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Regulating Biogas Power Plant from Palm Oil Mill Effluent (POME): A Challenge to Indonesia's Just Energy Transition

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Abstract

Palm Oil Mill Effluent (POME) is a potential source of bioenergy but it is also known as one of the biggest emission's contributor from palm oil industry thus capturing the produced methane (CH4) is necessary in creating a sustainable energy for the environment. This article examines current regulations of generating electricity from POME. The aim is to promote renewable energy deployment in Indonesia in order to support the just energy transitions to a low carbon economy. This study initially looks at the existing regulations by using legal doctrinal and socio legal research. Afterwads, interviews are conducted to the palm oil industry in order to explore potential threats in developing this source of energy. The main findings suggest that there are number of government interventions needed to support the construction of POME based biogas power plant, such as providing a scheme of green loans, adjusting the feed-in tariffs and revising the grid systems, imposing incentives for carbon reduction, and applying the power purchase agreement. In addition, increasing public perception to combat the climate change by moving significantly to a low carbon economy is critical to fostering the 2030's emission reduction target.

I. Introduction

Palm oil has been one of the most prominent agricultural commodity towards national economy. The production of palm oil was started in 1970s and has been rapidly growing ever since 1980s with approximate total area of plantations of 294 thousand hectares (Haryana et al., 2010), and 16.1 million hectares by 2017, including 9 million

hectares of smallholder plantations' areas. Meanwhile, total areas of government plantations has reached 5.15 million hectares (pse.litbang.pertanian.go.id, 2017). The presence of aforementioned land expansion could be expected to produce more products, e.g. industrial and cooking oil as well as biofuel, for domestic use and export (ITPC, 2013). Thus, the value of Indonesia's export from January to September 2020 yields 24.08 million tons, especially from Crude Palm Oil (hereinafter 'CPO') development (ekbis.sindonews.com, 2021). The international markets of Indonesia's palm oil who offer high selling value are namely Europe, India, and China (Douglas Sheil, 2009). Besides, the increase use of CPO in any ingredient elevates the generated number, i.e. 24.08 million tons.

These conditions put Indonesia as the highest palm oil producer with a total production of 25 million tons or equal to 54 percent of overall palm oil production in the world, i.e. 64 million tons. Therefore, in February 2020, Indonesia earned 3.5 billion USD as part of the country's income, respectively. Moreover, the industry has been a paramount factor to the local government in alleviating poverty and employing more workers, as shown by the data from the Ministry of National Development Planning in 2018, by approximately 16.2 million people (Harahap et al., 2019).

Table 1. Area of Several Types of Plantation Commodities in Indonesia

Types of Large Plantation Crops	Plantation Area (Hectares)	
	2019	2020
Palm oil	8559.8	8854.5
Rubber	406.9	375.9
Chocolate	18.0	19.1
Tea	59.8	61.5
Coffee	24.1	21.9
Quinine	-	61.5
Sugarcane	173.9	192.1
Tobacco	0.3	0.1

Source: (Databoks.katadata.co.id, 2021)

The increased area of oil palm plantation and the production of palm oil lead to more waste. The waste is generated from leftovers of oil palm cultivation process as well as the processing industry into CPO hence palm oil has become the biggest biomass source in Indonesia (sawitindonesia.com, 2019). A million hectare of oil palm plantation induces solid and liquid waste, such as 2 tons of fibre, 8 tons of effluent, 3 tons of empty fruit bunch (hereinafter 'EFB'), and 1 ton of shell (Harahap et al., 2020).

The most produced waste among others is EFB, i.e. 23%. Untreated EFB could pollute the environment and emanate pests, i.e. Oryctes sp. A high-priced technology is necessary to treat the waste (Haryanti et al., 2014). In contrary, if the waste is not being handled well, it potentially becomes the source of greenhouse gas (GHG) emission due

to decomposition process. The challenge of palm oil waste management in Indonesia is mostly the improper way in managing the waste traditionally, i.e. let the waste decomposed by nature. Many studies have highlighted that EFB e can be turned into bioenergy, such as biogas, bioethanol, biohydrogen; fuel for steam boilers; briquettes; pellets; etc. EFB can also be converted into high value-added products such organic fertilizers, bioactive compounds, etc.

Palm Oil Mill Effluent (POME) is wastewater palm oil mill generated in a high volume. POME contains high organic materials, and currently remains a major challenge to be tackled. Yet, many studies have reported that, due to tts high calorific value, POME is a potential feedstock for biogas production (Harahap et al., 2019). Utilizing POME biomass in Riau province can potentially generate 90 Megawatt of energy production and reduce emission by 568 thousand tons CO_2/year (sawitindonesia.com, 2019). The number is an aproximate calculations by taking into account the areas of palm oil plantations in Riau, as mentioned by the Central Bereau of Statistics (*Badan Pusat Statistik*, BPS) in 2021, have reached 2.2 million hectares with an estimation to produce 6.5 million tons of palm oil per year and wastewater as of 16.25 million tons/m^3. Looking at the results of these estimates, it is certain that the potential for using bioenergy from POME is enormous, given that Sumatra currently holds the first largest province for palm oil production in Indonesia by almost 70% (Harahap et al., 2019).

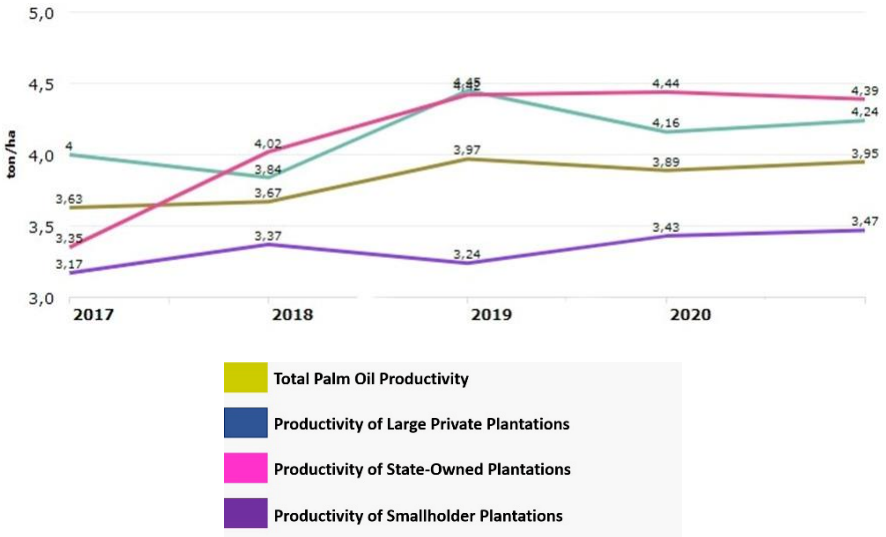

Figure 2. Productivity of Palm Oil Areas in Indonesia (Ton/Ha)

Source: (databoks.katadata.co.id, 2021)

(Translated by Authors)

In order to accomplish sustainable development, Indonesia establishes a regulation, i.e. the Ministry of Agriculture Regulation Number 38/2020. Meanwhile, the Indonesian Government has set a national target of 23% for the New and Renewable Energy (hereinafter 'NRE') mix by 2025, which includes 5500 MWe of capacity in the field

of bioenergy. Target setting of the NRE mix is expected to reduce greenhouse gas emission by 29% in 2030. Currently, Indonesia has non-renewable energy reserves, i.e. conventional natural gas amounted to 142.72 TSCF (as of December 2017) in Papua, East Kalimantan, the Natuna islands, Maluku, and South Sumatra. If the discovery of new reserves is not to be found, yet gas reserves in Indonesia will be extinct in the next 49 years (PLN (Persero), 2019). Similar conditions apply to other non-renewable energy, i.e. coal, as the data shown by Geological Agency of the Ministry of Energy and Mineral Resources entitled the Handbook of Energy and Economic Statistics of Indonesia in 2018, total inventory as of December 2017 was 125.2 billion tons.

Depletion of non-renewable energy reserves in Indonesia requires national policies which address the need of transiotional energy that prioritize climate change awareness and new energy in regard to Paris Agreement. Towards attempting transitional energy, a guarantee of justice is necessary by balancing climate justice, environmental justice, and energy justice as well as focussing on distributional justice, procedural justice, restorative justice, recognition justice, and cosmopolitan justice for every citizen (Heffron & McCauley, 2018). Just Transition is a concept that combines climate justice, which focusses on strengths and weaknesses of climate change towards human activities, environmental justice, which focusses on justice for everyone towards law development, implementation, and enforcement to the environment as well as any environmental regulation and policy, and energy justice, which focusses on the analysis of energy use implementation's impact to every citizen. Just Transition concept is required to determine suitable justice for every citizen when the whole world tries to shift their energy from non-renewable to renewable one and accomplishes zero CO_2 emission (Heffron & McCauley, 2018); (Heffron, 2020). Furthermore, a collaboration of social and natural science as well as technological advancement is needed to achieve it. The shift of energy has been strived in Indonesia by switching from non-renewable energy, e.g. coal and natural gas, to POME bioenergy for attaining Indonesia's NRE mix target by 2035 (Harahap et al., 2020). POME unlocks the possibility for Indonesia to fulfill its target on national bioenergy by 50% and emission's reduction by 40 $MtCO_2$. Besides, it can power 50% of electrical needs in Sumatera if it is utilised for electricity production and grid network can support the electricity transmission. It is advisable to improve the system gradually. In short term, increasing the yields of smallholder plantations is the most appealing approach to maximize local economy's profit from palm oil industry. In long term, the enhancement of electrical network to palm oil factories strengthens its economical value owing to an excess of commercialized electricity.

Due to these circumstances, the research aims to explore the policy options to deploy POME for energy production through the construction of biogas plant. To support the analysis, this study initially looks at the existing regulations. Afterwads, it conducts an analysis of drawbacks on renewable energy development, especially POME in Indonesia. Lastly, the strategy for developing POME as an alternative renewable energy in Indonesia will be presented.

This study combines two types of law researches, i.e. doctrinal law research (Marzuki, 2009) and empirical law research (socio-legal) (Cane & Kritzer, 2012). Doctrinal law research emphasizes the description of current law underpinned on new energy and renewable ones, especially waste energy from POME. Meanwhile, socio-legal research is conducted to examine the adequacy of existing regulational instruments towards POME power plants development in Indonesia by comparing the policy design and implementation. Thus, this study is conveyed through several steps as follows 1) documents analysis on relevant regulations for biogas production from POME; 2) literature study by examining the obtained search information from technical reports, reviews, book chapters, and peer-reviewed research articles that are relevant to the scope of this study; 3) stakeholders interview to gain field data and strengthen the analysis of the study; 4) transcript, tabulated, and categorized the information; and 5) analytical discussions and conclusion.

There are four respondents that have been interviewed, which are palm oil companies who produce CPO as well as various solid and liquid waste, are categorized as follows 1) local palm oil companies whose CPO production capacities are roughly 30-50 tons per hour; 2) palm oil producers whose CPO production capacities are more than 400 thousand tons per year yet do not acquire POME installations; and 3) palm oil producers whose CPO production capacities are more than 400 thousand tons per year and obtain POME installations. This technique gathers necessary information to form synthesis between *das solen*, that investigates the content of regulations, and *das sein*, that focusses on the reality or the actual condition in the field. Therefore, the study gains a thorough analysis about regulations or policies of POME waste energy, the challenges upon the current regulations, and strategy formulation as well as solutions to reinforce biogas resources which intensificated from POME.

II. Regulations on Waste to energy from Pome in Indonesia

In Indonesia, energy policy has been emerged in the Law Number 30 of 2007 entitled Energy. There are at least 8 points highlighted as objectives of energy management based on the Energy Act, as follow: (1) achieving self-sufficiency in energy management; (2) securing the availability and supply of domestic energy, both from domestic and foreign sources; (3) ensuring optimum , integrated, and sustainable management of energy resources; (4) efficient use of energy in all sectors; (5) the accessibility enhancement of energy to the poor and/or those who live in remote areas in order to realize the welfare and prosperity of the people in a fair and equitable manner; (6) the achievement of developing the capacity of the domestic energy industry and energy services to be independent and to increase the professionalism of human resources; (7) creation of job opportunities; and (8) the preservation of environmental functions is maintained. Energy management is very important for the lives of many people. In addition, energy is also a basic need for production activities.

International Energy Agency (IEA) defines energy security as a result of sustainable availabity of energy sources regardsless its affordable price. Energy can be classified into non-renewable energy (such as petroleum, natural gas, coal, turf, and bitumen flakes) and renewable energy (such as hydropower, bioenergy, solar power, wind power). Bioenergy is a renewable energy derived from biomass (Harahap et al., 2020). Article 1 of the Energy Law recognizes bioenergy as one of important source of renewable energy that has to be utilized for the greatest extent of people's prosperity. Considering its sustainability, renewable energy sources has to be the path of energy development in the future. However, renewable energy development will only achieve its sustanability if well-managed. As an example, bioenergy development as biodiesel of palm oil has to be committed to non-deforestation. Other illustration is the utilization of water-based power plants should be constructed in non-conflict areas.

Currently, Indonesia is strongly dependent on the use of coal and petroleoum to operate daily production activities. In fact, in 2018, total production of primary energy, e.g. petroloum, natural gas, coal , and renewable energy, is 411.6 MTOE although 64% or 261.4 MTOE of its total production is exported, especially coal and natural gas. Apart from the export of coal and natural gas, Indonesia imports energy, i.e. crude oil and fuel products as of 43.2 MTOE. It is calculated the total energy consumption (excluding traditional biomass) in 2018 has reached 114 MTOE. The detail of consumptions is as follows: transportation sector uses 40%, industrial sector is 36%, 16% of households, as well as commercial and other sectors are 6% and 2%, respectively. (BPPT, 2019)(BPPT, 2019)Let alone the consumption of coal in Indonesia is expected to continuously arise due to meet the supply for power plants and industrial sector as well as international demand (export) (BPPT, 2019).

Aside from its high non-renewable energy sources' consumption, especially coal, Indonesia has set a target on renewable energy portion as of 23% or equal to 92.2 MTOEby 2030 which its quater or 23 MTOE will be provided by biofuel and by 2050, as of 31% if, assuming a stable economy. Petroleoum usage will decrease as of 25% and 20% by 2025 and 2050, respectively. The same condition applies to the use of coal declines 30% in 2025 and 25% in 2050. Natural gas also plays a role in decreasing the utilization by 2025 and 2050 roughly 22% and 24%, respectively (Traction Energy Asia, 2019). Furthermore, Indonesia has made a commitment to reduce greenhouse gas emission as of 29% by 2030. As part of the initiatives, Indonesia has set 10 priorities for "Making Indonesia 4.0", i.e. material drainage improvement, redesigning industrial area, sustainable accomodation standart of allowing competitiveness opportunities through sustainable trends globally, e.g. EV, biofuel, and renewable energy which has been the priority of Ministry of Energy and Mineral Resources. Regulations on NRE play a significant role in driving the country's economy. In contrast, the presence of regulation has been part of the challenges for investing in the industry thus does not attract investors by far. The aforementioned challenge is mainly due to never-ending discussions prior to the validation in the Energy Commission of Parliament since 2017. As long as improvement

of NRE regulations is not yet to be seen, then the acceleration of clean energy has to be called off. Nevertheless, a set of regulations is needed to gain legal certainty. It is appropriate that NRE Law requires clean energy as the main energy source of every region in Indonesia, thus NRE will become a priority and its new utilization by 11.2% of the total primary can be increased (koran.tempo.co, 2021).

In contrast to Indonesia's neighboring country, i.e. Thailand, the environment of NRE investment set by Thai Government is a semi-open market where private companies produce NRE and the Government distributes the products, new policies are also introduced by the Government to attract investors by elevating the benefits for NRE producers. In 2007, Thailand's legal system carried out the latest regulatory reforms through the establishment of the Energy Industry Law which regulates electrical licensing system. Under the Law, Thailand can generate, transmit, or sell electricity which will obtain a permit from the energy regulatory commission (ERC) which has the authority to regulate in the industry. Thailand relies on the electricity licensing system to liberalize it as power plants and attract private investors to invest (Eiamchamroonlarp, 2018).

Whereas in other neighboring country, Malaysia government provides ample subsidies for all fuels, which included natural gas. The subsidy is amounted to nearly 40 % of fossil gas market price (Poh Ying Hooa, Piera Patriziob, Sylvain Leducb, Haslenda Hashima,Florian Kraxnerb, Sie Ting Tana, 2017). The Malaysian government aims to facilitate the renewable energy (RE) sector by introducing the National Renewable Energy Policy and Action Plan during 2010. 4,000 MW of installed RE capacity is targeted by 2030, with 410 MW biogas capacity. Palm oil mill effluent (POME), agro-based industries and farming industries are identified as potential sources of biogas. (Poh Ying Hoo, et al, 2017). Therefore, the Renewable Energy Act was enforced in 2011 to accelerate contribution from green energy such as solar photovoltaic (PV), biomass, biogas and mini hydro in Malaysia's electricity generation mix. The Act provides for the establishment and implementation of Feed-in Tariff (FiT) special tariff system to catalyse the generation of renewable energy, and the governing authority here is the Sustainable Energy Development Authority (Act 725 of the Renewable Energy Act 2011). Malaysia's Feed-in Tariff (FiT) system obliges Distribution Licensees (DLs) to buy from Feed-in Approval Holders (FIAHs) the electricity produced from renewable resources (renewable energy) and sets the FiT rate. The DLs will pay for renewable energy supplied to the electricity grid for a specific duration (SEDA, 2022). By guaranteeing grid access and setting a favourable price per unit of renewable energy, the FiT mechanism would make renewable energy a viable long-term investment for companies, industries, and individuals.

Nevertheless, despite the fact that POME is non-lethal, there is a concern that economic expansion, environmental protection and sustainable development need to be balanced due to the fact that POME is a potential cause of pollution (Rupani, P.F.; Singh, R.P.; Ibrahim, H.; Esa, 2010). To ensure that this industry remains sustainable and

environmentally friendly, POME needs to be managed properly and cannot directly be discharged into a water body as it can contaminate the water and endanger the aquatic ecosystem (Vijaya, et al. 2010).

In this matter, in Malaysia, the safety and reliability of gas piping or reticulation systems in nonindustrial premises are governed by the Gas Supply Act 1993 (Act 501) and the Gas Supply Regulations 1997, under the purview of the Energy Commission (ST). Act 501 regulates the piping of natural gas downstream of city gate stations or the piping of liquefied petroleum gas (LPG) from the filling point of storage vessels or cylinders up to end user appliances or equipment. Under Regulation 65, Gas Supply Regulation 1997, the main requirements to be complied with before connection is to ensure that no gas shall be taken from the gas main pipeline until an agreement for the supply of gas has been entered into between the parties and the gas installation connected to the gas main pipe has been inspected, tested and found to be safe by a competent person registered with the Director General (Aminullah, et al, 2017).

Sustainable development of renewable gases requires appropriate government policy, legislation, and promotion of renewable energy to mitigate climate change. POME biogas helps the gas industry go green. It is the best way to provide a clean, affordable, efficient, and secure energy source. To use biogas effectively and safely, it must be purified to meet the user's needs. This expands biogas's off-site use. Biogas development must follow standards and legislation to succeed. Standard and law monitor operation and biogas quality. Gas delivery by truck may be cheaper, but has strict road safety regulations. Pipeline gas must meet the local gas company gas quality standards set by the pipeline owner. Poor gas quality could damage gas equipment, which is a justifiable concern. Therefore, strict gas quality monitoring and fail-safe disconnection of biogas from the natural gas pipeline network are likely. Hence, government incentives also encourage palm oil players to use biogas both on-site and off-site. Effective biogas use will boost economic growth and the environment.

Aiming to achieve energy transition, the Indonesia Mining Energy Forum (IMEF) states the needs of Indonesia in creating a new roadmaps national transitional energy started from national energy policies' revision (*Kebijakan Energi Nasional,* KEN) and general plan of national energy transition (*Rencana Umum Energi Nasional,* RUEN). The one recently ensembled in 2017, in fact, focusses on fossil-fuel energy by marking 77% of petroleum, natural gas, and coal as national energy mix in 2025. besides, the plan in 2030 is also dominated by fossil-fuel, which reaches 69% (Bisnis.com, 2021). Those figures are stated in Government Regulation Number 79/2014 concerning National Energy Policy and Presidential Regulation Number 22/2017 on the General Plan of National Energy.

The presence of the Minister of Energy and Mineral Resources Regulation No. 20/2020 concerning the Government's Electric Power System Network Regulation (Grid Code) through PT Perusahaan Listrik Negara (PLN Persero) should be able to optimize power generation from NRE considering its extensive potential in Indonesia. The regulation was established with

the aim of seeking reliable power generation and distribution as well as determining energy transitions to a cleaner and more sustainable direction (Mulyana, 2021). It is in line with the recommendation of the Supreme Audit Board of Indonesia (BPK RI) on the effectiveness of NRE improvement program in national energy mix. However, Indonesia currently only reaches 11.5% of NRE mix, this figure is still very far from the estimated 13.4% in 2020, thus existing regulations must be reformulated to awaken the desire of business actors as well as increase development, especially for NRE.

Indeed, to accelerate the development of NRE, in addition to the regulation on grid code, Presidential Regulation Number 4/2016 in Article 14 about the Acceleration of Electricity Infrastructure has also been established which emphasizes the implementation of electricity acceleration's infrastructure to prioritize the use of NRE and local governments can provide fiscal incentives, ease of licensing, price fixing. buy electricity from NRE, establish a separate business entity to supply electricity which later sold to PT. PLN (Persero) as a support for the provision of electricity. However, the usefulness of these regulations is still questionable due to the fact that PT PLN (Persero) has been experiencing obstacles, e.g. funding for the construction of power plants and electricity networks which solely rely on their internal finances. Loans are quite far from being secured by PT PLN because of their hardship in meeting the reuired credit enhancement due to their questionable solvency.

Other rules related to the development of POME Power Plants are as follows:

1. Government Regulation Number 25 of 2021 on the Implementation of Energy and Mineral Resources, which regulates the supply of electrical energy;
2. Regulation of the Minister of Energy and Mineral Resources Number 39 of 2018 about Electronically Integrated Business Licensing Services in Electricity Sector, which regulates the business of installing power plant services;
3. Regulation of the Minister of Energy and Mineral Resources Number 2 of 2016 concerning the Purchase of Electricity from Biomass Power Plants and Biogas Power Plants by the State Electricity Company (Persero), which regulates the mechanism for purchasing electricity by the State Electricity Company (PLN) considering that electricity is controlled by PLN; and
4. Government Regulation Number 78 of 2019 jo. Investment Coordinating Board Regulation Number 6 of 2018 and Regulation of the Minister of Energy and Mineral Resources Number 16 of 2015, which regulates income tax reduction facilities in certain energy developments, for example biogas power plants with a required investment of at least 30 billion Rupiah with a minimum workforce of 100 people.

These regulations show that the incentivize scheme regulated by the Government is output-based. Incentives will only be given in the form of feed in tariffs and income tax reduction facilities if the company has produced electrical energy. However, there is no incentive or funding scheme that focuses on the development process of the biogas installation. In addition, there has been no technical assistance provided by

the Government, especially if there is palm oil company who wants to build a POME installation with a budget constrant.

A regulation from Indonesian Sustainable Palm Oil (ISPO) as regulated in the Minister of Agriculture Regulation Number 38 of 2020 about the Implementation of Indonesian Sustainable Palm Oil Plantation Certification also does not focus on optimizing the utilization of waste to energy from palm oil waste. On the other hand, the third principle of ISPO, i.e. regarding environmental management, natural resources, and biodiversity, companies are advised to utilize waste as well as allowed to dispose the waste following the byproduct of processed waste as regards environmental quality standards. Therefore, the rules in ISPO have not fully emphasized the use of waste to increase efficiency and reduce negative impacts on the environment.

A. Indonesia's Challenges in Processing and Utilizing Pome

Palm oil in Indonesia has transformed into a prime market. Stiff growth of palm oil Industry's development influences an increase percentage in palm oil production. Besides, palm oil is rocketed country's revenue, e.g. tax revenue. In contrast, palm oil creates large quantity of waste residue from production activities, e.g. shells, fibers, EFBs, and especially wastewater (POME), regardless its immense contribution to the economy and country's revenue. POME, as a byproduct of palm oil industry, is quite underrated to be fully purposeful and might become a threat for the environment if thrown to the drains or river right away, i.e. unprocessed. POME is a liquid waste arises from extraction process of palm oil, i.e. fresh fruit bunch at palm oil companies. Characteristics of POME are as follows:

Table 2. Characteristics of Raw POME

Parameter	Unit	Range	References
pH	–	4–5	[62,63]
Biological oxygen demand (BOD)	mg/L	25,000–65,714	[11,64]
Chemical oxygen demand (COD)	mg/L	44,300–102,696	[63,64]
Total solids (TS)	mg/L	40,500–72,058	[9,64]
Suspended solids (SS)	mg/L	18,000–46,011	[9,64]
Volatile solids (VS)	mg/L	34,000–49,300	[11,65]
Oil and grease (O and G)	mg/L	4000–9341	[9,64]
Ammoniacal nitrogen (NH_3–N)	mg/L	35–103	[11,64]
Total nitrogen (TN)	mg/L	750–770	[11,16]

Source: Chin May Ji et al, 2013

POME potrays a significant role as long as being utilized, e.g. to supply sustainable energy which then contribute to the reduction of greenhouse gas emission by capturing methane and the shift of biogas into electrical energy (ebtke.esdm.go.id, 2018). It is estimated that 33.5% of palm oil plantation in Indonesia is from forestry including peat swamp forest, 26.3% is from bushes, and 34.1% is from agroforestry. Palm oil plantation constitutes 15% of total national emission and mostly from oxidation process of peat swamp plantation due to land clearing, and liquid waste produced by the palm oil mill (Traction Energy Asia, 2019).

Surely, the source of bioenergy raw materials in Indonesia is palm oil, because of its massive plantation's are, i.e. 14 million hectares in 2018, the industry could produce 35 million tons of CPO, 28.7 million tons of POME, and 18 million tons of fibre every year yet its waste is expected to reached 150 million tons/year.

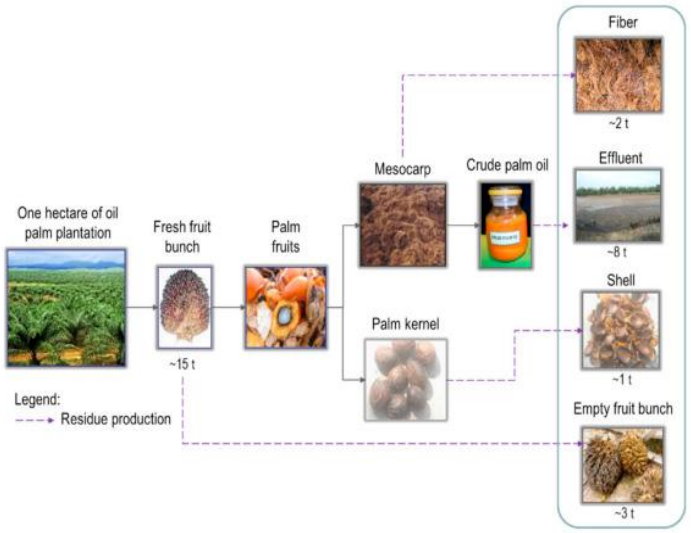

Figure 2. Illustration on Residues Generated from One Hectare of Palm Oil Plantation
Source: (Harahap et al., 2019)

Apart from CPO, Indonesia can actually utilize liquid waste such as POME for POME-based power plants. The pilot project of palm oil utilization as Biogas Power Plant (PLTBg) from POME has been successfully pioneered by PT SEIK/ BPPT located in Pekanbaru, i.e. palm oil company's location owned by PTPN V. The power plant supplys electrical power up to 700 kW which has been distributed through a network facility with a length of 7 km to the location of need in the nearby palm oil mills. As a result of the initiation, POME-based power plant is expected to encourage POME as a renewable energy source that can support electricity supply in Indonesia. PLTBg unit in Pekanbaru employs Covered Aerobic Lagoon (CAL) technology (ptseik.bppt.go.id, 2020).

The urgency of POME management is at its peak owing to three fundamental reasons, namely unprocessed liquid waste can harm the environment especially drains and/or river by throwing it straight away because of its substance will decompose and produce methane emission; provide added value to the availability of alternative fuel sources that produce electricity or as a source of industrial heat (boiler fuel); and control greenhouse gasses (GHG) from CH_4 to CO_2 (Harahap et al., 2019). However, Indonesia is far behind its neighbouring country, i.e. Malaysia, in optimizing the utilization value of POME. Malaysia is the second largest palm oil producer that utilizes POME by creating projects to support green technology

development through a platform called Green Technology Financing Scheme (GTFS) where the Government collaborates with financing institutions or banks to incentivize green projects (Harahap et al., 2019). Therefore, at the end of the day, this program facilitates the company to install their biogas' equipments in Malaysia. On the other hand, Indonesia does not consider such approach yet, i.e. Malaysia's strategy. Biogas development in Indonesia should consider the necessity of POME management along with the increase market demand domestic and internationally for CPO thus its liquid waste is escalated simultaneously. Electricity production based on bioenergy has been set to meet its target as of 5.5 GW by 2025 yet the figure raised in 2018 was only 1.8 GW including 31.8 MW from POME-based power plants which for electrical power or boiler fuel in the mills. Indonesia has nearly 1000 palm oil companies yet it is estimated barely 10% has biogas plant with a total installed capacity of 23 MWe (ptseik.bppt.go.id, 2020).

The lack of new renewable energy's utilization on electricity is cause by its high cost in constructing power plants based on renewable energy thus i tis quite hard to compete with fossil-fuel ones. According to similar researches, insufficient support for local industry in providing components of NRE-plants to the hardship faced in finding available low interest funds (BPPT, 2019). Aforementioned finding is in line with the data obtained in this study which explains palm oil company who has successfully established POME-based power plants is hardly earn additional revenue for the company.

Due to its importance of providing electricity to preserve tenacity and supply of energy, electrical industry, e.g. power plants, transmission, and electrical distributions, should be synergized. Even though the government has broaden electrical accessability in recent years, it is estimated roughly 2500 villages has no access at all to electricity in Indonesia. These villages, which afar from particular locations targeted on national energy distribution, are rural areas that have uneven geographical landscape (Setyowati, 2021).

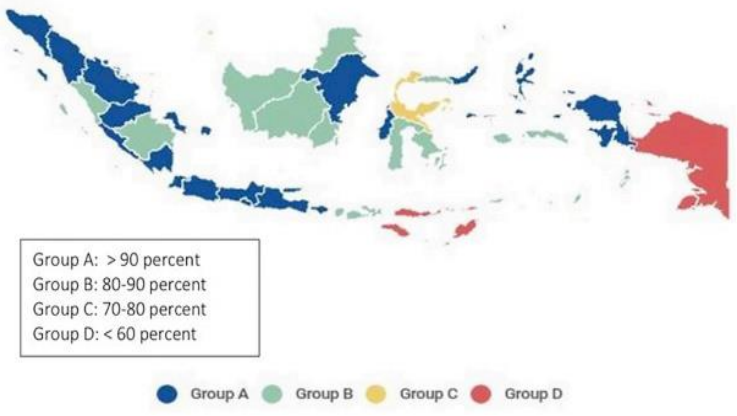

Figure 3. Electrification Ratio in Indonesia in 2017
Source: MEMR, 2018

As illustrated by Picture 3, it can be concluded that the west part of Indonesia, e.g. Java and Sumatra, shows more than 90% has enjoyed stable and reliable networking system of electricity. Conversely, the middle and east part experience power outages and power deficits regularly. The fact that Indonesia has more than 17,000 islands scattered is indeed a challenge in the mission of equalizing energy. Given this problem, the Indonesian government has designed efforts to succeed in equitable distribution of energy by setting a target of 1400 MW renewable energy projects will be developed to meet energy targets. PT PLN (Persero) certainly has a very important role in alleviating energy poverty given that the position of which is strategic in generating, transmitting, and distributing electricity to all regions in Indonesia. The following are the implications and inability to address various elements of justice in an effort to eradicate energy poverty in terms of access to electricity in remote areas.

1. Distributive justice, which means that providing energy that is affordable and accessible to everyone is prioritized over other principles of justice.
2. Procedural justice, which means ensuring that stakeholders participate fully in the energy decision-making process, including in policy steps that bring the livelihood of many people.
3. Recognition justice, which means that the need to ensure equal rights even if they come from different groups or identities. In Indonesia, most people without electricity live in outer islands or remote areas.

Indeed, on paper, Indonesia has a clear vision that embraces the achievement of energy justice, the firmness of providing electricity, a commitment to the construction of new and renewable energy power plants. Moreover, energy justice in Indonesia cannot be accomplished by focusing only on distributive justice or partially, but a comprehensive synergy is needed.

III. Strategies for Indonesia to Support the Utilization of Pome as a Renewable Source of energy

In order to increase a sustainable and low carbon of NRE mix, it is necessary to intensify policies and regulations. As explained in the previous discussion, the use of waste to energy from palm oil waste, especially POME, can have a significant impact on national energy security, reduce GHG, and support the realization of NDC on the Paris Agreement. Therefore, there are several alternative solutions which are formulated as follows:

A. Providing loans to palm oil entities, as an effort to emphasize production development and the use of circular economy of palm oil by occupying green industry. Indonesia can implement a green industry financing scheme which will stimulate palm oil business actors. The loan is a collaboration between the government and financing institutions in providing loans to palm oil

business actors who want to establish a green practice business by enabling a discounted interest. The scheme will be a leading initiative because over the years the government mostly incentivize fossil fuel energy compared to new renewable ones. The funding scheme is expected to help companies financially to facilitate biogas installations at palm oil mills in Indonesia. Moreover, the scheme can imitate the financial assistance scheme that has been implemented by the Malaysian Government by providing benefits to producer companies and companies that build green industries, by offering financing of up to RM 50 million in addition to providing low interest (Chin et al., 2013). This will provide a new innovation in controlling greenhouse gases because it can be a source of income for carbon emitting entities and its application will be more effective in reducing the expansion of GHG emissions.

B. Biogas produced from wastewater treatment or POME can be increased by scrubbing H_2S and CO_2 which is then used in engines for biogas power plants. H_2S and CO_2 must be removed or released because these substances have the potential to cause corrosion and will damage the engine parts of the power plant. Palm oil mills can take advantage of this and will get additional profits for generating electricity to the national electricity grid. Later, the palm oil mill, which has been integrated with the national electricity network, will receive a feed-in tariff (FiT) for a certain period. Additional benefit apart from the added profits to the companies, electricity supply in the area will remain available. Therefore, by implementing the national grid system and FiT, palm oil mills can be more confident about the feasibility of developing the biogas power plant.

C. Another effort that can be done is the implementation of a carbon tax, a carbon tax intended for individuals or entities that buy goods that contain carbon or carry out activities that produce carbon emissions. With the implementation of a carbon tariff scheme of US$5-10/ton CO_2 for developing countries like Indonesia, it seems reasonable given the high tariffs in other countries, with the assumption or scheme of this carbon tax rate, it is possible that the income from this sector can reach 57 trillion (Madaniberkelanjutan.id, 2021). The income from the implementation of this carbon tax can be used to support clean energy programs, reduce taxes, compensate low-income households, and will even restore the fiscal deficit to 3% in 2023. Plus, Indonesia has been named the world's largest palm oil plantation country, because of its plant growth. According to the research of Henson (1999), each hectare of palm oil plantations can absorb 162 tons of CO_2/ha/year, meaning that if the area of Indonesian

palm oil plantations is 14 million hectares in 2018 then Palm oil plantations can absorb around 2.2 billion tons of carbon, so it can be ascertained that the value of palm oil plantation services reaches 600 trillion per year.

D. Optimization of the Power Purchase Agreement (PPA) scheme is a power purchase agreement made by PT PLN (Persero) with Independent Electricity Developers, this is in accordance with the Minister of Finance Regulation Number 77/2011 concerning Guidelines for the Implementation of Business Feasibility Guarantee of the State Electricity Company (Persero) for the Development of Electric Power Generation and/or Transmission Using Renewable Energy, Coal, and Gas Conducted in Cooperation with Private Electricity Developers. This scheme will motivate independent electricity developers because it provides a guarantee of feasible business. This PPA will certainly be the first instrument in attracting private investment because of the electricity purchase agreement was successfully developed by private sector. By far, there has been a regulation that requires PLN to buy electricity according to the availability factor (AF) or capictu factor (CF) at an agreed price whilst private sector is obliged to provide energy according to the contract, then PLN will buy it at the agreed rate. However, setting the price is restricted to the clause in the agreement, there are no guidelines for calculating a fair economic price.

IV. Conclusion

Bioenergy from palm oil processing waste is the largest energy source in Indonesia that can be used as an alternative energy source, i.e. power plant, that supports production activities and daily life. However, power plant development cannot be accomplished without the support of palm oil business actors and the government. On the other hand, if all necessary aspects are mutually integrated, Indonesia's targets set out in the Paris agreement will certainly be achieved soon. By far, the use of POME has not been massively utilized and tends to be processed by disposal after neutralizing the liquid's acidity, but it turns out, at the same time, liquid waste will undergo a decomposition process that produces methane. By using a mixed research approach, it is known that there are still very few palm oil business actors who considers the benefit, not even more than 10% of palm oil mills have a power plant with 23% installed capacity.

Besides, the Government does not regulate the use of methane capture in palm oil companies, thus contributes quite a large number of GHG emissions. Therefore, in line with Indonesia's vision which targets the principle of sustainable plantations, POME is an opportunity to produce biogas in all palm oil mills hence Indonesia's target of achieving a 23% NRE mix in 2035 can be achieved. Therefore, careful planning and use of technological models and implementation of sustainable regulations' support are expected to issue more power plants' installation from

new renewable energy. To achieve this, the Indonesian government can carry out several programs as outlined in the Indonesia vision project in energy distribution, namely by providing loans for palm oil business actors, national grid connection, implementation of carbon taxes and optimization of the PPA.

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