sources. Demonstrate the economic viability and long-term profitability of the biomass hub to attract potential investors.

58 Consult Malaysian Investment Development Authority (MIDA) for attractive tax incentive offered to developer of biomass hub.

- **Skills Development and Capacity Building:** Invest in training programs and capacity-building initiatives to develop a biomass skilled workforce capable of managing biomass hub operations. Collaborate with educational institutions and vocational training institutions to provide specialised training in biomass project management, technology operation and business development.

Navigating the Path Ahead

By incorporating these key considerations, the planning and implementation of a biomass hub in Malaysia can be guided towards successful development especially within the framework of good practices. It is important to continuously monitor and adapt to changing market conditions especially availability of feedstock at reasonable price and favourable business model of potential off-takers targeting either local or premium overseas market which are classified as **critical success factors**.

Case Reference: Oil Palm Biomass Collection and Processing Centre (CPC)

Special Purpose Vehicle (SPV) for the Oil Palm Biomass Collection & Processing Centre (CPC)

On 5 April 2023, Nextgreen Global Bhd announced that Nextgreen Biomass Sdn Bhd (NGBSB), its wholly-owned subsidiary had entered into a Shareholders' Agreement (SA) with Greentech Malaysia Alliances Sdn Bhd (GTMASB) i.e. a fully-owned subsidiary of Malaysian Green Technology & Climate Change Corporation (MGTC), Koperasi Sahabat Amanah Ikhtiar Malaysia (KOOP SAHABAT) Berhad and Koperasi Perkhidmatan Setia Berhad (KOSETIA), to establish a joint venture in the special purpose vehicle (**SPV**) company namely **GTC Biomass Berhad** for constructing, developing and commissioning Twenty (20) Oil Palm Biomass Collection and Processing Centres (CPC) throughout Malaysia.

Business Model of the Oil Palm Biomass Collection & Processing Centre (CPC)

The estimated cost to develop one oil palm biomass collection centre is approximately RM50 million and the target is to aggregate oil palm biomass, especially EFBs from the surrounding palm oil mills which are within a 100 km radius. The financing of the project is expected to be completed through a debt financing structure such as the Green Technology Financing Scheme (GTFS) or green sukuk. The total investment cost of the 20 oil palm biomass centres is approximately RM1 billion which is expected to be completed within 7 years.

Figure 7.2: Proposed Oil Palm Biomass Collection & Processing Centres (CPCs) in Malaysia



Source: Nextgreen Global Bhd

These collection centres will act as a one-stop centre to collect palm oil waste such as EFBs and the processed EFBs will be sold to Nextgreen Global Bhd (*off-taker*) for conversion into pulp and paper products. The collection centres are located close to palm oil mills, resulting in cost-effective transportation of EFBs and reduced greenhouse gases from transportation.

The oil palm biomass collection centre business model is the first of its kind in Malaysia and in the world especially in the context of oil palm biomass commercialisation model. Globally, there are similar biomass business models mainly to collect waste and convert it to bioenergy. Thus, these Malaysian oil palm biomass CPCs are unique by aggregating EFBs from the surrounding palm oil mills through the SPV i.e. **GTC Biomass Bhd and the EFBs will be converted into semi-processed EFBs and sold to Nextgreen Global Bhd.** The SPV is expected to work with palm oil mills in the vicinity of the proposed biomass hub to supply EFBs which are in Gua Musang (Kelantan) and Pekan (Pahang). Subject to the price fluctuation of EFB feedstock, logistics costs and revenue of relevant business models, the oil palm biomass CPCs have an indicative payback period between 6 to 7 years.

1. Semi-treated EFBs will be transported to Nextgreen's Pulp Mill located in Pekan, Pahang
2. Other biomass such as Oil Palm Frond (OPF), Palm Kernel Cake (PKC) and Oil Palm Trunk (OPT) will be transferred to the animal feed, biofertiliser and biomass pellet plant.
3. Treated water will be reused back in the manufacturing line.
4. Sludge is converted into energy through anaerobic digestion in the biogas plant.

Business Model of Off-taker

Nextgreen Global Bhd will convert the processed EFBs into high-value bio-based products i.e. EFB pulp & paper for export to Japan market (average price between USD600 – USD1,200) per tonne depending on quality and specification of the products. The plant is designed to produce up to 10,000 tonnes of Wood Free Paper and 2,000 tonnes of Unbleached Pulp for Premium Packaging Paper. This manufacturing segment is expected to contribute a constant annual turnover between RM30 to RM35 million.⁵⁹

Figure 7.4: Pulp & Paper Manufacturing Plant in Pekan



Source: Nextgreen Global Bhd

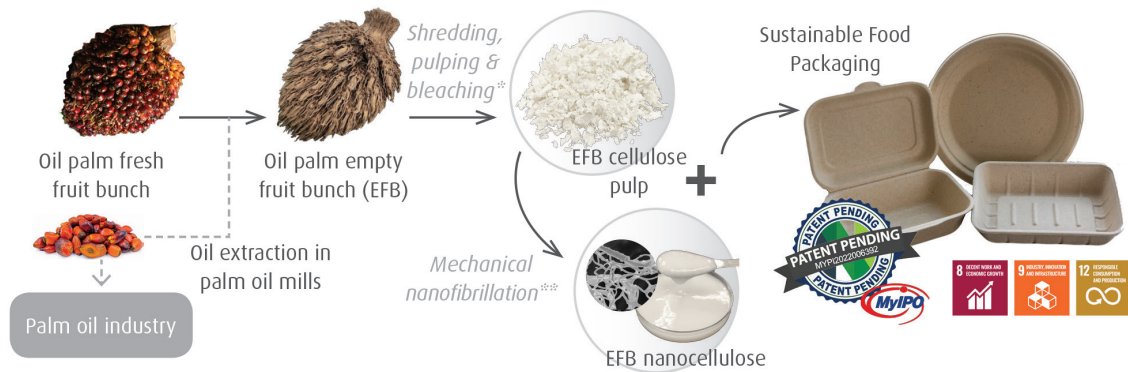
This business model targets to work with the following stakeholders:-

- a) Existing 452 palm oil mills in Malaysia with total processing capacities of 90 - 100 million tonnes of fresh fruit bunches (FFBs);
- b) Fruit bunch collectors i.e. FELDA's settlers; and
- c) EFB Pulp & Paper's sole sales agent or off-taker i.e. a multi-national corporation from Japan

⁵⁹ Company Documents of Nextgreen Global Bhd as per announcement to Bursa Malaysia.

Additionally, Nextgreen’s collaborative project with the Ministry of Science, Technology & Innovation (MOSTI) and Universiti Putra Malaysia (UPM) on the sustainable production of EFB-based food packaging that incorporates nanocellulose worth RM4.4 million was completed in 2022.

Figure 7.5: Flowchart of EFBs Turned Sustainable Food Packaging Products (Enabled by EFB Nanocellulose)



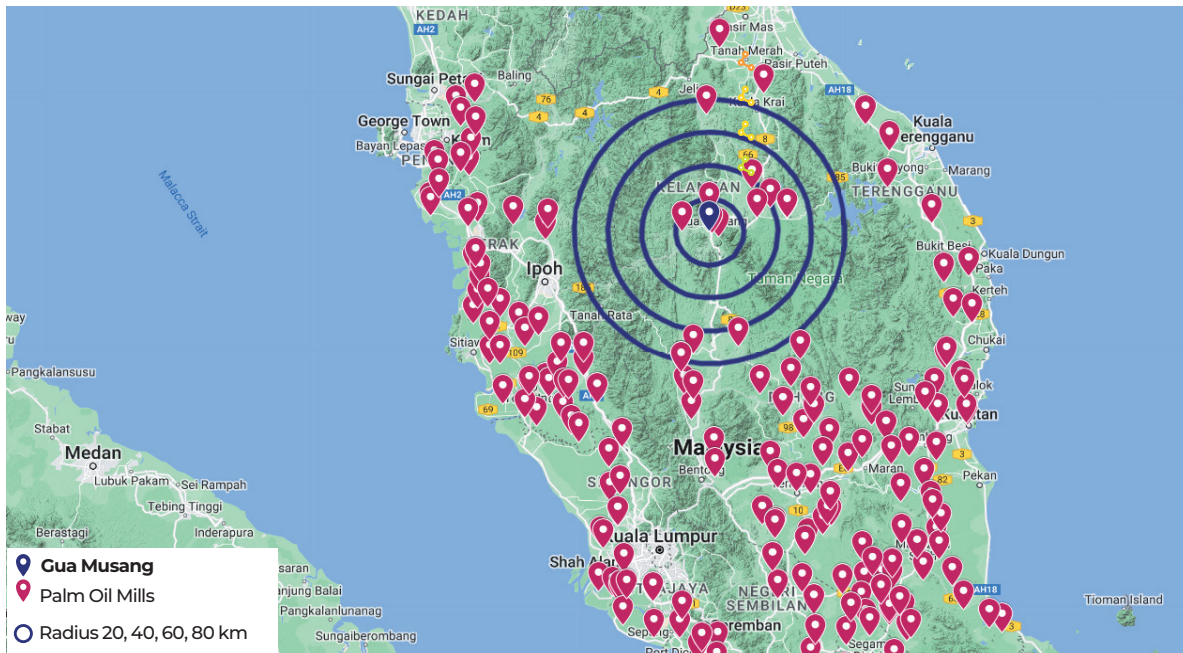
Notes:

* Nextgreen’s preconditioning refiner chemical-recycle bleached mechanised pulp patented technology

** Nextgreen-UPM nanofibrillation technology licensing

Source: Nextgreen Global Bhd

Figure 7.6: Mapping of Palm Oil Mills for the Biomass Hub in Kelantan



Nextgreen Global Bhd plans a pilot oil palm biomass collection centre in Gua Musang, Kelantan and Pekan, Pahang with a total processing capacity of 450,000 – 500,000 tonnes of oil palm biomass annually. The oil palm biomass collection and processing centre is part of the Kelantan Sustainable Projects to be developed by Nextgreen Global Bhd.⁶⁰

⁶⁰ The above-mentioned project has been jointly launched by Kelantan State Government and Nextgreen Global Bhd on 18th May 2023. The project promoter is in the midst of seeking financing through various options.

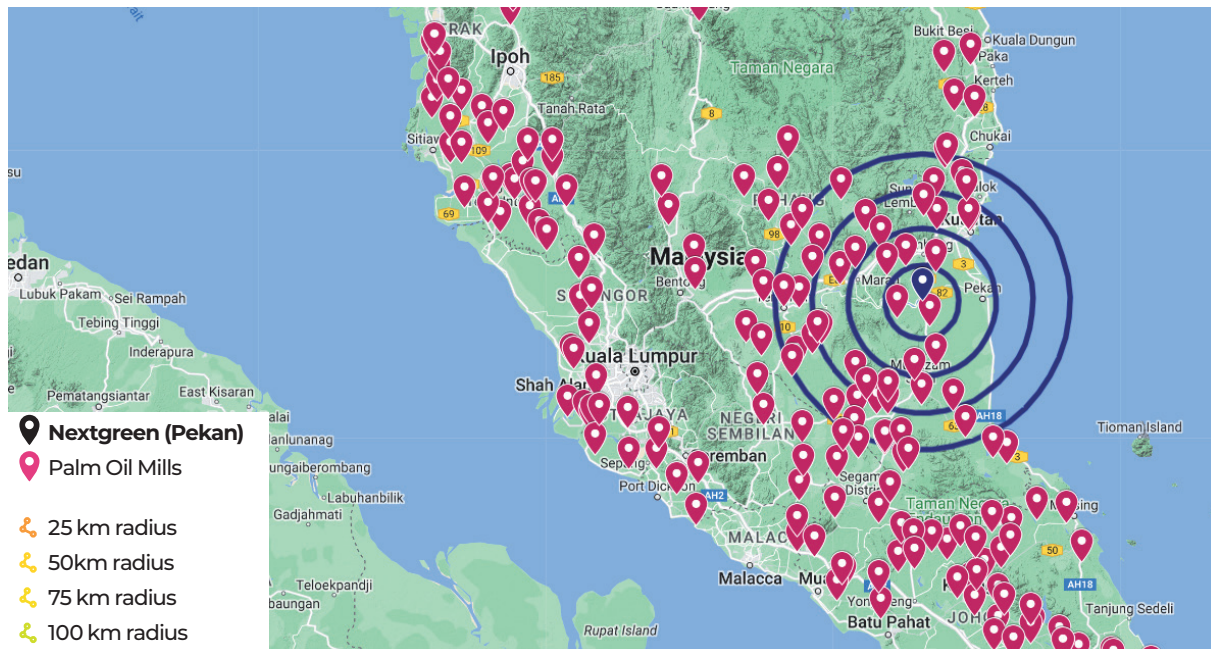
The following table highlights the various proposed biomass-related development projects themed as Kelantan Sustainable Projects:-

Table 7.1: Kelantan Sustainable Projects

No	Kelantan Sustainable Projects	Land Size (Acres)	Estimated Investment (RM billion)
1	Palm Oil Waste Collection and Processing Centre (Feedstock sources such as EFBs, OPF)	50	0.05
2	Forest Plantation Development Project	250,000	0.58
3	Pulp Mill - 400,000 tonnes per annum (Feedstock sources includes timber, EFBs and bamboo)	400	1.50
4	Animal Feed Mill (livestock & poultry) - 50,000 tonnes per annum (Feedstock sources – palm biomass)	50	0.05
5	Biofertiliser Plant – 50,000 tonnes per annum (Feedstock sources – palm biomass and other by-products)	50	0.05
Total		250,550	2.23

Source: Nextgreen Global Bhd's Announcement to Bursa Malaysia on 28 January 2022

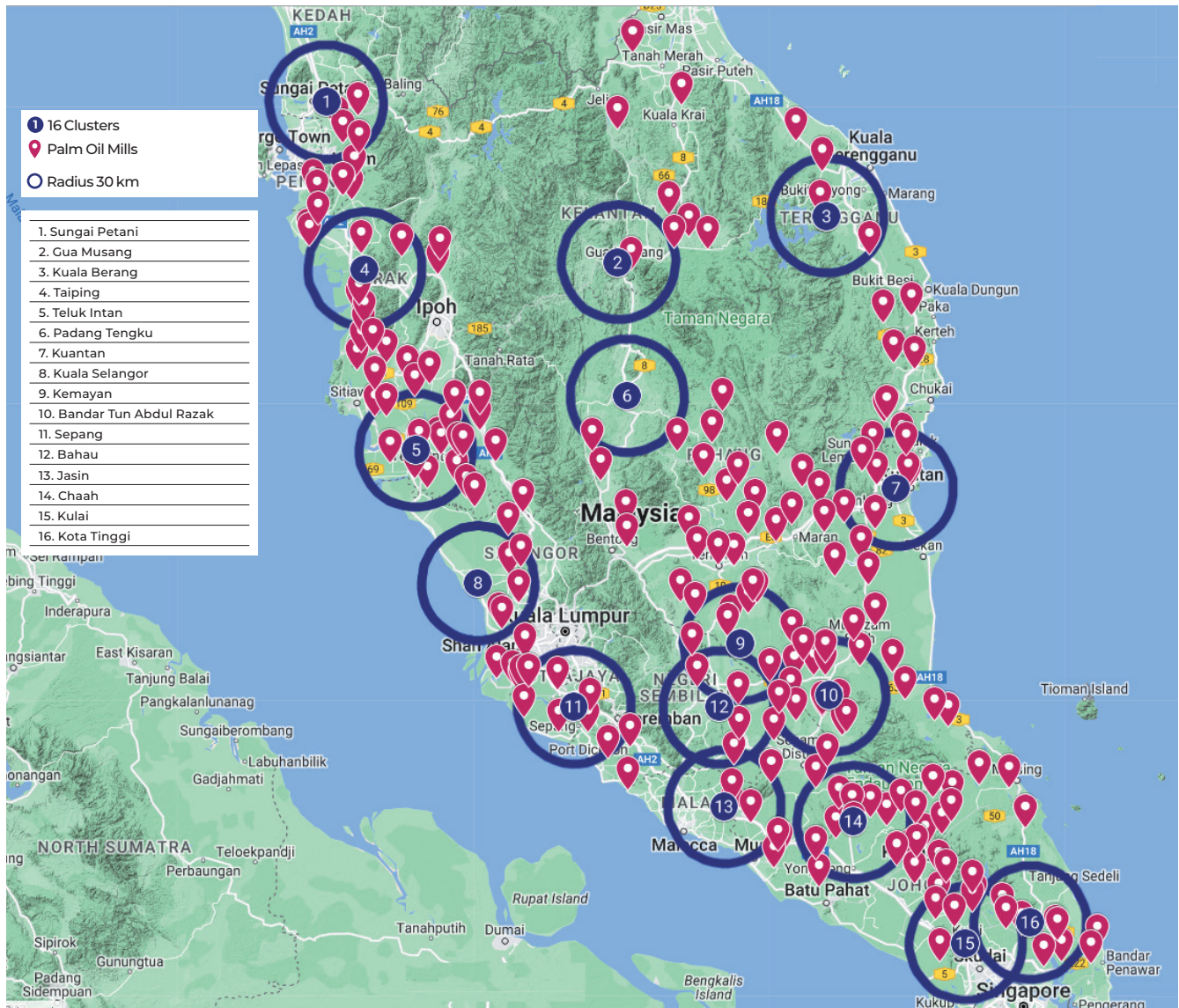
Figure 7.7: Mapping of Palm Oil Mills for the Biomass Hub in Pekan



The proposed oil palm biomass collection and processing centre in Pekan is surrounded by many palm oil mills within a 25 km to 100 km radius. The concept of a biomass hub is expected to set a new milestone in biomass industry development in Malaysia.

Oil Palm Biomass Clusters in Malaysia

**Figure 7.8: Oil Palm Biomass Clusters in Peninsular Malaysia
(For Potential Grid-connected Biomass Plant)**



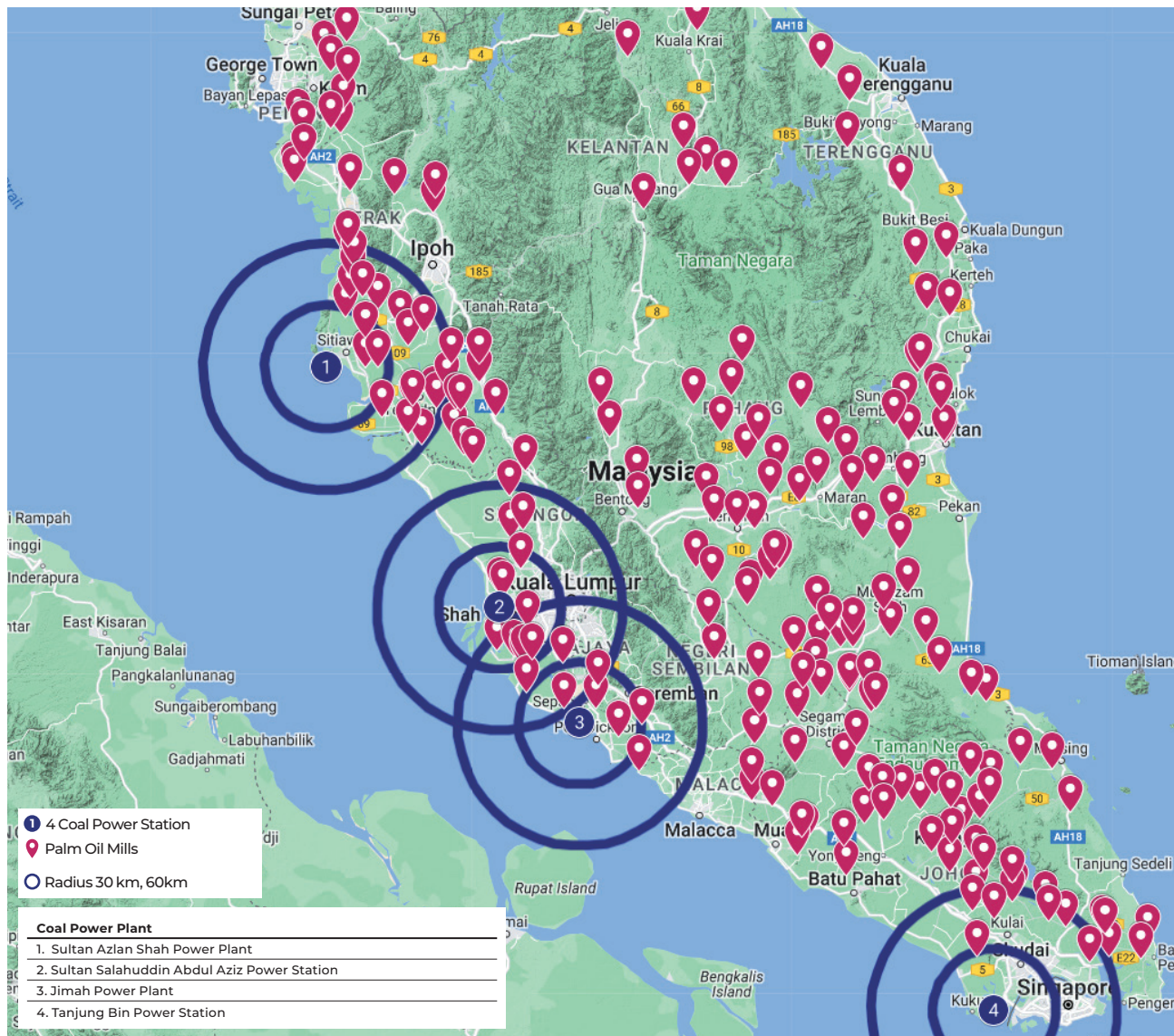
Source: MyRER & Consultant's Research

The above-mentioned biomass clusters are highlighted in the SEDA's Malaysia Renewable Energy Roadmap (MyRER) 2035 due to the locational advantages of palm oil mills and grid substations to support the biomass renewable energy development under the FiT initiatives. This study has integrated the availability of EFB data furnished by MPOB and to match with the outlined biomass clusters. It is observed that zones of Gua Musang, Padang Tengku and Kuala Berang have less EFBs resources now vis-à-vis MyRER findings which were derived a few years ago.

Nevertheless, the above mapping provides a bird's eye view on the EFB availability in biomass clusters identified by MyRER. Hence, interested biomass project developers such as EFB pellets and biofertiliser producers can also use the aforesaid information to assess the feasibility of their biomass projects whether to form joint ventures with palm oil mills or direct feedstock procurement.

Potential Biomass Cluster's to Support Biomass Co-Firing Initiatives

Figure 7.9: Potential Biomass Clusters In Peninsular Malaysia to Support Biomass Co-Firing Initiative

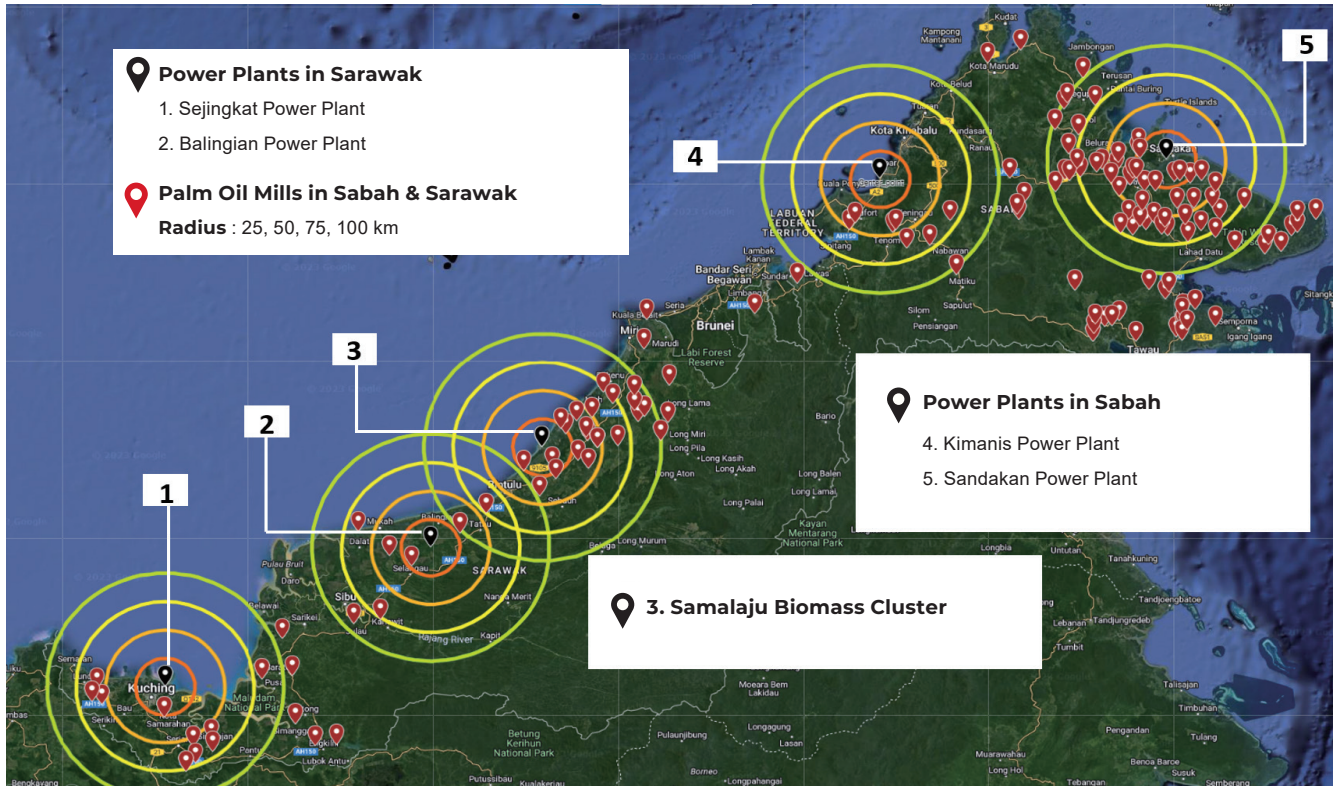


Source: Consultant's Research

By analysing Malaysia's coal-fired power plant distribution, the Perak biomass cluster near Sultan Azlan Shah Power Plant (SASPP) showcases the potential for the national biomass co-firing drive. SASPP, Malaysia's largest coal power plant, aligns strategically with biomass feedstock availability criteria, ideal for biomass co-firing. The locale boasts 25 palm oil mills, capable of supplying 420,000 tonnes of EFB pellets annually.

Simultaneously, Tanjung Bin Power Plant's biomass co-firing initiative, outlined in the National Energy Transition Roadmap launched in July 2023, is set for a 2024 pilot run phase. The phase aims to augment biomass co-firing capacity, targeting a 15% minimum by 2027.

Figure 7.10: Biomass Clusters In Sabah & Sarawak to Support Various Business Models



Source: Consultant's Research

For Sarawak and Sabah, a further feasibility study is recommended for Sarawak Energy Bhd and Sabah Electricity Sdn Bhd to assess the energy economics of using EFB pellets in the context of biomass co-firing or renewable energy export initiative in Borneo which can leverage on the ongoing biomass database development initiative championed by MPOB.

In Sarawak, the promising biomass cluster with underutilised EFBs is Samalaju area (part of the Sarawak Corridor of Renewable Energy) which is a potential location for the setting up of biomass hub to address industrial need of bioenergy or bio-based products such as EFB pulp and paper, biofertiliser etc. It is further observed that the three CFPPs in Sarawak are surrounded with only a few palm oil mills. Hence, the quick win feasible business models are to undertake captive power models through biomass boilers fueled by shredded EFB or EFB pellets, EFB pellets export to Japan, biofertiliser projects as well as biomass power plants integrated with renewable energy export initiative to Brunei Darussalam, Indonesia and Singapore.

Whilst in Sabah, oil palm biomass has been used as green fuel for generating bioenergy under FIT, self-generation and co-generation practices with total installed capacity of 221 MW which outperforms both Sarawak and Peninsular Malaysia. Nonetheless, Sandakan Power Plant can be considered for biomass co-firing as the biomass cluster is blessed with many palm oil mills with underutilised EFBs. Soon, more affirmative actions are foreseen to take place which will unlock the potential in Borneo especially the emergence of various business models pillared on ESG agenda.

The Way Forward

Current Stage (2023)

Early Planning Stage of Oil Palm Biomass Collection & Processing Centre (CPC)

Desired Stage (2030)

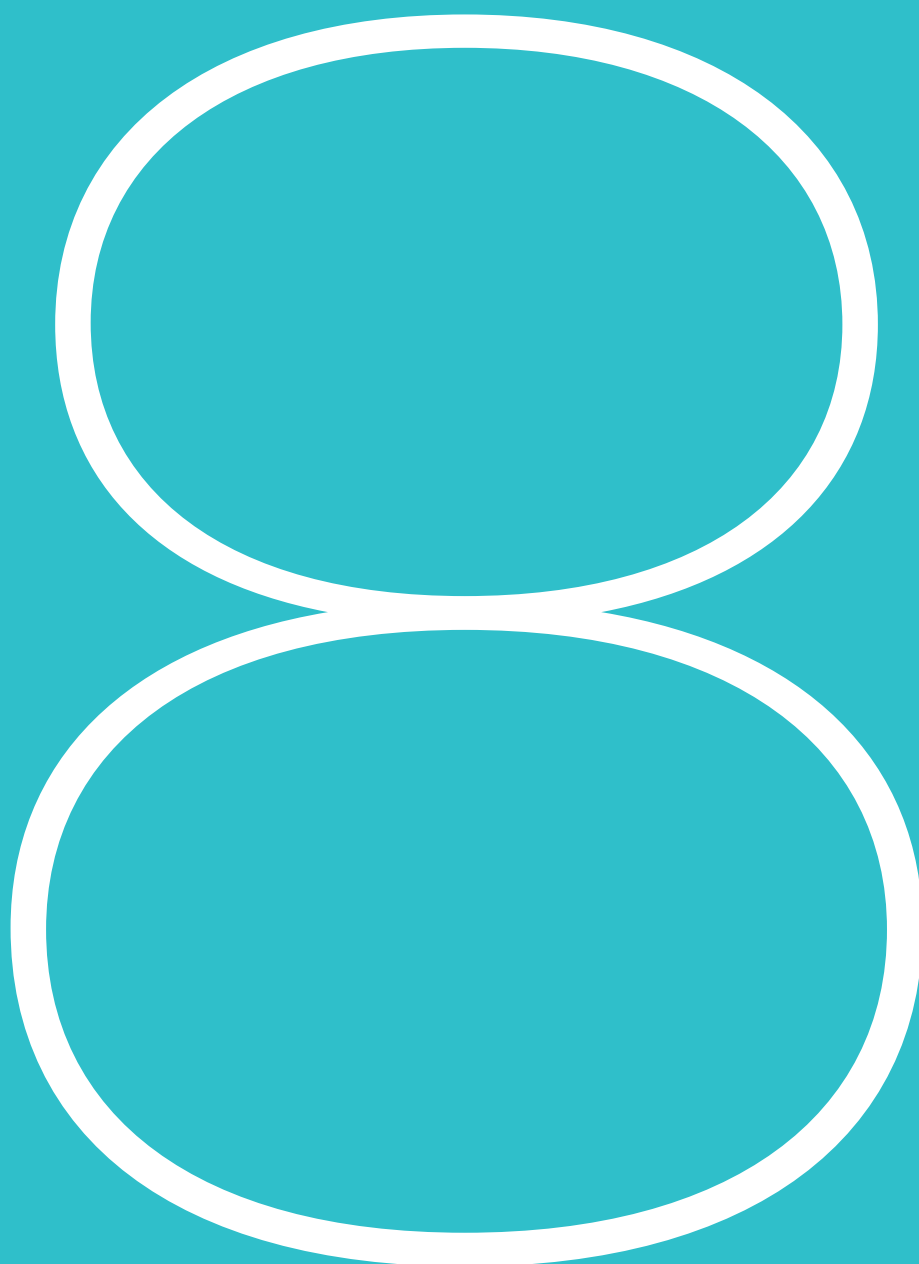
Facilitate potential industry partnerships from local biomass stakeholders including plantation companies, palm oil mills or multi-national corporations such as those from Japan to participate in the biomass hub as project developers, investors, traders, or technology partners and biomass R&D&C&I collaboration.

The biomass hub serves as a role model, exemplifying the realisation of circular economy models for palm biomass, acting as a precursor to KPK.

Conversion of other biomass clusters in Malaysia including those in Sarawak and Sabah to be scaled up as Biomass Collection and Processing Centres (CPC) to be facilitated by the Ministry of Plantation and Commodities (KPK), Sarawak and Sabah Governments.

Chapter

**The Way Forward
and Action Plan**



The Way Forward & Action Plan

Realising the development potential of biomass will involve a wide range of strategies :-

a) Feedstock Availability:

Feedstock utilisation options, procurement strategies, collection, processing and logistical consideration

b) Technology Driven Business Models:

Cascading use of biomass to the best circular economy model for optimum value creation enabled by viable technologies.

c) Government Support:

Government facilitative enablers in the context of policy, legislative and regulatory measures, soft loans, tax incentives, grants or subsidies will spur the industry development.

d) Access to Finance:

Improving knowledge gap for biomass project developers to raise funds along the business life cycle; familiarise bankers with various biomass business models through capacity building

e) Research & Development & Commercialisation & Innovation (R&D&C&I):

Focus on quick win innovative biomass R&D&C&I with immediate commercialisation potentials

f) ESG Factors:

New orientation adopted by both the public and corporate sectors will drive market demand sustainably for bio-energy and bio-based products

g) Multi-stakeholders Partnership:

Collaboration across government, feedstock owners, technology providers, off-takers, financiers and MSMEs.

h) Human Capital:

Capacity development of entrepreneurs, technical professionals, financiers as well as government officers will drive the growth of the biomass industry

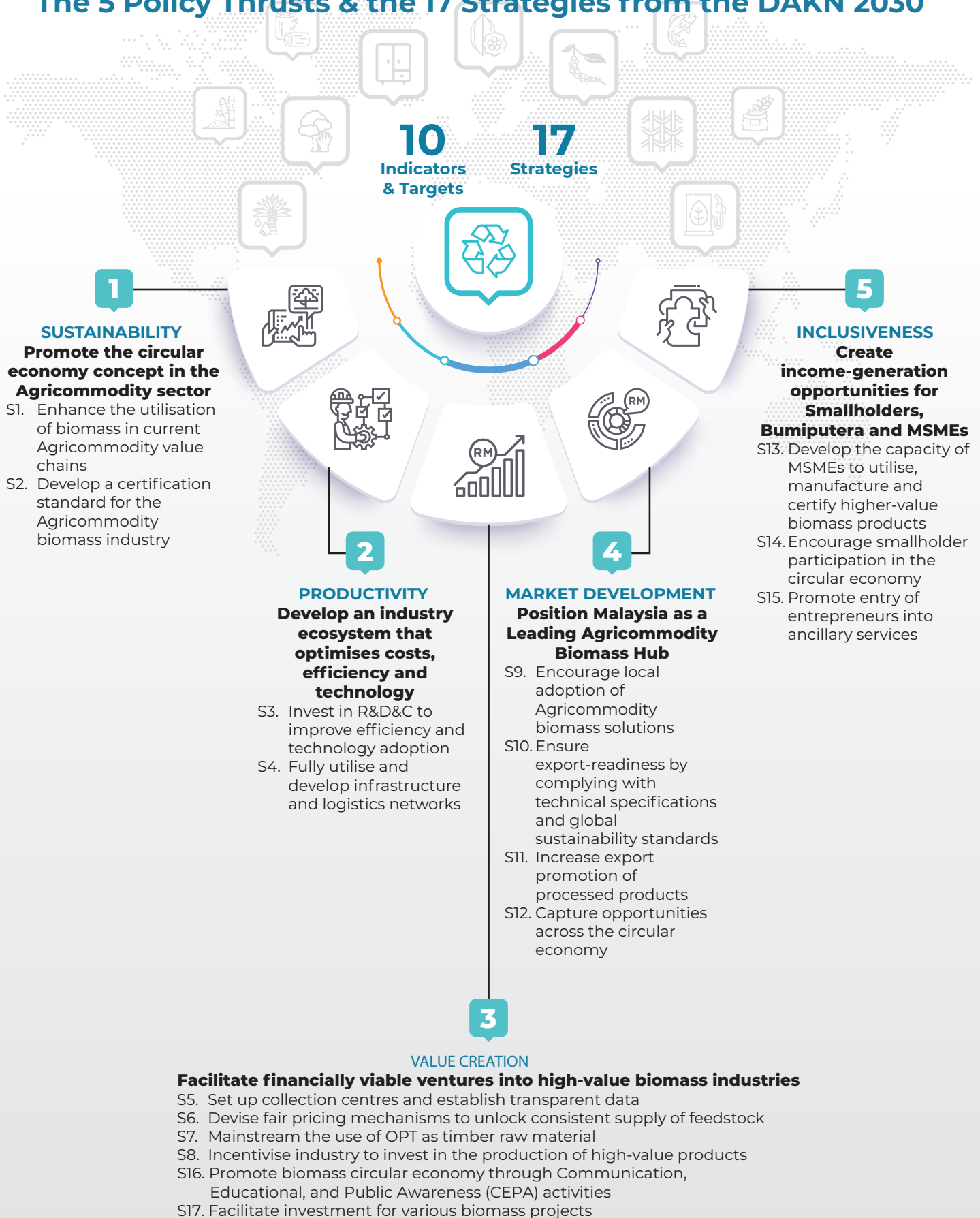
The Ministry of Plantation & Commodities (KPK) will coordinate the development of biomass industries at the Ministry-level with the participation of various ministries and government agencies in the context of the National Biomass Action Plan (NBAP) 2023 – 2030. This action plan has outlined various proposed implementable strategies and defined suitable targets and key performance indicators (KPIs) which are aligned with the **Framework outlined in the DAKN 2030 for the Biomass Sector, encompassing its 5 Policy Thrusts and 17 Strategies**. It also takes into account of other significant policies including the 12th Malaysia Plan, National Biotechnology Policy 2.0, National Energy Transitional Roadmap, National Energy Policy 2022 – 2040, National Agrofood Policy 2021 – 2030 etc.

By focusing on the framework, Malaysia can leverage its biomass resources to achieve new economic growth, reduce GHG emissions and enhance energy security while creating new job opportunities and fostering innovation in the biomass sector.

Framework

For the National Biomass Action Plan

The 5 Policy Thrusts & the 17 Strategies from the DAKN 2030



NATIONAL BIOMASS ACTION PLAN

5 Policy Thrusts & 17 Strategies

Policy Thrusts	T1 SUSTAINABILITY	T2 PRODUCTIVITY	T3 VALUE CREATION	T4 MARKET DEVELOPMENT	T5 INCLUSIVENESS	
Strategies	2 Strategies	2 Strategies	6 Strategies	4 Strategies	3 Strategies	Total 17
Actions	7 Actions	10 Actions	17 Actions	8 Actions	9 Actions	51
Quick Win	1	-	4	1	-	6
High Impact	6	7	9	7	2	31
Entry Point	-	3	4	-	7	14

Cross-cutting Enablers

- Feedstock Availability
- Policy & Regulations
- Financing and Investment Incentives
- Research & Development & Commercialisation & Innovation
- Technology & Business Models

Key Outcomes

- Reduce key imported commodities (fuel, feed, fertilisers etc) using local biomass resources
- Accelerate exponential scale-ups through biomass R&D&C&I
- Drive growth of investment in biomass sector for both domestic and export market



Social-economic Impacts

- Increased in GDP
- Jobs creation and job multipliers
- Increased in circular economy investment
- Social well-being of MSMEs smallholders and Bumiputra
- Reduced GHG emissions & environmental impacts

Conclusion

The National Biomass Action Plan (NBAP) 2023 to 2030 has presented a comprehensive analysis of crucial data and findings concerning biomass ecosystems in the five focal sectors.

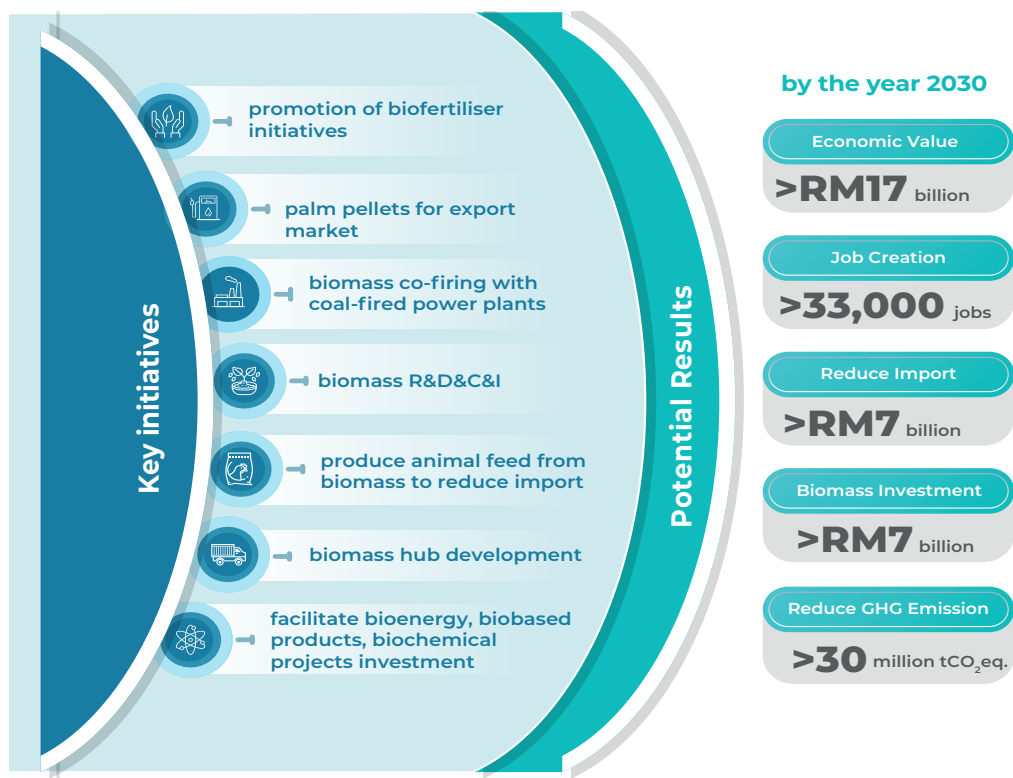
The plan includes five key enablers that enhance and facilitate the rapid advancement of the biomass industry. These include feedstock availability, policy and regulatory frameworks, financing & investment incentives, viable business models, as well as research and development, commercialisation and innovation efforts. The proposed actions are pragmatic and implementable, having garnered support from relevant stakeholders and involve the concerted efforts of key ministries and agencies.

Successful implementation of this plan can result in substantial economic benefits. By 2030, it is projected that the plan could contribute to a remarkable RM17 billion economic value, a potential RM7 billion investment in biomass projects and the creation of approximately 33,000 jobs.

The plan envisions significant breakthroughs, including the execution of relevant government initiatives for blending biofertilisers to encourage their usage, converting empty fruit bunches into energy pellets for export or co-firing with coal power plants, potential commercialisation of high-value graphite and activated carbon, utilising biomass as animal feed for reducing reliance on imported feed and developing biomass hub.

The way forward is the actualisation of the action plan which contains transformative strategies. Let us work in unison to harness the vast biomass business prospects to spur GDP and its spin-offs, viz job creation, developing MSMEs and enhancing Bumiputera participation. Ultimately, the overarching goal is to elevate the nation's contribution towards reducing global greenhouse gas emissions and mitigating climate change.

Figure 8.1: Potential Results of the National Biomass Action Plan





T1. SUSTAINABILITY

Promote the circular economy concept in the Agricommodity sector

S2. Develop a certification standard for the Agricommodity biomass industry

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Targets	
			2025	2030
MSPO-COC of Oil Palm Biomass To promote adoption of Malaysian Sustainable Palm Oil (MSPO) Chain of Custody (CoC) which ensures traceability of biomass products, to be embraced by palm pellets producers. QW	Percentage of palm pellet producers certified with MSPO-CoC of oil palm biomass	MPOCC, MIDA, MATRADE, SME Corp	> 50% palm pellets producers to be certified with MSPO-CoC of oil palm biomass	100% palm pellets producers to be certified with MSPO-CoC of oil palm biomass



T3. VALUE CREATION

Facilitate financially viable ventures into high-value biomass industries

S16. Promote biomass circular economy through Communications, Education and Public Awareness (CEPA)

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Targets	
			2025	2030
Biomass MSMEs Financing Training Address biomass industry's issues to access financing through the conference and specific training session for MSMEs. QW	Number of biomass MSMEs attended the training session	IMPAC, MGTC	> 100 biomass MSMEs	-
Green Financier Training Build the capacity of financial institutions to be familiarised with biomass circular economy models, improve the knowledge cap of bankers and enhance bankability of various biomass projects. QW	Number of training session organised Number of green financiers benefited	IMPAC, MGTC	> 2 training sessions Engage > 40 bankers representing > 20 financial institutions	-
NBAP Launching Launching of the National Biomass Action Plan (NBAP) 2023 – 2030 at the National Biomass Conference 2023-2024. QW	Number of media reach	KPK	Reach > 1 million engagement viewers/ reach through media reporting	-

S16. Promote biomass circular economy through Communications, Education and Public Awareness (continue)

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Targets	
			2025	2030
National Biomass Conference Organise the National Biomass Conference 2023-2024. QW	Number of participants	KPK	> 200 participants	-



T4. MARKET DEVELOPMENT

Position Malaysia as a Leading Agricommodity Biomass Hub

S9. Encourage local adoption of Agricommodity biomass solutions

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Targets	
			2025	2030
Booster Liquid Fertiliser To assess the potential of applying booster liquid biofertiliser made of fishery waste to increase the crop yield of high value agricultural commodities such as chili, Japanese muskmelon, curry leaves through a partnership off-taker programme with the booster liquid biofertiliser producer and participating farmers. QW	Status of feasibility study on business model analysis focusing on production increment, cost reduction and raising farmers' income, etc	KPKM, DOA, MARDI, DOF	Complete > 1 feasibility study	-

S10. Ensure export-readiness by complying with technical specifications and global sustainability standards

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Targets	
			2025	2030
Biomass MSMEs Capacity Building To address new market barrier imposed by the EU such as the EU Deforestation-free Regulation (EUDR) and Carbon Border Adjustment Mechanism (CBAM) through relevant capacity building programmes (CBP) for Malaysian biomass MSMEs. HI	Number of modules introduced Percentage of biomass companies attended the CBP	IMPAC	> 1 comprehensive training module of CBP > 20% of the companies in the biomass industry	- > 50% of the companies in the biomass industry

S12. Capture opportunities across the circular economy

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Targets	
			2025	2030
Bio-energy Feasibility Study Conduct the feasibility study for palm oil mills with excess bioenergy capacity under existing co-generation practices to export to the national grid. HI	Status of feasibility study	SEDA	Complete > 1 feasibility study	-
Fish Waste Utilisation Assessment Evaluate the current practice of converting fish waste into fish meal in relation to responsible and sustainable fishing practices. HI	Status of social impact study	Department of Fisheries (DOF)	Complete > 1 social impact study	-



T1. SUSTAINABILITY

Promote the circular economy concept in the Agricommodity sector

S1. Enhance the utilisation of biomass in current Agricommodity value chains

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Targets	
			2025	2030
<p>Decarbonise Electricity Supply Decarbonise electricity supply through biomass co-firing initiatives with palm EFB pellets combusted by utility scale power plants in Malaysia. HI</p>	Percentage of biomass pellets blending in co-firing initiative	Ministry of Economy, NRECC, KPK	> 1% blending rate	> 5% blending rate
<p>Biomass Co-firing Incentive Formulate incentives for retrofitting coal-fired power plants for co-firing with biomass and design special investment incentives to expedite the development of new EFB pellet plants in the context of national biomass co-firing. HI</p>	Enhanced incentive	MIDA, MOF	Expand Energy transition incentives by the percentage of biomass pellets in co-firing	-
<p>Biomass Co-firing Financing Mechanism Conduct a study to assess innovative financing mechanisms using various options to support the national biomass co-firing initiatives. HI</p>	<p>Status of the study to assess the financing mechanism</p> <p>Status of the implementation and the review of the new financing mechanism</p>	Ministry of Economy, NRECC, KPK, MOF	Complete > 1 assessment study to finalise the financing mechanism	-
<p>Biofertiliser Legislation Increase the use of biofertiliser in agriculture farming and plantation activities through legislative measures. HI</p>	<p>Affirmative action of national biofertiliser initiative switching to use bio fertiliser, to be included in the Fertiliser Bill</p> <p>Percentage increase in the utilisation of biofertiliser</p>	KPKM, KPK, MPOB, DOA	Affirmation of legislative provision in the Fertiliser Bill	-
			> 20% increase	> 30% increase

S1. Enhance the utilisation of biomass in current Agricommodity value chains (continue)

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Targets	
			2025	2030
Biofertiliser Assistance Programme (Oil Palm) Increase biofertiliser usage under the existing Fertiliser Assistance Programme for agricommodity through biofertiliser producers certified with MS 1517. HI	Percentage of increase in biofertiliser subsidy allocation	KPK, MPOB	> 20% increase	> 30% increase
Biofertiliser Producer Certification Develop certified biofertiliser producers, with certification scheme matching grant reimbursed by SME Corp. HI	Number of biofertiliser producers certified with MS 1517	KPK, KPKM, DOA, SME Corp	> 50% certified biofertiliser producers	100% certified biofertiliser producers

**T2. PRODUCTIVITY**

Develop an industry ecosystem that optimises costs, efficiency and technology

S3. Invest in R&D&C to improve efficiency and technology adoption

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Poultry Feed R&D&C&I Undertake accelerated R&D&C&I on animal feed for poultry farming (broiler / layer chicken) using palm kernel cake (PKC) or other potential biomass. HI	Improved accelerated R&D&C&I result Higher production capacity from the PKC poultry feed business model, supported by successful R&D outcomes and strong market acceptance.	MPOB & Industry Partners	Completion of accelerated R&D&C&I result > 125,000 tonnes of PKC animal feed annually for layer & broiler chicken.	- > 500,000 tonnes of PKC animal feed annually for layer & broiler chicken.
PKS-based Graphite & Graphene R&D&C&I Undertake R&D&C&I for PKS-based graphite and graphene with industry partners for commercialisation. HI	Number of PKS-based graphite & graphene pilot plant Status of the market study for bio-graphite & bio-graphene Number of technologies to be commercialised	MPOB & Industry Players	Complete > 1 pilot demonstration plant Complete > 1 market study.	- - Commercialisation of > 1 technology

S4. Fully utilise and develop infrastructure and logistics networks

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
<p>Regulate Oil Palm Biomass Data</p> <p>Regulate the oil palm biomass data through MPOB Act 1998 for the purpose of registering availability of various biomass feedstock and processed products such as biofertiliser, animal feed, fuel pellets etc. HI</p>	<p>Status of the new regulations on biomass data registration to ensure the completion of the biomass feedstock database system</p>	<p>MPOB</p>	<p>Implement new regulations on the registration of biomass feedstock data</p>	<p>Completion of the biomass feedstock database system</p>
<p>MSPO System to Incorporate OPT Data</p> <p>MPOCC to upgrade the MSPO system by incorporating the additional features of oil palm replanting scheme information to capture data of fell OPTs and their utilisation. HI</p>	<p>Status of upgraded system with replanting scheme and OPT data</p>	<p>MPOCC & MPOB</p>	<p>Completion of the upgraded system</p>	<p>-</p>
<p>Biomass Big Data</p> <p>Development of database for oil palm biomass feedstock integrating the existing MPOB's innovation i.e. Oil Palm Resource Information System (OPRIS) and MPOCC's MSPO system. HI</p>	<p>Status of the phased implementation plan for successful biomass data integration.</p>	<p>MPOB & MPOCC</p>	<p>Completion of the phased implementation plan for the biomass data integration</p>	<p>Completion of the database system integration</p>



T3. VALUE CREATION

Facilitate financially viable ventures into high-value biomass industries

S5. Set up collection centres and establish transparent data

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Oil Palm Biomass Hub Development of oil palm biomass collection centre serving as centralised location for the collection, processing and distribution of biomass. HI	Number of biomass hub	KPK, MPOB, MGTC, Industry Partners	> 1 biomass hub	> 5 biomass hub
Unused Biomass Regulation Regulatory enforcement for unused oil palm biomass to be sent for downstream industry utilisation as value-add products. HI	Number of new regulation	MPOB & Industry Partners	The regulation is in place	-

S6. Devise fair pricing mechanisms to unlock consistent supply of feedstock

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Biomass Fair Pricing Mechanism Conduct a study on Fair Pricing Mechanism for sales and purchase of oil palm biomass feedstock. HI	Status of the study Status of the Fair Pricing Mechanism implementation	MPOB	Complete a study	- Completion of the Fair Pricing Mechanism implementation

S7. Mainstream the use of OPT as timber raw material

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
OPT Taskforce Set up an OPT Taskforce mainstreaming the strategic use of OPT to increase its utilisation. HI	Number of collaboration facilitated to access OPT supply	KPK, MPOB, MTIB, Council, Associations	> 3 Joint Venture, MOU or contract facilitated on OPT feedstock supply	> 5 Joint Venture, MOU or contract signed on OPT feedstock supply.
	Percentage of OPT supply facilitated.	MTIB	> 3% OPT feedstock mobilised	> 10% OPT feedstock mobilised
Downstreaming OPT Reserve fell OPTs as raw material for downstream processing industry built on BNM's Climate Change and Principle based Taxonomy (CCPT)'s recommendation which called for financial institutions to ascertain loan applicants (estate owners) of new oil palm replantation scheme (more than 500 hectares) to systematically collect, accumulate and transfer OPT for processing by biofuel producer. HI	Number of actions facilitated to expand the existing OPT Action Plan	MTIB, MPOB	> 1 action introduced to facilitate OPT supply	-
	Total increased quantities of OPT utilisation		> 300,000 tonnes of OPT per annum (dry weight)	> 1 million tonnes of OPT per annum (dry weight)

S17. Facilitate investment for various biomass projects

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Oil Palm Biomass Hub Facilitate investment and development of Biomass Hub. HI <ul style="list-style-type: none"> 20 Oil palm biomass collection & processing centre (CPC) 	Value of investment	MIDA	> RM350 million	> RM350 million

S17. Facilitate investment for various biomass projects (continue)

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Bio-energy Investment				
Facilitate investment and development of various Bioenergy Projects. HI				
• Wood pellet plant	Value of investment	MIDA	> RM100 million	-
• EFB pellet plants production	Value of investment	MIDA	> RM200 million	> RM100 million
• Large scale fuel switching project	Feasibility study	MIDA	> RM350 million	-
• Torrefied pellets plant (2nd phase)	Value of investment	MIDA	> RM150 million	-
• Biogas power plant	Value of investment	MIDA	> RM500 million	-
• Biomass power plant	Value of investment	SEDA	> RM360 million	-
• Bio methanol plant (animal manure)	Feasibility study & value of investment	MIDA	Complete > 1 feasibility study	> RM150 million
Bio-based Product Investment				
Facilitate investment and development of Biobased Products. HI				
• OPT pellets plant for furniture industry	Value of investment	MIDA, MPOB, MTIB	> RM300 million	-
• Animal feed plant (palm biomass)	Value of investment	MIDA	> RM50 million	-
• Biofertiliser plant	Value of investment	MIDA	> RM140 million	> RM200 million
• Pulp & paper plant	Value of investment	MIDA	> RM1.5 billion	-
• Booster liquid fertiliser plant- off taker high value farming project	Value of investment	MIDA	> RM43 million	> RM657 million
• Biobased packaging products	Value of investment	MOSTI, Bioeconomy Corporation	> RM10 million	> RM15 million
Biochemical Plant				
Facilitate investment and development of Biochemical projects. HI				
• Reactivated carbon plant	Value of investment	MIDA	> RM30 million	-
• Graphene and Graphite production plant	Value of investment	ECERDC	> RM430 million	-
• Biochemical plant	Feasibility study & value of investment	MIDA	Complete > 1 feasibility study	> RM 1 billion



T4. MARKET DEVELOPMENT

Position Malaysia as a Leading Agricommodity Biomass Hub

S11. Increase export promotion of processed products

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Biomass Products Export Promotion Facilitate trade delegation for export promotion to potential target countries via potential G2G and B2B collaboration related to biomass products.	Number of MOU, MOA signed	KPK, MIDA, MATRADE	> 5 MOU or MOA signed	> 10 MOU or MOA signed
HI				

S12. Capture opportunities across the circular economy

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Government Green Procurement Affirmation in a new Treasury Circular on Government Green Procurement. Prioritise procurement of biomass products i.e. EFB pulp & paper, biofertiliser, biopackaging products and furniture (palm wood, rice husk biocomposite).	Enhanced adoption of government green procurement	MOF, NRECC, MGTC	Implemented by > 10 government agencies	Implemented by > 20 government agencies
HI				
Biomass as Prioritised Area for R&D&C&I Funding Propose biomass related R&D&C&I projects to be recognised as prioritised area to receive funding from MOSTI funding eco-system.	Number of Request for Proposals (RFP) for biomass projects and number of projects achieve commercialisation	MOSTI	R&D&C&I funding approval for > 5 biomass projects	Achieve commercialisation for > 5 approved biomass projects
HI				



T5. INCLUSIVENESS

Create Income-generation opportunities for Smallholders, Bumiputera and MSMEs

S13. Develop the capacity of MSMEs to utilise, manufacture and certify higher-value biomass products

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
<p>Paddy Biofertiliser</p> <p>Review existing fertiliser formulations and promote utilisation of biofertiliser/micronutrients in paddy plantations to enhance soil/plant growth, rice production and environmental sustainability. HI</p>	Number of biofertiliser and micronutrient programmes for paddy cultivation	KPKM, DOA	> 1 program	> 10 programs
<p>Biomass Smallholders & Bumiputera Participation</p> <p>Conduct a feasibility study on the facilitation of smallholders' participation in the green supply chain of EFB pellets in the context of biomass co-firing through investment in a MPOB-led special purpose vehicle (SPV) and remunerated in the form of preference shares. HI</p>	Status of feasibility study	MPOB	Complete > 1 feasibility study	-



T2. PRODUCTIVITY

Develop an industry ecosystem that optimises costs, efficiency and technology

S3. Invest in R&D&C to improve efficiency and technology adoption

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Reactivated Carbon R&D&C&I Prioritise reactivated carbon R&D&C&I to improve circular economy of bio-based activated carbon. HI	Number of commercialised reactivated carbon plant	MPOB & Industry Partners	Complete > 1 pilot demonstration plant	Complete > 1 commercialisation of reactivated carbon technology
Chicken Manure (Biochar) R&D&C&I Undertake R&D&C&I of chicken manure to produce carbonised products/ biochar as a national pilot demonstration project HI	Number of commercialised chicken manure biochar pilot plant	DVS & Industry Partners	Complete > 1 pilot demonstration plant -	Complete > 1 commercialisation of chicken manure biochar



T4. MARKET DEVELOPMENT

Position Malaysia as a Leading Agricommodity Biomass Hub

S12. Capture opportunities across the circular economy

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Biomass National Technology & Innovation Sandbox (NTIS) Incorporate Biomass Technology & Innovation as a Priority Area under existing Agriculture Cluster in the National Technology & Innovation Sandbox (NTIS) HI	Number of new biomass high value products for commercialisation Valuation of the approved biomass technology companies	MOSTI	> 3 biomass high impact projects to be approved -	> 1 approved project to achieve commercialisation > RM100 million is achieved by nurtured companies



T3. VALUE CREATION

Facilitate financially viable ventures into high-value biomass industries

S16. Promote biomass circular economy through Communication, Educational and Public Awareness (CEPA) activities

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
CEPA Programme Facilitate and promote biomass industry's participation in new ventures and R&Ds focusing on national priority areas through national seminars and relevant CEPA activities. EP	Total audience reached through television & radio programmes, print & social media	KPK	> 1 million reached	> 20 million reached
Key Events Promotion Leverage on existing government-industry event platforms such as PIPOC, IGEM, MAHA, BioMalaysia, MCY etc. to promote the biomass circularity concept to the Rakyat. EP	Number of visitors at key exhibitions	KPK	> 10,000 visitors in each key exhibition	> 10,000 visitors in each key exhibition



T5. INCLUSIVENESS

Create income-generation opportunities for Smallholders, Bumiputera and MSMEs

S14. Encourage smallholder participation in the circular economy

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Cocoa Pod Husk Biochar Undertake pilot trial on utilisations, technical viability and market acceptance of cocoa pod husk as potential carbonised raw materials to produce activated carbon. EP	Pilot testing to produce biochar from cocoa pod husk	KPK, LKM	Complete > 1 pilot testing	-
	Pilot testing on cocoa pod husk biochar to be used as activated carbon		Complete > 1 pilot testing	-
	Number of smallholders producing cocoa pod husk biochar		> 100 smallholders	> 200 smallholders

S14. Encourage smallholder participation in the circular economy (continue)

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Bamboo Biochar Undertake pilot trial on using bamboo as potential carbonised raw materials to produce activated carbon. Once proven, industry users will be determined EP	Pilot testing to produce biochar from bamboo for various applications such as agriculture, water purification, medical, food & cosmetic and carbon plastic	KPK, MTIB	Complete > 1 pilot testing	-
	Pilot testing in bamboo biochar to be used as activated carbon		-	Complete > 1 pilot testing
	Number of smallholders producing bamboo biochar		> 25 smallholders	> 50 smallholders

S15. Promote entry of entrepreneurs into ancillary services

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
Biomass National Occupational Skills Standard (NOSS) Conduct National Occupational Skills Standard (NOSS) programmes to train and certify biomass technicians; formulate NOSS training Models. EP	Number of biomass new training modules	IMPAC	> 5 biomass technical courses developed	-



T2. PRODUCTIVITY

Develop an industry ecosystem that optimises costs, efficiency and technology

S3. Invest in R&D&C to improve efficiency and technology adoption

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
<p>Pineapple Biomass R&D&C&I Undertake R&D&C&I for converting pineapple biomass into high value bromelain and bio-fibre products and assess the commercialisation potential EP</p>	<p>Number of market study</p> <p>Number of commercialised biomass technology</p>	<p>Bioeconomy Corporation, MPIB & Industry Partners</p>	<p>Complete > 1 market study</p> <p>-</p>	<p>-</p> <p>Full-scale commercialisation of > 1 technology</p>
<p>Kenaf Biomass R&D&C&I Undertake R&D&C&I for converting kenaf biomass into high value product and bio-fibre products and assess the commercialisation potential EP</p>	<p>Number of market study</p> <p>Number of commercialised biomass technology</p>	<p>NKTB, Industry Partners</p>	<p>Complete > 1 market study</p> <p>-</p>	<p>-</p> <p>Full-scale commercialisation of > 1 technology</p>

S4. Fully utilise and develop infrastructure and logistics networks

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
<p>Woody Biomass Database Establish a database of processed woody biomass quantities and production capacities of its value-add products such as fuel pellets, charcoal, MDF, particleboard, wood plastic composite. EP</p>	<p>Status of the development of add-on features in the MTIB registration and licensing system</p>	<p>MTIB</p>	<p>Completion of an updated woody biomass database</p>	<p>-</p>



T3. VALUE CREATION

Facilitate financially viable ventures into high-value biomass industries

S8. Incentivise industry to invest in the production of high-value products

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
<p>GITA Biomass Machineries Include relevant biomass machinery and equipment assets such as EFB shredder machines, composting machines, carbonisation machines, briquetting machines, pelleting machines, chain conveyor, bucket elevator, hammering equipment and biomass cutter etc. as eligible items for tax incentive under the Green Investment Tax Allowance (GITA). EP</p>	Machinery and equipment of various biomass assets are listed as GITA assets	MGTC, MIDA & MOF	Increase > 5 Biomass machineries and equipment listed in GITA.	Increase > 10 Biomass machineries and equipment listed in GITA.



T5. INCLUSIVENESS

Create income-generation opportunities for Smallholders, Bumiputera and MSMEs

S14. Encourage smallholder participation in the circular economy

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
<p>Bumiputera Biomass Entrepreneurship Accelerate Bumiputera entrepreneurship development in the biomass industry. EP</p>	Number of seminars	IMPAC, TERAJU	> 5 seminars	-
	Number of Bumiputera entrepreneurs		> 200 Bumiputera entrepreneurs	-

S15. Promote entry of entrepreneurs into ancillary services

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
<p>Biomass Ancillary Services Facilitate service provider to engage in supportive ancillary services with new biomass projects (EFB pellets, biofertiliser, biomass hub etc.) through seminars. EP</p>	Number of entrepreneurs involved in ancillary services	IMPAC	> 200 entrepreneurs	> 300 entrepreneurs



T3. VALUE CREATION

Facilitate financially viable ventures into high-value biomass industries

S7. Mainstream the use of OPT as timber raw material

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
<p>OPT Product Standards</p> <p>Accelerate the development of standards for OPT-based wood products to escalate certification, commercialisation and exports in the global markets. EP</p>	Number of new standard on OPT-based wood products	MTIB, Department of Standard Malaysia	-	> 1 Malaysia & International standard on OPT-based wood products



T5. INCLUSIVENESS

Create income-generation opportunities for Smallholders, Bumiputera and MSMEs

S14. Encourage smallholder participation in the circular economy

Programme / Activities	Measurable Outcomes	Ministries / Agencies	Target	
			2025	2030
<p>Bio-based Accelerator (BBA) Programme</p> <p>1. Oil palm biomass converted animal feed and other bio-based farm input products</p> <p>To facilitate smallholders' participation in the supply chain EP</p>	Number of recruited MSMEs in the supply chain of animal feed and other agricultural products through the BBA Programme using CEPA activities	Bioeconomy Corporation	-	> 200 participants in CEPA activities & > 20 MSMEs participate in BBA
<p>2. Rice straw bio-packaging products development for Paddy Farmers (Commercialisation Programme)</p> <p>To encourage paddy farmers to move up the value chain as vendors or satellite producers of bio-based packaging products. EP</p>	Number of paddy farmers participated in BBA	Bioeconomy Corporation	-	> 100 farmers

Appendix 1:

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Glossary

Abbreviation

ACE	Access, Certainty, Efficiency Market
AEDP	Alternative Energy Development Plan
AES	All Economic Sectors Facility
AF	Agrofood Facility
AIF	Applied Innovation Fund
APP	Implementation and Monitoring Agency
B2B	Business to Business
BAP	Business Accelerator Programme
BBA	Biomass & Biofuel Division, KPK / Bio-based Accelerator Programme
BBB	British Business Bank
BCF	Biotechnology Commercialisation Fund
BCX	Bursa Carbon Exchange
BEIS	Department for Business, Energy and Industrial Strategy
BGF	Bridging Fund
BICEP	Biomass Innovation Circular Economy Programme
Bio-CNG	Bio-Compressed Natural Gas
Bioeconomy Corporation	Malaysian Bioeconomy Development Corporation
BNM	Bank Negara Malaysia
BOD	Biological Oxygen Demand
BPMB	Bank Pembangunan Malaysia Bhd
BRF	BNM Business Recapitalisation Facility
BSF	Black Soldier Fly
BSN	Bank Simpanan Nasional
CAGR	Compounded Annual Growth Rate
CapEx	Capital Expenditure
CBAM	Carbon Border Adjustment Mechanism
CBE	Circular BioEconomy
CBP	Capacity Building Programmes
CCPT	BNM's Climate Change and Principle-based Taxonomy
CCS	Carbon Capture & Storage
CCU	Carbon Capture & Utilisation
CEPA	Communication, Educational and Public Awareness
CFPP	Coal-fired Power Plants
CGC	Credit Guarantee Corporation Malaysia Bhd
CHP	Combined Heat & Power

CIT	Corporate Income Tax
CMTF-i	Commodity Murabahah Term Financing-i
CNF	Cellulose Nanofibre
CNG	Compressed Natural Gas
COC	Chain of Custody
COD	Chemical Oxygen Demand
CPC	Collection and Processing Centres
CPN	Convertible Promissory Note
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
D/E	Debt-to-equity
DAKN	Dasar Agrikomoditi Negara / National Agri-commodity Policy 2021-2030
DFIs	Development Financial Institutions
DKB	Bumiputera Prosperity Fund
DOA	Department of Agriculture
DOE	Department of Environment
DOF	Department of Fisheries
DOSM	Department of Statistics Malaysia
DSD	Department of Skills Development
DSTIN	Malaysian Science, Technology and Innovation Policy
DVS	Department of Veterinary Services
EAM	Export Acceleration Mission
ECERDC	East Coast Economic Region Development Council
ECF	Equity Crowdfunding
EES	Economic-Environment-Social
EFB	Empty Fruit Bunches
EPCC	Engineering, Procurement, Construction and Commissioning
ESG	Environmental, Social and Governance
EUDR	EU Deforestation-free Regulation
FFBs	Fresh Fruit Bunches
FGD	Focus Group Discussion
FIDEC	Fibre and Biocomposite Centre
FIT	Feed-in Tariff
FRIM	Forest Research Institute of Malaysia
FSC	Forest Stewardship Council
GAC	Granular Activated Carbon
GASMSIA	Gas Malaysia Bhd
GDP	Gross Domestic Product
GGL	Green Gold Label
GGP	Government Green Procurement

GGS	Green Growth Strategy
GHG	Greenhouse Gas
GITA	Green Investment Tax Allowance
GITE	Green Investment Tax Exemption
GLCs	Government-linked companies
GTFS	Green Technology Financing Scheme
GTMA	Greentech Malaysia Alliance Sdn Bhd
HTG	High Tech & Green Facility
IBA	Industrial Building Allowance
ICPT	Imbalance Cost Pass Through
ICT	Information and Communications Technology
IoT	Internet of Things
IMPAC	Institute of Malaysian Plantation and Commodities
IPO	Initial Public Offering
IRB	Inland Revenue Board
IRDA	Iskandar Regional Development Authority
IRENA	International Renewable Energy Agency
ITA	Investment Tax Allowance
ITB	Ijarah Thummal Bai' Term Financing
JICA	Japan International Cooperation Agency
JST	Japan Science and Technology Agency
KCAL	Kilocalories
KE	Ministry of Economy
KG	Kilogram
KOOP SAHABAT	Koperasi Sahabat Amanah Ikhtiar Malaysia
KOSETIA	Koperasi Perkhidmatan Setia Berhad
KPK	Ministry of Plantation & Commodities
LCTF	Low Carbon Transition Facility
LEAP	Leading Entrepreneur Accelerator Platform
LKIM	Fisheries Development Authority of Malaysia
LKM	Malaysian Cocoa Board
M&A	Mergers and Acquisitions
MADA	Muda Agricultural Development Authority
KPKM	Ministry of Agriculture and Food Security
MAP	Modern Agriculture Platform
MATRADE	Malaysia External Trade Development Corporation
MBIC	Malaysia Biomass Industries Confederation
MDA	Management Discussion Analysis
MDG	Market Development Grant
MDEC	Malaysia Digital Economy Corporation

MDF	Medium Density Fibreboard
MEF	Micro Enterprises Facility
METI	Ministry of Economy, Trade & Industry
MGTC	Malaysian Green Technology & Climate Change Corporation
MIGHT	Malaysian Industry-Government Group for High Technology
MNCs	Multinational Corporations
MOF	Ministry of Finance
MOSTI	Ministry of Science and Technology and Innovation
MP12	12th Malaysia Plan
MPIB	Malaysian Pineapple Industry Board
MPOB	Malaysian Palm Oil Board
MPOC	Malaysian Palm Oil Council
MPOCC	Malaysian Palm Oil Certification Council
MRC	Malaysian Rubber Council
MSMEs	Micro, Small and Medium Enterprises
MSPO	Malaysian Sustainable Palm Oil
MTC	Malaysian Timber Council
MTCDP	Mid-Tier Companies Development Programme
MTDC	Malaysian Technology Development Corporation
MTIB	Malaysian Timber Industry Board
MW	Megawatt
MyCC	Malaysian Competition Commission
MYRER	Malaysia Renewable Energy Roadmap
NAP	National Agrofood Policy
NBAP	National Biomass Action Plan
NCER	North Corridor Economic Region
NDC	Nationally Determined Contribution
NEA	National Energy Administration China
NGBSB	Nextgreen Biomass Sdn Bhd
NGPP	Nextgreen Pulp & Paper Sdn Bhd
NKTB	National Kenaf & Tobacco Board
NMP	Nutrient Management Plan
NOSS	National Occupational Skills Standard
NPK	Nitrogen, Phosphorus & Potassium
NRECC	Natural Resources, Environment & Climate Change
NTIS	National Technology & Innovation Sandbox
°C	Celsius
OCBC	Oversea-Chinese Banking Corporation
ODA:	Overseas Technical Assistance

OPEX	Operational Expenditure
OPF	Oil Palm Fronds
OPRIS	Oil Palm Resource Information System
OPT	Oil Palm Trunk
OPTL	Oil Palm Trunk Lumber
PC	Polycarbonates
PE	Polyethylene
PEFC	Programme for the Endorsement of Forest Certification
PEMACU	Strategic Technology Driver Fund Programme
PET	Polyethylene Terephthalate
PFI	Participating Financial Institutions
PKC	Palm Kernel Cake
PKE	Palm Kernel Expeller
PKS	Palm Kernel Shell
PLCs	Public Listed Companies
PLN	Perusahaan Listrik Negara
POME	Palm Oil Mill Effluent
POMREQ	National Seminar On Palm Oil Milling, Refining, Environment & Quality
PPBMM	The Malay Rice Millers Association of Malaysia
PPF	Press Fruit Fibre
PUNB	Perbadanan Usahawan Nasional Berhad
R&D	Research & Development
R&D&C&I	Research & Development & Commercialisation & Innovation
RA	Readiness Assessment
RCCPS	Redeemable Convertible Cumulative Preference Shares
RECODA	Regional Corridor Development Authority
REPPA	Renewable Power Purchase Agreement
RHA	Rice Husk Ash
RM	Ringgit Malaysia
ROI	Return on Investment
RSB	Roundtable on Sustainable Biomaterial
RTO	Reversed Takeover
SA	Shareholders' Agreement
SAG	Smart Automation Grant
SATREP	Science and Technology Research Partnership for Sustainable Development
SBP	Sustainable Biomass Programme
SC	Securities Commission Malaysia
SCORE	Sarawak Corridor of Renewable Energy
SCP	Sustainable Consumption & Production

SDE++	Stimulation of Sustainable Energy Production and Climate Transition
SDG	Sustainable Development Goal
SEDA	Sustainable Energy Development Authority
SEDIA	Sabah Economic Development and Investment Authority
SFD	Sabah Forestry Department
SJPP	Syarikat Jaminan Pembiayaan Perniagaan Berhad
SME	Small and Medium-sized Enterprises
SPAC	Special Purpose Acquisition Company
SPV	Special Purpose Vehicle
SRF	Strategic Research Fund
SSM	Company Commission of Malaysia
ST	Energy Commission
STIDC	Sarawak Timber Industry Development Corporation
SUP	Disposable Plastic & Paper
SWOT	Strength-Weakness-Opportunities-Threat
TEKUN	Tabung Ekonomi Kumpulan Usaha Niaga
TGA	Thermogravimetric Analyser
TIM	Trade & Investment Missions
TNB	Tenaga Nasional Berhad
TNBR	TNB Research Sdn Bhd
TOR	Term of Reference
TRL	Technology Readiness Level
UIA	Universiti Islam Antarabangsa
UMS	Universiti Malaysia Sabah
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNITEN	Universiti Tenaga Nasional
UPM	Universiti Putra Malaysia
UTM	Universiti Teknologi Malaysia
VC	Venture Capital
VCM	Voluntary Carbon Market
WCGS-B	Working Capital Guarantee Scheme - Bumiputera
WCGS-SU	Working Capital Guarantee Scheme - Bumiputera Start Up



ACTION PLAN

NATIONAL BIOMASS ACTION PLAN 2023-2030



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