CHALLENGES FOR SUSTAINABLE BIOFUEL INDUSTRY DEVELOPMENT IN INDONESIA AND MALAYSIA: A POLICY RECOMMENDATION

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ABSTRACT: This research will talk about biodiesel specifically from palm oil processing waste, one of the forms of biofuels that will produce bioenergy, which has not only been looked upon globally but has been extensively studied by ASEAN and ASEAN countries, including Indonesia and Malaysia. These two countries are highly relevant to be talked about since they are the leading producer of palm oil and thus also the major producers of the potentially harmful-for-the-environment waste that could be utilized as biomass for biofuel production instead, hence benefited both countries in seizing the increasing global demand. In this research, the current outlook on Indonesia and Malaysia's POME sourced biofuel industry is being looked upon before identifying the challenges on multiple aspects that involve multiple key stakeholders. After finding those gaps or issues, general and country-specific policy recommendations that address the challenges are provided.
Keywords: biofuel, Indonesia, Malaysia, palm oil, policy, sustainability

1 BACKGROUND

Bioenergy (bio-based source energy) is one of the alternatives of renewable energy, commonly used as a heating source, transportation fuel, and electricity, among others. In 2017, renewable energy accounted for 17,7% of global energy consumption, with bioenergy provided an estimate of 70%. Almost half of the energy consumption was in the form of biomass heating, either from residential or industrial sectors, while bioenergy utilization in the transportation and power generation sectors contributed up to 3.1% and 2.1% in the global energy consumption respectively [1].

The main liquid biofuel products are ethanol and biodiesel. In 2019, the global production of liquid biofuel reached 161 billion liters (equivalent to 4 EJ), which comprised 59% bioethanol and 35% biodiesel. Ethanol is produced mostly from corn and sugarcane while biodiesel is commonly sourced from vegetable oils and fats, including wastes such as used cooking oil and converted into fatty acid methyl ester (FAME). The production of alternative biofuels besides FAME such as hydro-treated vegetable oil (HVO) and hydro-treated ester and fatty acids (HEFA) also arises a 6% share in the biofuel production [2].

A report by International Energy Agency [3] suggests that Indonesia took the lead as the global largest biofuel producer by contributing 17% to the global production share. Indonesia's arising biofuel production overtook the United States (14%) and Brazil (12%). The next largest biofuel producers were Germany (8%), France (6.3%), and Argentina (5.3%).

To meet rising biofuel demand from both road transport (especially heavy goods vehicles) and aviation, the biofuels industry has increased its investments in facilities that convert biomass such as waste, residues, and virgin vegetable oils into HVO/HEFA. If all HVO/HEFA plants that were under construction or planned in 2019 came online, global production capacity would triple to more than 22 billion liters annually [2].

Palm oil processing waste has also been extensively studied and reviewed in ASEAN countries such as Indonesia and Malaysia, as the waste is abundant. This significant amount of neglected waste that poses risk to the environment could be maximized as biomass for biofuel production. In Indonesia, 37,816,105 tons EFB and 91,224,865 tons POME were produced in 2020 and the numbers are predicted to rise to 53,904,512 tons EFB and 130,035,387 tons POME in 2030 [4]. Another study suggests that the total of 34 million tonnes of available residues per year in Indonesia could be converted into approximately 7.4 million tonnes of renewable diesel per year. Drop-in biofuel made from sustainably available residues could thus displace approximately 15% of that annual bioenergy demand [5].

Meanwhile, in Malaysia, about 17,980,000 tons of waste from palm oil mill and 31,500,000 tons of POME were generated in 2015. This high number of palm oil waste could be potentially utilized to generate 4784 GWh with a capacity of 542 MW [6]. Further, recent studies on biomass-based biodiesel in Malaysia showed that up to 50.5% FAME yield and 98.1% biodiesel yield could be derived from oil palm empty fruit bunch processing [7]. Rough calculation from this high fuel yield estimated that about 24,5 tons of biodiesel could be produced from palm oil residue and POME.

1.1 ASEAN Biofuel Target

It is projected that a sharp increase in biofuel use enables ASEAN to keep gasoline and diesel consumption in road transport roughly flat, even as total energy demand more than doubles from 2017 to 2040. Thus, the ASEAN countries' target biofuel rises from 5 Mtoe in 2017 to 29 Mtoe in 2025 and 79 Mtoe in 2040 [8].

Meeting such high demand would require strong, systematic support across the supply chain, and further actions are described in the APAEC Phase II. The main objective of these actions is to strengthen and further increase the share of renewable energy use and to accelerate decarbonization in the transport sector as presented in Fig. 1.

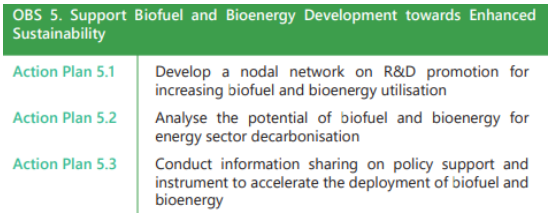

Figure 1: ASEAN outcome-based strategies and action plans for renewable energy 2021 – 2025 [9]

1.2 The Future Potential of Biofuel

As demand in the global biofuel industry continuously increases, growing investment from key biofuel producers as well as policy support from national governmental bodies and ASEAN in regional to stimulate FAME and HVO production growth, it is only natural that the biofuel industry will continue its rise. In 2023-2025, average global output of 182 billion L is projected, with the greatest production increases being for ethanol in China and Brazil, and biodiesel and HVO in the United States and the ASEAN region. Biofuels are expected to meet around 5.4% of road transport energy demand in 2025, rising from just under 4.8% in 2019 [2].

With such targets, needs, and potential, it is even more important for biofuel producing countries to mitigate and resolve all challenges on actualizing a sustainable biofuel industry. In that regard, this research will first understand the current outlook on Indonesia and Malaysia's POME sourced biofuel industry before identifying the challenges on multiple aspects that involve multiple key stakeholders. After finding those gaps or issues, general and country-specific policy recommendations that address the challenges are provided.

2 OVERVIEW

2.1 Indonesia

Indonesia is the leading palm oil producer globally, contributing to 50% of the total world production. Throughout the years, palm oil continuously grew to become one of the most valuable export commodities in the country, growing from US$ 3.4 billion to US$ 17.5 billion in 10 years during 2004-2014 [10]. The huge amount of palm oil production creates the potential for development outside of agricultural purposes. The National Energy Policy was enacted in 2006 through Presidential Regulation No. 5/2006 and formally initiated Indonesia's development towards renewable energy. The policy was passed to maintain energy security, considering Indonesia's heavy reliance on fossil fuels. It also aims to promote a reduction of oil in the national energy mix to less than 20% and instead of increasing renewable energy, including biofuel, to more than 5% by 2025 [11][12]. In line with the proliferation of palm oil plantations, biofuel development also shows significant progress. In 2019, Indonesia's biofuel production reached 8.3 BL and grew by 44% in one year, reaching 12 bL in 2020. Indonesia plans to maintain these efforts in 2021 through the expansion of biodiesel factories and a biofuel production target reaching 16 bL by end of the year [13].

The ambitious biofuel development in Indonesia is driven by supporting policies from the government. From the energy sector, The Ministry of Energy and Mineral Resources (MEMR) through Regulation Number 12/2015 sets biofuel mixing targets to increase biodiesel consumption up to 30% of the total energy consumption from the transport, industry, and electricity sectors by 2025 [14]. In 2017, the National Energy Plan (RUEN) set a target of 23% renewable energy contribution to the national energy mix in 2025 further supporting the fuel diversification target [15]. In line with the policies, Indonesia mandates biofuel blending for B20 in 2018, followed by B30 in January 2020, and has a B40 target for mid-2021.

From the economic aspect, Indonesia sets a tariff for palm oil export-based on CPO reference price through the Ministry of Finance (MF) regulation number 191 /PMK. 05/ 2020. The minimum tariff for CPO export is US$ 55/ton and a maximum of US$ 255/ton while the minimum export tariff for palm oil-based biodiesel is US$ 25/ton reaching a maximum of US$ 192,5/ton [16]. Previously, the export tariff was not set based on the current CPO price.

Environmentally, palm oil development is a highly controversial subject in Indonesia. The Presidential Instruction number 8/2018 initiated a moratorium on new palm oil development, a review of existing plantation permits, and boosting palm oil plantations' productivity [17]. This regulation is valid for 3 years and involves cross-governmental stakeholders to map and identify unclear permits and land tenures to support sustainable palm oil development and biofuel production. The Ministry of Agriculture also requires palm oil plantations in Indonesia to certify for the Indonesian Sustainable Palm Oil (ISPO) which is then continued with Presidential Regulation Number 44/2020 that obliges company-owned or individual palm oil plantations to certify for ISPO [18].

2.2 Malaysia

As one of the largest palm oil producers in the world, Malaysia has been a leading nation in palm-based biodiesel production due to its vast oil palm plantation area. In 2020, Malaysia produced a total of 26,655,394 MT of palm oil products, with a total value of RM 72,766 million [19]. Since 1982, there has been a lot of research on biofuel derived from Malaysian palm oil, particularly winter-grade palm biodiesel.

As of 2019, there are 19 operating biodiesel plants in Malaysia, mostly located in Selangor and Johor [20]. The main policy regarding biofuel production in Malaysia is the National Biofuel Policy (NBP), released in 2006. Following the NBP, the Malaysian government ratified several acts into law regulating the implementation of the policy, including the Malaysian Biofuel Industry Act

2007 [21], National Green Technology Policy 2009, and National Biomass Strategy 2020 [22].

The NBP envisions the use of environmentally friendly, sustainable, and viable sources of energy to reduce the dependency on depleting fossil fuels through five strategic thrusts: biofuel for transport, biofuel for industry, biofuel technologies, biofuel for export, and biofuel for a cleaner environment. A diesel blend of 5% processed palm oil and 95% petroleum diesel, called the B5 diesel, is made available throughout the country for land and sea transport. The biofuel for transport is prioritized in the NBP since this sector is highly subsidized by the government [23].

B5 diesel is also supplied to the industrial sector, including firing boilers in manufacturing, construction machinery, and generators. To enable increased use of biofuel, research, development, and commercialization of biofuel technologies are funded by both the government and private sectors, including venture capitalists. To supply the growing global demand for biofuel, the Malaysian government encourages and facilitates the establishment of plants for producing biofuel for export. Lastly, the use of biofuel will reduce the use of fossil fuels, minimize the emission of greenhouse gases (carbon dioxide), carbon monoxide, Sulphur dioxide, and particulates, therefore enhancing the quality of the environment [23].

The NBP is implemented in three terms: short term, medium-term, and long term. In the short term, the government establishes the Malaysian standard specifications for the B5 diesel. Selected government departments with their fleets of diesel vehicles will participate in trials for using B5 diesel, and B5 diesel pumps at selected stations are established for the public. Voluntary trials on B5 diesel are run by MPOB for selected users in the industrial sector and monitored to enhance acceptance of B5 diesel. To educate the public on the use of B5 diesel, a promotional awareness program is established [23].

In the medium term, the Malaysian government establishes standard specifications for palm oil-based methyl ester biofuel for domestic use and export. Efforts are made to get engine manufacturers to extend their warranties to the use of B5 diesel. The Malaysian government passes and enforces legislation to mandate the use of B5 diesel, and to meet strategic thrust for exporting biofuel, MPOB acts as a catalyst of commercial methyl ester plants establishment by pioneering it in collaboration with the private sector.

In the long term, the diesel blend will be gradually increased and the uptake of biofuel technology by Malaysian companies and foreign companies abroad will be encouraged [23].

Envo Diesel was the first biodiesel product issued in Malaysia. Announced on March 22, 2006, the Envo Diesel consisted of 5% local refined, bleached, and deodorized palm olein blended with 95% of petrol diesel. Palm olein was chosen for blending instead of fatty acid methyl ester (FAME) to reduce production time and cost. However, opposition came primarily from engine manufacturers, since it was claimed that the product would cause clogging to the engine. As a result, the Malaysian government stopped the program and replaced the palm olein with palm methyl ester. The new program was called the B5 Biodiesel Program, officially launched on June 1, 2011 [22].

Malaysia also has a huge potential for the production of other forms of biofuel, especially from oil palm residues. In 2011, about 44 million tonnes of solid oil palm residues and 62 million tonnes of palm oil mill effluent. The solid oil palm residues consist of empty fruit bunch (EFB), shell, and fiber [24]. Research showed that solid oil palm biomass contained considerably similar heating values compared to other lignocellulosic biomass from fast-growing timber species, e.g. A. falcataria, Endospermum spp., Macaranga spp., and Acacia spp. [25]. These solid oil palm biomasses could be used as a fuel using torrefaction as a suitable thermal pretreatment process to enable biomass energy densification and biomass homogenization [26].

3 KEY STAKEHOLDERS

3.1 Indonesia

The palm oil and biofuel industry are interrelated, involving diverse stakeholders in policy-making and shaping the economy. Governmental stakeholders are responsible for developing policies to boost biofuel production while minimizing environmental and social impact. Key government stakeholders include the Ministry of Energy and Mineral Resources (MEMR) which sets biofuels blending targets and quality standards, the Ministry of Finance which controls palm oil and biofuel taxes, along with Indonesia Oil Palm Estate Fund (BPDPKS) which manages palm oil funds allocation. Land and environmental protection are regulated by the Ministry of Environment and Forestry (KLHK) which authorizes land-use change and the Ministry of Agrarian and Spatial Affairs which authorizes land usage for plantations [12].

Non-governmental stakeholders are driving the economy and providing supervision for biofuel or palm oil development including actors such as oil palm plantations (private owned and smallholders), middlemen, biofuel producers, investors, traditional landowners, and NGOs [11]. Smallholder farmers take a crucial role in the national palm oil production as they own up to 42% of the total plantation area. Smallholders are involved in one of the five transactional models in supplying oil palm fresh fruit bunch to companies. These transactional models include small-scale independent farmers (transaction via local agent), larger-scale independent farmers (transaction via local traders or mills), farmer-managed cooperative (direct trade with mills), smallholder farmer-managed plots (linked with company plasma schemes), and company-managed plantations (leasing agreement). Besides CPO processing, private companies also contribute to a large share of oil palm fresh fruit bunch production as the companies own 51% of palm oil plantation in Indonesia. PT Perkebunan Nusantara (PTPN), the state-owned palm oil company, owns 7% of the oil palm area and contributes 9% of the national CPO production [27]. Under the MEMR Ministerial Decree 252.K/10/MEM/2020 enacted in 2020, there are 20 fuel and biofuels companies, of which the majority are private-owned, appointed to process the CPO and supply the national biofuel production [28]. The only national biofuel buyer is the state-owned oil and gas company, PT Pertamina, to fulfill the national biodiesel blending mandate. While the international buyers are big companies such as Sumitomo, Marubeni, Ithocu, and Nestle Oil [29].

3.2 Malaysia

In general, the main stakeholders involved in Malaysian biodiesel production are the Malaysian government, industry players consisting of crude palm oil producers and biofuel producers, traditional land-owners/farmers, and environmental NGOs. These stakeholders play key roles in the implementation of biofuel policy in Malaysia, leading to several challenges due to conflict of interests between these stakeholders.

The Malaysian government regulates the biofuel policy implementation according to the National Biofuel Policy. The Malaysian Palm Oil Board (MPOB) is the government agency in charge of the biofuel policy implementation, under the supervision of the Ministry of Plantation Industries and Commodities. The agency's main role is to promote and develop national objectives, policies, and priorities for the wellbeing of the Malaysian palm oil industry. The MPOB licenses regulate and coordinate all activities related to the palm oil industry. It also provides technical advisory services to the palm oil industry and organizes training and human resource development programs based on the needs of the industry.

Palm oil producers generally own palm oil plantations and produce crude palm oil (CPO) to be used as feedstock for biodiesel production. The CPO is then converted into biodiesel by biodiesel production companies under the Malaysian Biodiesel Association (MBA). Many palm oil producers face opposition from various other stakeholders, mainly due to conflict of the legal status of land ownerships against many individual land-owners, economic welfare of farmers and plantation workers, and environmental issues.

There have been continuous reports on how palm oil plantations disregard the environmental impacts caused by deforestation, water pollution, etc., prompting criticisms and even boycotts from environmental NGOs who point out the importance of environmental sustainability and preservation of biodiversity. Palm oil plantations are also, reportedly, not safe for their workers, especially because of their labor-intensive activities. Women workers face bigger challenges in the palm oil plantations since many of their activities are harmful specifically for women's reproductive health and they often receive lower wages compared to male workers.

4 CHALLENGES

From the identified challenges, it can be concluded that the issues in both countries can be classified into governmental issues, labor rights and/or socio-economic issues, food vs fuel dilemma, and environmental issues.

4.1 Indonesia

4.1.1 Governmental Issues

The development of palm oil-based biofuels in Indonesia is aimed to reduce oil imports and increase renewable energy usage in the national energy mix. Export tariffs collected from palm oil are managed by the Indonesia Oil Palm Estate Fund (BPDPKS) and distributed for various programs including biodiesel subsidies. During 2015-2019, palm oil funds collected amounts to $3.3 billion of which 71% was allocated for biodiesel producers and less than 5% for small farmer [30].

As mentioned before, the biodiesel industry in Indonesia is dominated by private companies, while state-owned enterprises are not directly involved in the downstream industry [31]. On the other hand, private companies also own palm oil plantations thus evoking debates on the palm oil funds usage, which mostly flows to subsidize biofuel producers. Ideally, biofuel development would increase feedstock demands and lift domestic CPO and FFB market prices. Nevertheless, FFB prices did not increase since the implementation of B20 and B30 thus putting small farmers at a disadvantage. Additionally, the COVID-19 pandemic results in a low CPO export thus funding from CPO export levies are not adequate for biodiesel incentives. The government through the National Economic Recovery program issued Rp 2.78 trillion subsidies for the biodiesel industry sourced from the state budget [32]. Contrarily, small farmers do not receive any additional aid for their palm oil production. These issues signify the lacking inclusion of smallholder farmers and state-owned enterprises in biofuel development and renewable energy targets.

Certification such as Roundtable in Sustainable Palm Oil (RSPO) and Indonesia Sustainable Palm Oil (ISPO) are issued as an effort to achieve sustainability in the industry. RSPO focuses more on the buyer's requirement while ISPO concentrates on the country's requirement. Unfortunately, the certification process arises a conflict of interest between the government and stakeholders which brings ISPO's integrity into a questionable position. Smallholder farmers also lack awareness and participation in these certifications as they are not looped in and given information. Further, the government does not provide any subsidy or cost recovery plan to cover the certification cost, making the certification financially inaccessible for the farmers [33].

4.1.2 Labor Rights and/or Socio-economic issues

There is still much room for improvement in Indonesia's palm oil plantations. Small scale palm oil farmers can earn a seventh-time higher pay compared to subsistence farmers thus providing them with better livelihoods [11]. However, smallholders are at risk during price swings as they lack knowledge of good farming practices to achieve high-quality harvest. While the government set the pre-transaction fresh fruit bunch price, the net price paid by the companies is much lower and depends on FFB quality. Transparency in the grading and price calculation by the company has not been practiced and resulted in farmer's inadequate awareness of quality standards and their relation to pricing. Further, typical FFB prices are usually reported on a regional government website and other media. However, these are not always up to date or easily accessible for the farmers, resulting in farmer's weak position to negotiate while transacting with the companies [34]. Thus, capacity building for small farmers in Indonesia is crucial to keep up with the growing demand for palm oil.

Besides the need for structured training, gender discrimination is still evident within palm oil workers. Women workers hold an important role in Indonesia's palm oil production, contributing to 15 out of 16 types of work in palm oil plantations [35]. However, women are usually categorized as casual workers which deprives them of rights given to permanent workers thus exposing them to poor working conditions. Salary or minimum wages, healthcare, training, and capacity building access, leave and holiday are amongst the rights withheld from women workers by the palm oil companies [35][36].

Aside from working, women are also responsible for household tasks that are dependent on access to clean water and firewood, which becomes difficult to acquire due to pollution and deforestation caused by the palm oil industry [36].

4.1.3 Food vs Fuel Dilemma

Another rising issue is the potential of food and fuel competition due to Indonesia's ambitious target for biofuel development. Palm oil produced by smallholder farmers and private companies is widely used for food and cosmetics products that have become daily necessities for a long time. This competition between crude palm oil allocation for biofuel or food/cosmetics products is potentially detrimental to Indonesia's land use. Therefore, to fulfill food and biofuel demand nationally as well as meeting export demands, it is only natural that Indonesia will have to increase palm oil yields. Yield improvement could be a solution to increase production without further damaging the environment or introducing climate risks [10]

4.1.4 Environmental Issue

The development of the oil palm and biofuel industry and the ambitious national target issued by the government have triggered smallholders and companies to expand plantation areas. This has caused 23% of the national forest coverage loss in a 15-year study until 2016 [37]. Deforestation of Indonesia's forests results in biodiversity loss and extinction risks of iconic animals like orangutans, Sumatran elephants, and Sumatran tigers. Since most rainforests grow on peat soil, the destruction of rainforests will further increase Indonesia's greenhouse gas emissions [38]. Further, land conversion into oil palm plantations leads to higher carbon emissions as 25% of the plantation in Indonesia are on peat soils [11].

This issue further brings outcry from NGOs as they urge the government to resolve the adverse environmental impacts related to the palm oil industry as biofuel development practice is not necessarily sustainable. Further aggravated by the government's ambitious target for biofuels that calls for a massive expansion for palm oil plantations, more deforestation and forest fires could occur. Hence, NGOs recommend starting to explore other renewable energy options such as electric vehicles for the future of transportation.

4.2 Malaysia

4.2.1 Governmental Issues

There have been barriers between the Malaysian government and transportation companies to the implementation of the biofuel policy. The Envo Diesel roll-out controversy was one of the major examples of how transportation engine manufacturers influenced the biofuel policy implementation. Moreover, the declining performance of the Malaysian transportation sector also contributes to the dynamics of biofuel policy implementation. In 2015, the performance of the transportation sector decreased by 3.7% due to the economic slowdown [39].

Since the launch of the B5 Biodiesel Program, the Malaysian government through the MPOB has been gradually increasing the blending requirements through issues of governmental mandate. In 2015, the Malaysian government decided to implement the B7 mandate due to the increasing CPO stocks and decreasing CPO prices. However, the goal was not fully implemented until 2016. The effort to increase the blend rate to B10 in 2016 was also not achieved until 2019. These delays of biodiesel blend rate implementation were mainly caused by objections from the transportation industry, mostly related to the high cost of retrofitting vehicles to accommodate higher blend rates [20].

The B20 mandate which was derived from the Eleventh Malaysia Plan (2016–2020) was scheduled to be implemented in early 2020, but with the COVID-19 pandemic causing a significant performance decrease in the transportation sector and the economy in general, the mandate is now delayed until mid-2021. Furthermore, the strict national movement controls and travel minimization caused by the pandemic caused a forecasted decrease of 13.5 percent in domestic transportation fuel consumption [20].

A study showed that the current government incentives and financing mechanisms are insufficient to motivate transportation companies to adopt biodiesel. The unequal subsidies between petrol diesel and biodiesel contribute to the difficulty of biodiesel usage [40]. This is because the production cost of oil palm biodiesel ($0.632/l) is proven to be higher than that of petroleum-derived biodiesel ($0.581/l) unless financial support such as tax exemption and subsidies are implemented to make the biodiesel price more competitive to petroleum-derived diesel [41]. To address this issue, the Malaysian government has attempted to provide financial schemes to make the biodiesel program financially viable. In 2009, the Malaysian government resolved the disparity between biodiesel price (RM2.80/l) and petrol diesel price (RM1.70/l) by subsidizing the B5 biodiesel so the biodiesel was sold at similar prices (RM1.80/l) to petrol diesel [22]. For the current B10 mandate, the Malaysian government uses an Automatic Pricing Mechanism (APM) where the biodiesel price is capped at RM2.18/l [20].

4.2.2 Labor Rights and/or Socio-Economic Issues

One of the most crucial social issues in oil palm plantations is gender inequality. This issue dates to the British colonial era when Indian laborers were imported to mostly rubber plantations. Indian men and women faced economic hardship after they migrated to Malaysia, but the women's challenges were much harder. This was because they were paid less due to assumptions that women were dependents of men and they were expected to provide a steady supply of low-wage labor through reproduction [42].

After Malaysia's independence from the British, the shift to oil palm plantation did not stop the gender issues in Malaysian plantation. The highly labor-intensive work in the oil palm plantation is considered unsuitable for women workers. Women work primarily on maintenance tasks such as spraying pesticides, often with limited access to safety equipment. This type of work is highly unsafe for women since it will lead to reproductive challenges including miscarriages, premature births, birth defects, and low birth weight [42]. In addition, there have also been reports on child labor, especially in plantations in the Sabah area [43].

The welfare of the plantation workers in general, especially foreign workers, is often violated. The abuse of the workers' prosperity often happens due to insufficient legal framework of Malaysian employment laws to protect foreign workers, poor housing conditions,

contract violations, lack of health and safety training, wage fraud, and alleged breaches of OSH requirements by the palm oil companies. Furthermore, despite the increase in land dispute cases filed by native land-owners, their legal and customary rights are still commonly violated [44].

4.2.3 Food vs Fuel Dilemma

Malaysia has made efforts to evaluate the environmental impacts of biodiesel production from several feedstocks, including palm and other non-edible feedstocks such as jatropha, rapeseed, and soybeans. Comparisons between palm biodiesel and biodiesel from non-edible feedstocks are important to address the food vs. fuel dilemma. Palm biodiesel sequestrates CO2 20 times higher than that from jatropha biodiesel. Furthermore, the energy ratio for palm biodiesel is higher than that for rapeseed. The combustion of palm biodiesel as fuel should reduce CO2 emission to 38% per liter of combusted fuel in comparison to petrol. These analyses show that the use of palm biodiesel as fuel is feasible to reduce environmental impact compared to petrol diesel and biodiesel from other feedstocks [7].

4.2.4 Environmental Issues

Despite being a relatively eco-friendly fuel, environmental issues do exist in Malaysian palm oil plantations. Despite the introduction of the Malaysian Sustainable Palm Oil (MSPO) certification system in 2013, there are still environmental issues caused by the plantation system. Palm oil plantations still have the risk of causing environmental problems such as deforestation, biodiversity loss, water pollution, soil erosion, carbon emissions resulting from land-use change and forest fires, and pesticide use [44]. Moreover, the residues from palm oil production will cause significant negative environmental impacts if not treated properly. These issues led to opposition and even boycott attempts to oil palm companies from environmental protection groups since they believed that oil palm plantations caused the major haze pollution in the Southeast Asia region and the extinction of Orangutan, the Borneo island's endemic species [22].

Continuous environmental issues caused by palm oil plantations are mostly due to a lack of law enforcement on environmental law breaches. There is a high risk that the required Environmental Impact Assessment is not complied with due to a poor vetting and monitoring process. This can be caused by a lack of personnel and/or sufficient expertise by the relevant authorities.

5 POLICY RECOMMENDATIONS

5.1 General recommendations

In response to those identified challenges in governmental, social, and environmental issues as well as the food vs fuel dilemma there are few policies or initiatives that could be generally proposed.

- Develop a policy to include small farmers in biofuel production by obligating biofuel producers to obtain a portion of palm oil feedstock from small-scale farmers.
- Setting targets for biofuel production from state-owned enterprises: include state-owned enterprises in the biofuel production roadmap and create a plan for its target contribution to the national biofuel production capacity.
- Ease and promote the implementation of biofuel projects by cutting bureaucracy and provide incentives for enterprises that utilize biofuel in their operation through tax cut
- Enforce laws, policies, and apply sanctions that prohibit deforestation and unsustainable ecosystem conversion
- Demand transparency and accountability from palm oil companies through regular reports on source, usage, labor conditions, and progress on sustainable practices to be provided to specifically appointed bodies
- Ensure an adequate and environmentally responsible palm oil supply through addressing palm oil quality improvement in different types of production units in the country and providing capacity building for small farmers to produce better quality yields in a more efficient manner.
- Create and impose guidelines that protects and acknowledge all workers, male and female, that must be adhered by the palm oil companies with possible non-compliance cost of operation license
- Establish Smallholder database in palm oil industry that maps smallholder groups and their specific issues as a reference to carry out empowerment program and funding allocation
- Increase awareness on certifications and monitor the implementation of such certified practices through government programs and CPO funding
- Provide safety nets and funds for companies' replanting grace periods as well as providing alternative sources of income, subsidies, and training for all workers in such periods.
- Increase changes monitoring on forest coverage and omit any kinds of support, including funds, for deforestation and environmental degradations acts

5.2 Recommendations for Indonesia

- Review the existing funding allocations and prioritize the funding on technologies and systems that advance sustainable market practices
- Escalate investment in infrastructure such as roads, mini mills in rural areas, etc. to increase efficiency in CPO production to prevent post-harvest loss

5.3 Recommendations for Malaysia

- Accelerate downstream industry by increasing R&D to explore high-value downstream product and utilization of biomass hence ensuring consistent and sustainable growth in PO industry despite the limited land availability
- Create and enforce domestic certification to ensure applicable sustainable practices fitting to local context

6 REFERENCES

[1] Statistics, W. G. B. (2019). "World Bioenergy Association: Stockholm." (2019)
[2] Secretariat, R. (2012). Renewables 2020 Global Status Report. Rep Paris: REN12.
[3] Renewables 2020, IEA. (2020). International Energy Agency: Paris
[4] Hambali, E., & Rivai, M. (2017, May). The potential of palm oil waste biomass in Indonesia in

2020 and 2030. In IOP Conference Series: Earth and Environmental Science (Vol. 65, No. 1, p. 012050). IOP Publishing.
[5] Paltseva, J., Searle, S., & Malins, C. (2016). Potential for advanced biofuel production from palm residues in Indonesia. Washington, DC: The International Council on Clean Transportation
[6] Mahlia, T. M. I., Ismail, N., Hossain, N., & Silitonga, A. S. (2019). Palm oil and its wastes as bioenergy sources: a comprehensive review. Environmental Science and Pollution Research, 26(15), 14849-14866.
[7] Rezania, S., Oryani, B., Cho, J., Sabbagh, F., Rupani, P.F., Talaiekhozani, A., Rahimi, N. & Ghahroud, M.L. (2020). "Technical Aspects of Biofuel Production from Different Sources in Malaysia—A Review." Processes, 8(8), 993.
[8] ASEAN Centre for Energy (ACE) & Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ). (2020, November). The 6th ASEAN Energy Outlook. ASEAN Center for Energy.
[9] APAEC Drafting Committee. (2020, November). ASEAN Plan of Action and Energy Cooperation (APAEC) Phase II: 2021 – 2025. ASEAN Center for Energy.
[10] Khatiwada, D., Palmén, C., & Silveira, S. (2021). Evaluating the palm oil demand in Indonesia: production trends, yields, and emerging issues. Biofuels, 12(2), 135-147.
[11] Mukherjee, I., & Sovacool, B. K. (2014). Palm oil-based biofuels and sustainability in southeast Asia: A review of Indonesia, Malaysia, and Thailand. Renewable and Sustainable Energy Reviews, 37, 1–12.
[12] Kharina, A., Malins, C., & Searle, S. (2016). Biofuels policy in Indonesia: Overview and status report. Washington DC, USA: International Council on Clean Transportation.
[13] Asosiasi Produksi Biofuel Indonesia. (2020, November 18). Hingga 2021, Kapasitas Produksi Biodiesel Bertambah 3,9 Juta kL. Aprobi. https://aprobi.or.id/2020/11/18/hingga-2021-kapasitas-produksi-biodiesel-bertambah-39-juta-kl/
[14] Indonesian Ministry of Energy and Mineral Resources, Ministerial Regulation 12 (2015)
[15] Indonesian Ministry of Energy and Mineral Resources, Ministerial Regulation 22 (2017)
[16] Indonesian Ministry of Finance. Ministerial Regulation No. 05 (2020)
[17] Indonesian Presidential Instruction No. 8 (2018)
[18] Indonesian Presidential Instruction No. 44 (2020)
[19] Malaysian Palm Oil Board (2020). "Monthly Palm Oil Trade Statistics 2020." Accessed from http://mpoc.org.my/monthly-palm-oil-trade-statistics-2020/, March 10, 2021.
[20] USDA Foreign Agricultural Service. "Malaysia: Biofuels Annual," Accessed from https://www.fas.usda.gov/data/malaysia-biofuels-annual-3 on March 10, 2021.
[21] Amir F.N. Abdul-Manan, Azizan Baharuddin, and Lee Wei Chang, "Application of Theory-Based Evaluation for the Critical Analysis of National Biofuel Policy: A Case Study in Malaysia," Evaluation and Program Planning 52 (2015): pp. 39-49.
[22] Hon-Choong Chin et al., "Issues of Social Acceptance on Biofuel Development," Journal of Cleaner Production 71 (2014): pp. 30-39.
[23] Malaysian Ministry of Plantation Industries and Commodities, "The National Biofuel Policy", accessed March 10, 2021, https://policy.asiapacificenergy.org/node/1283.
[24] Malaysian Ministry of Plantation Industries and Commodities. "The National Biofuel Policy." Accessed from https://policy.asiapacificenergy.org/node/1283 on March 10, 2021.
[24] Yoon Lin Chiew and Sohei Shimada, "Current State and Environmental Impact Assessment for Utilizing Oil Palm Empty Fruit Bunches for Fuel, Fiber and Fertilizer – A Case Study of Malaysia," Biomass and Bioenergy 51 (2013): pp. 109-124.
[25] K. L. Chin et al., "Fuel Characteristics of Solid Biofuel Derived from Oil Palm Biomass and Fast Growing Timber Species in Malaysia," BioEnergy Research 6, no. 1 (March 2012): pp. 75-82.
[26] K.L. Chin et al., "Optimization of Torrefaction Conditions for High Energy Density Solid Biofuel from Oil Palm Biomass and Fast Growing Species Available in Malaysia," Industrial Crops and Products 49 (2013): pp. 768-774.
[27] Glenday, S., Paoli, G. (2015): Indonesian Oil Palm Smallholder Farmers: A Typology of Organizational Models, Needs, and Investment Opportunities. Bogor (Indonesia): Daemeter Consulting.
[28] Elfadina, E. A. (2021, Januari 4). Daftar 20 Badan Usaha Pemasok Biodiesel di Tahun Kerbau Logam. Warta Ekonomi. https://www.wartaekonomi.co.id/read321134/daftar-20-badan-usaha-pemasok-biodiesel-di-tahun-kerbau-logam
[29] Jupesta, J., Harayama, Y., & Parayil, G. (2011). Sustainable business model for biofuel industries in Indonesia. Sustainability Accounting, Management and Policy Journal.
[30] Jong, H.N. (2020, December 21). Indonesia's biofuel bid threatens more deforestation for oil palm plantations. Mongabay. https://news.mongabay.com/2020/12/indonesia-biofuel-deforestation-oil-palm-plantation-b30/
[31] Margianto, H. (2020, September 10). Program B30 dan Nasib Petani Sawit. Kompas. https://money.kompas.com/read/2020/09/10/115938126/program-b30-dan-nasib-petani-sawit?page=all
[32] LPEM FEB UI. (2020). Risiko Kebijakan Biodiesel dari Sudut Pandang Indikator Makroekonomi dan Lingkungan. https://www.greenpeace.org/static/planet4-indonesia-stateless/2020/11/cc19cf62-laporan-biodiesel-lpem_bahasa-indonesia_final.pdf
[33] Yuliawati, D. (2016). Power dynamic in smallholders' participation in sustainable certification: A case study of Indonesian sustainable palm oil certification.
[34] Bronkhorst, E., Cavallo, E., van Dorth tot Medler, M., Klinghammer, S., Smit, H. H., Gijsenbergh, A., & van der Laan, C. (2017). Current practices and innovations in smallholder palm oil finance in Indonesia and Malaysia: Long-term financing solutions to promote sustainable supply chains (Vol. 177). CIFOR.
[35] Zidane. (2019, September 30). Indonesia: Violence

against Women Workers in Oil Palm Plantations. World Rainforest Movement. https://wrm.org.uy/articles-from-the-wrm-bulletin/section1/indonesia-violence-against-women-workers-in-oil-palm-plantations/

[36] Grantmyre, H. (2015, December 24). Women's role in the Palm Oil Industry in Indonesia. UNDP. https://www.id.undp.org/content/indonesia/en/home/presscenter/articles/2015/12/24/-blog-women-s-role-in-the-palm-oil-industry-in-indonesia-.html

[37] Austin, K. G., Schwantes, A., Gu, Y., & Kasibhatla, P. S. (2019). What causes deforestation in Indonesia?. Environmental Research Letters, 14(2), 024007.

[38] Petrenko, C., Paltseva, J., & Searle, S. (2016). Ecological impacts of palm oil expansion in Indonesia. Washington (US): International Council on Clean Transportation.

[39] Yusoff, M.N.A.M., Zulkifli, N.W.M., Sukiman, N.L., Chyuan, O.H., Hassan, M.H., Hasnul, M.H., Zulkifli, M.S.A., Abbas, M.M. & Zakaria, M.Z. (2020). "Sustainability of Palm Biodiesel in Transportation: A Review on Biofuel Standard, Policy and International Collaboration Between Malaysia and Colombia." BioEnergy Research, 14(1) 43–60.

[40] Zailani, S., Iranmanesh, M., Hyun, S.S. & Ali, M.H. (2019). "Barriers of Biodiesel Adoption by Transportation Companies: A Case of Malaysian Transportation Industry." Sustainability, 11(3), 931.

[41] Ong, H.C., Mahlia, T.M.I., Masjuki, H.H. & Honnery, D. (2012). "Life Cycle Cost and Sensitivity Analysis of Palm Biodiesel Production." Fuel, 98, 131–139.

[42] Reed, R. (2019). "Gender-based Impacts of Labour Migration, Sustainability Challenges and Oil Palm in Malaysia." The Public Sphere, 7(1), 79–90.

[43] Sapienza, S. (February 12, 2013). "Growing Demand for Palm Oil Drives Malaysia to Employ Child Migrant Workers." Accessed from https://www.pbs.org/newshour/show/palm-oil-demand-drives-employment-of-child-migrant-workers.

[44] NEPCon (2017). "Palm Oil Risk Assessment Malaysia – Sabah." Accessed from https://preferredbynature.org on March 2, 2021.