INDONESIAN BIOGAS MARKET: AN OPPORTUNITY ALONGSIDE B100 PROGRAM

Elisabeth Rianawati[1], Saut Sagala[1,2], Andreas Dwiputra[1], Johannes Anhorn[3], Wondwosse[4], Jorge Hilbert[5], Dwight Rosslee[6], Mutala Mohammed[7], Yaseen Salie[8], Felix Colmorgen[9], Wlcek Benhard[10], Mieke Decorte[11], Benhard Stummer[12], Aleksejs Zacepins[13], Frank Hofmann[14], Tara Khaira[15], Shinta Mulyasari[16], Nadiya Pranindita[1], Michael Hananta[1]
[1] Resilience Development Initiative, Bandung – Indonesia
[2] Bandung Institute of Technology (ITB), Bandung 40132 Indonesia
[3] Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany
[4] Iceaddis, Ethiopia
[5] Instituto Nacional de Tecnologia Agropecuaria, Argentina
[6] Selectra, South Africa
[7] Institute for Sustainable Energy and Environmental Solutions, Ghana
[8] Green Cape, South Africa
[9] WIP Renewable Energies, Germany
[10] Austrian Energy Agency, Austria
[11] European Biogas Association, Belgium
[12] Austrian Compost & Biogas Association, Austria
[13] Latvijas Lauksaimniecibas Universitate, Latvia
[14] Fachverband Biogas, Germany
[15] Energi Andalas, Indonesia
[16] Ecody, Indonesia
Resilience Development Initiative
Jl. Imperial II No. 52, Dago Asri, Bandung, Indonesia 40135
(+62) 22 253 6574 rdi@rdi.or.id

ABSTRACT: With the continued growth of the palm oil industry in Indonesia, the Government of Indonesia has been triggered to set up the national targets for new and renewable energy through biodiesel blend mandatory (B100 program). As more solid and liquid wastes will be generated as a result of biodiesel production, it can be converted to renewable energy using biogas plants. Along with the B100 program, the POME-based biogas development seems could be more notable. However, the biogas technology market in Indonesia is still in a nascent state. This study aims to attempt the macro-environmental factors analysis of the Indonesian biogas industry using PESTLE analysis. With the existence of cross-sectional stakeholders, overlapping, and conflicting interests whose policies and actions may cause obstacles that influence the industry, this paper aims to capture the macro picture of the biogas market and identify its challenges alongside the B100 program. It is concluded that barriers for the deployment of biogas come from the political proactiveness which prioritising biofuel over biogas as new energy source, public opposition in term of wage, environment, and risks for indigenous people, lack of experts and success case to prove new technology implementation, and weak and inconsistency of the law enforcement.
Keywords: biogas, palm-oil, market, renewable energy

1 INTRODUCTION

Indonesia is the world's largest Crude Palm Oil (CPO) producer and exporter, with producing over 47.2 million tons and exporting 37.4 million tons of CPO in 2019 (Association of Indonesian Palm Oil Entrepreneurs, 2018). Until 2019, there were a total of 2,056 palm oil plantation companies [47]. 608 of those are designated Palm Oil Mills (POMs), 38 of which are equipped with methane-capture facilities [40] and the remaining 569 are still operating a series of open lagoons. Ten of these POMs have Palm Oil Mill Effluent (POME)-to-electricity projects [4] and only one is connected to the national power grid [46]. Currently in Indonesia, as of 2018, there are more than 850 palm oil mills, it is estimated that less than 10% of those palm oil mills utilizes biogas plants with a total installed capacity of 23MWe [45].

Indonesia's production of liquid waste from Palm Oil Mills (POM) reflects its status as a key player in global palm oil production. The country's Palm Oil Mill Effluent (POME) production is estimated at 109.8 million tons, with every ton of CPO produced generating an average of 3.05 ton of POME [39]. POME is extremely harmful to the environment, it is also a major cause of water pollution if discharged improperly [15,30]. If treated properly, POME has the potential to produce biogas and for land application usage such as fertilizer [40]. However, the POME-based biogas technology industry in Indonesia is still facing political, economic, social, technological, and environmental challenges. The related issues are broad, cross-sectoral, and involve different actors. Thus, identifying stakeholders and their roles is required [43].

The study of POME-based biogas technology development is still limited [29]. discusses the technological advancement from the pre-treatment of POME and bioreactor for the biogas production. This study presented several methods of POME pre-treatment that include de-oiling, sedimentation, pre-hydrolysis and addition of biological or inorganic additives. Another study conducted a process optimization study for a palm oil factory in Jambi (Sumatra, Indonesia) that found the optimum operating condition for 1 and 2 stage digesters [35]. Apart from technical discussion, POME-based biogas technology development is also hindered by financial issues due to the nature of the project being cost-intensive [7]. From the point of view of biogas-to-electricity enterprise, biogas power plant has high initial set up and operating cost but less supports from the current policy and is facing economic challenges in terms of the low feed-in tariff when it is sold to Indonesia's state-owned electricity cooperation [37]. Conversely, instead of relying on the exclusive support of government policy in biogas-to-electricity, a study took the lessons from Bali for small-scale biogas development in Indonesia and found that implementing a market-based approach might be more effective for biogas deployment [34]. However, there is still a lack of market analysis on specifically POME-based biogas.

To fill this gap, this study attempts to analyse the macro-environmental factors of the Indonesian POME-based biogas market by mapping interactions among stakeholders, the parameters, and the affected sector. The study is novel by employing the PESTLE framework, an approach to assess the external macro-environment which includes political, economic, social, technological, legal, and environmental factors, and combining with market nature such as competition, resources, and incentives policy. This study may contribute to a better understanding of how the interaction between actors and macro-environmental analysis influences the respective sector in its relation to the development of the POME-based biogas technology market and be the base for scholars and researchers to conduct relevant studies in the future. The issue related to biodiesel mandatory program by the Government of Indonesia (GoI) is included in the discussion as a counterpart program in the biogas market.

2 METHODOLOGY

The biogas market assessment was analysed qualitatively based on data from desk review and fulfilled through several key aspects and was done through the consideration of four factors, which are PESTLE analysis. The market analysis included in this study was therefore conducted from the perspective of POME-based Biogas Engineering-Procurement-Construction firms (EPCs), the implementation scale is industrial, and market scope is national. The PESTLE framework is a multifaceted approach to assess the external macro-environment, which includes political, economic, social, technological, legal, and environmental factors. This framework is used to map and analyse how the macro-environmental factors influence an industry and are excellent in describing multi-dimensional aspects and serving as a generalized foundation for further market assessment [36].

3 PESTEL Analysis

3.1 Political aspects

National Targets and Strategies

The development of biogas technology in Indonesia is inextricably tied to the nation's aspirations towards energy security. The revised National Energy Policy (*Kebijakan Energi Nasional* – "KEN"), signed through Government Regulation 79/2014, is a policy revolving energy mix diversification, independence, and a push towards renewable energy sources including biogas. Another policy also exists as a renewable energy target in Indonesia. The General Electric Generation Plan (*Rencana Umum Pembangkitan Tenaga Listrik*/RUPTL), promulgated in 2019, is essentially a business plan of the state-owned enterprise State Electricity Company (PLN). However, since they are the sole distributor of power in Indonesia, this plan can also serve as an indicator of governmental interest to the sector in a moderate-to-long term. RUPTL also indicates the extent of guaranteed support PLN will give to renewable energy development, in terms of budget and capacity to renewable energy generation.

Fossil Fuel Dominance

Indonesia's purported enthusiasm for the broader promotion of renewables in its recent energy policies falls flat through its lack of a clear strategy and implementation. The Indonesian government continues to contradict its clean energy goals with heavy investments towards new coal-fired power plants development as fossil fuels have historically been, and continues to be, a major player in Indonesia's energy sector. The attraction to coal usage within Indonesia lies in its reliability, low price, as well as its central role in the country's revenue stream to counterbalance oil and gas deficits [6].

Lack of Prioritization on Biogas and POME

Within the renewable sector, the Government of Indonesia (GoI) has largely prioritized biofuel over biogas in its broader bioenergy strategy. In 2020, The Directorate General of New Renewable Energy and Energy Conservation set a target of constructing 3 unit of POME based biogas power plant located in South, East, and Central Kalimantan the target was not fulfilled as the project auction was deemed uninteresting by the prospective providers, taking into consideration the Covid-19 pandemic [50]. In addition to that, bioenergy investment in 2020 only reached 25.7% of the target or 0,108 Billion USD from 0.42 Billion USD with a 88.7% investment allocated to biodiesel, this has little implication to the biogas industry, complete details of the investment allocation in Table I [50]. In addition to that the realization of biogas power plant as 2019 only reaches 1.33% from the 5.5 GW target by 2025 [12]. Based on the current bioenergy trends, it could be assumed that this prioritization issue manifests as a decreased focus on biogas in lieu of biofuel development. Proper planning and execution of risk management is important to renewable energy development, since the sector is still relatively young. The absence of prioritization for biogas by the government causes financiers to be wary of the monetary risks. Furthermore, the Engineering-Procurement-Construction firms (EPCs) are still dependent on policy stability, and benefits for site owners are largely passive.

Table I: Bioenergy investment details for 2020 [50]

Business Sector	Status	Location	Investment (USD)
Biogas power plant	Domestic investment	South Kalimantan	3,471,900
Biogas power plant	Foreign investment	Lampung	1,600,719
Biogas power plant	Domestic investment	North Sumatera	3,534,722
Biogas power plant	Domestic investment	East Kalimantan	3,649,839
Biodiesel	Domestic investment	Riau	96,007,549
Total			108,264,7329

Governance

The project risks arising from the intersection of political, economic, institutional, and social characteristics should be considered when considering new biogas projects. Research by [3] on the potential of POME-to-energy programs in East Kalimantan demonstrates the need for intricate, multi-stakeholder cooperation in mitigating risks for new projects. These projects span multiple levels of government, ranging from regency, provincial government, and district governments. This complex decentralization is further complicated by the additional need to coordinate with the private sector, such as the palm oil mills supplying feedstock, as well as other financing bodies supporting the program. The lack of an administrative body for biogas development in Indonesia poses an issue for both Indonesia's aspirations towards energy security and disparity reduction. the Government of Indonesia (GoI) lacks proactiveness in establishing, implementing, or promoting biogas projects in a tangible form. The current form of leadership provided by the government is hindered by overlapping priorities and jurisdictions, which slows the decision-making process. Government decentralization also seeps into the problem of regulatory uncertainty, where the private sector is demoralized due to a lack of transparency on government support [37].

Large-scale palm oil plantations have been incentivized to introduce POME-to-energy projects out of corporate social responsibility, ethical or public relations purposes instead of through government initiation [9, 40]. However, this is not feasible for smallholder plantations, who may be more restricted in terms of capital and are deterred by higher risk factors and could benefit more from stricter biogas governance. Problems of governance are inextricably tied to previous issues of coal dominance and lack of focus on biogas, further made complicated by the lack of regulatory and administrative support by those who have the most influence [16].

3.2 Economic Aspect

Feed-in Tariffs

Feed-in tariffs (FITs) is the major policy support scheme for biogas development in Indonesia. It guarantees a fixed purchase price of renewable generation from power producers and aims to cover the costs of RE development, while providing reasonable rates of return to investors and reduce investor risks from RE projects financing [8]. Indonesia is a bit late in joining in, only having FITs implemented after the creation of the General Energy Plan (RUEN) in 2017. The rates in which FITs are implemented in Indonesia are also biased towards the government's rates for fossil electricity generation.

There are two key actors associated with the current FIT program. the Government of Indonesia (GoI), through the state-owned enterprise State Electricity Company (PLN), is the major player in determining investments by independent power producers (IPPs). PLN has power over tariff negotiations through their direct selection mechanism, providing an incentive to sign PPAs suitable with PLN's mandates, while excluding those that have failed to do so. Once selected, IPP projects are obligated to complete construction of the power plants in accordance with the PPA, where sanctions and penalties are imposed on those that fail to finish projects [27]. Investors have criticized these low power purchase prices, claiming high risk implications and a "roadblock" that keeps developers from recovering investment and generating reasonable profit from projects [16].

Investment Type

Renewable energy project development, including biogas, attracts significant investment risks due to its capital-intensive nature and low operational costs. Disseminating POME-to-energy projects highly relies on accessible investment support and progressive, transparent economic policy mechanisms. There are three types of Investments for biogas development: government support, private funding, and blended schemes with non-government organizations.

As for government support, biogas development is supported by other government-mandated mechanisms and incentives. This support scheme varies from a national, regional and local level, although implementation and execution are concentrated in the latter two. Private funding is an alternative to public funding for biogas projects and a key driver for Indonesia to reach its national energy targets and goals to shift towards cleaner energy. However, the case for Indonesia's private sector funding mechanism for renewables is complicated. This is due to the lack of experiences in commercial banking in funding renewable projects. Their unfamiliarity with renewable energy leads to a cautiousness that impacts financing costs, capital availability and project viability [10]. The novelty of biogas, let alone POME-to-energy projects, further complicates financing schemes as lenders have lack information from past projects, affecting their confidence in assessing future ones, leading to a conservative stance.

The constraints faced by financial institutions and mechanisms from the Government of Indonesia (GoI) and commercial banks has led to the growth of use in blended financing instruments. Blended financing is defined as "the use of public/philanthropic funds to mobilize multiples of additional private capital" [38]. Biogas development in Indonesia has enjoyed financing from international government-supported donor agencies, particularly the US Agency for International Development (USAID) and German Corporation for International Cooperation (GIZ) [5].

3.3 Social Aspect

Employment opportunities, skilled workers, equality

Oil palm plantations absorbed 7.27 million employees which consist of farmers and workers in 2019. There are no clear boundaries on types of jobs between farmers and workers/labourers, but in spite of that, the typical jobs for farmers include fruit pickers, fertilizer application, bedding, foremen, and supervisors [24]. Methane-capture facilities or AD installation at palm oil mills also contribute to job creations. The demand and structure of the workers depend on several factors such as the type of AD, the phase of the development of biogas technology, and the scale of business. Compared to farmers who fall under the umbrella of informal sectors, workers at biogas-capture facilities are considered as skilled workers and included in the formal sector.

Table II exhibits the employment in the oil palm plantations in Indonesia. As reported, the number of total farmers and workers/labourers combined (KK+TK) had gradually increased from 5,218,323 to 7,267,460 from 2014 to 2019. The growth of the number of workers absorbed in the oil palm plantation sector between 2014 and 2019 was 39%. Regarding equality on a company level, [32] report that certified plantation companies treat women and men equally as employees. The commitments and pledges to treat them equally, however, don't always turn into actions as cases of inequality in plantation employment could still be found [21, 23, 42].

Table II: The Employment in The Palm Oil Plantations [47]

Year	Total Farmers (Household)	Total Workers (Household)	Total Farmers & Workers
2014	2,052,050	3,166,273	5,218,323
2015	2,115,434	3,367,495	5,482,929
2016	2,165,305	3,633,979	5,799,284
2017(1)	2,618,127	4,340,848	6,958,975
2018(2)	2,673,810	4,422,226	7,096,036
2019(3)	2,740,747	4,526,713	7,267,460

Remuneration

The Government of Indonesia (GoI) regulates wage through PP RI No. 78 Th 2015. The Governor of each province is responsible to set the provincial minimum wage (Upah Minimum Provinsi - UMP). According to Article 43 of PP RI No. 78 Th 2015, the determination of UMP is conducted annually and adjusted based on the decent living need and with regard to productivity and economic growth. Scholars state that minimum wage might harm employment. Labour costs account for approximately 60% of the overall expenses on the plantations [32]. Indonesia is a developing country; thus, the above statement may not apply to this context.

To analyse the consequences of the rise of minimum wages, we have to look at the number of unemployed people and compare it to the capacity of the oil palm plantation sector in absorbing jobs. Interestingly, in oil palm plantations, the data shows that the rising UMP in oil palm producing areas didn't lead to lower labour demand. The number of total farmers and workers/labourers combined (KK+TK) indicated an increase during 2015 and 2017 (See Table 2). As a result, there is an indication that the UMP doesn't necessarily have negative consequences on the employment of oil palm plantations in Indonesia (Table III).

Table III: Average UMP from 2016-2021 of Top 5 Province Producing CPO [51,52]

Province	Total CPO Production 2019	2016	2017	2018	2019
	(Ton)	(Billion Rp)			
Riau	9,869,230	2,09	2,26	2,46	2,66
Central Kalimantan	7,441,879	2,05	2,23	2,42	2,66
North Sumatera	6,645,540	1,81	1,96	2,13	2,30
West Kalimantan	5,044,078	1,74	1,88	2,05	2,21
South Sumatera	4,256,106	2,20	2,39	2,59	2,80

Public concern

The palm oil industry, particularly oil palm plantation, faces public opposition due to two major concerns: weak law enforcement and lacking special regulations for the worker of oil palm plantations. Weak law enforcement includes forced labour, child labour, unfair wage practices, precarious work, ineffectiveness labour inspection, the prohibition of independent Labor Unions, and health impacts from biohazardous materials particularly on women [21]. Similar concerns expressed by [28], which highlight worker exploitation by Indofood, an RSPO certified Total Food Solutions company in Indonesia. Moreover, the palm oil sector is also a male-dominated sector in which women occupied 3% of total jobs at Aek Raso plantation and 14% of total jobs at Aek Raso mill based on case studies by [42]. Unskilled women's labour reportedly received a standard daily pay rate lower than men's: Rp 27,000 (2.2 EUR) in comparison to Rp 50,000 (4.12 EUR).

In the midst of large-scale oil palm expansion and deforestation controversies, indigenous communities in Kalimantan are struggling in preserving their forests and land [44]. The expansion of oil palm plantations in Indonesia also results in externalities linked to the livelihood of clan members or indigenous landowners in Papua in the form of reduced welfare, time and money lost during the negotiation process [4]. Earth, LifeMosaic and Sawit Watch [53] reported that despite the existence of laws Regulating Land Acquisition and Plantation Establishment, in practice, many companies violated the law. Conflicts arose during and after land acquisition due to the inability of the companies to fulfil the requirements, agreements, as well as promises to the indigenous communities.

3.4 Technological Aspect

POME characteristics

POME has typical characteristics such as oily and greasy, high concentration of organic matters, hot, acidic, and high solids concentration, as shown in Table IV [13]. Due to the high concentration of COD dan BOD, POME is considered as an effluent which is dangerous for the environment. Therefore, POME needs to be treated before being discharged to the environment. There are several technologies that have been applied for treating POME. Most conventional technology for POME treatment is a series of open lagoons as biological treatment.

Table IV: POME characteristics in Indonesia

Parameter	Unit	Range	Average
BOD	mg/L	8,200-35,000	21,280
COD	mg/L	15,103-65,100	34,740
TSS	mg/L	1,330-50,700	31,170
Ammonia	mg/L	12-126	41
Oil and Fat	mg/L	190-14,720	3,075
pH		3.3-4.6	4

Current POME-to-biogas technologies

Anaerobic digesters (AD) are now being used as primary treatment for POME at Indonesia Palm Oil Mills (POMs) because aeration processes do not need to be accommodated here, hence reducing cost and technical complexity effectively. Biogas from anaerobic processes, irrespective of the involved technology, can be utilized for other purposes such as producing electricity. This process will also produce sludge that can be reprocessed as fertilizer for agricultural applications [1]. Covered Lagoon is mostly used by Palm Oil Mill to treat POME in Indonesia [13]. Covered lagoon is an improved version from the open lagoon method, covering a waste reservoir with floating plastic membranes. The operational simplicity and low investment cost of covered lagoons support and enable more installations of the covered lagoon compared to other AD technologies in POME treatment in Indonesia [29]. However, the covered lagoon infrastructure requires large physical space and will still leave a sizable carbon footprint. Other than the covered lagoon, there are only three POMs using the tank system (CSTR) to treat POME in Indonesia [13]. A Continuous Stirred Tank Reactor (CSTR) is similar to a cylindrical closed tank reactor, but it uses an agitator to increase contact between biomass and waste. Due to the agitation, CSTR can produce more biogas than closed tanks. This reactor should be operated at steady state with continuous feed flow. There are several assumptions used in CSTR such as uniform composition throughout the reactor and uniform composition between exit stream and in the reactor.

There are several barriers in technical aspects, such as the lack of studies, technical expertise, and proven AD implementation in Indonesia. These barriers can lead to feelings of doubt from both technology suppliers and the industry, poor design, and ineffectiveness performance of the technology. Due to these barriers, there are challenges in providing the technology. This situation forced the industries to import technology from abroad. Then, procurement of this technology from countries outside Indonesia will be priced in foreign exchange and will pose a challenge of fluctuating exchange rate. The other challenge is the logistical transfer of technology equipment to remote areas.

3.5 Environmental Aspect

Impact of global warming and the environment

Although the choice of methods for POME treatment among mills might vary, 50% of the mills use anaerobic ponds [2]. Palm oil mills (POMs) in Indonesia mostly use open pond systems to treat POME through anaerobic process due to its low operational cost and operational simplicity [25, 40]. Methane (CH_4) and carbon dioxide (CO_2) as the major components of biogas which directly release to the air from open anaerobic ponds can contribute to global warming. Methane (CH_4) and carbon dioxide (CO_2) are GHG (Greenhouse Gas) emissions with methane (CH_4) as a major contributor of GWP (Global Warming Potential) [11, 33]. Methane (CH_4) is even considered to be 25 times higher GWP than CO_2 [18, 33].

Pollution and Environmental Risk Control

The main umbrella in pollution and environmental risk control was Governmental Regulation 32/2009 regarding Environmental Protection and Management. In this regulation, the principles of environmental protection and management must include, State's responsibility, Sustainability, Harmony and Balance, Cohesiveness, Utilization, Caution, Fairness, Ecoregion, Biodiversity, Polluter Pays, Participative, Local wisdom based, Good Governance, and Regional Autonomy. the Government of Indonesia (GoI) requires any project to do an environmental impact assessment at the earliest stage possible. These assessment reports help identify the environmental risks, mitigate, and monitor mills with electricity generators [40]. The sanction for those who violent the regulation, stretch from administration sanctions, such as written reprimand and revocation of the permit by the government, to punishment in jail as short as a year up to 15 years (UU Perlindungan dan Pengelolaan Lingkungan Hidup, 2009). The perpetrator also fined 500 million IDR up to 15 billion IDR, depending on their case (UU Perlindungan dan Pengelolaan Lingkungan Hidup, 2009). In this case, the perpetrator is not only limited to individuals but also the company itself.

For the case of palm oil mills, the Government of Indonesia regulates the level of contents in treated POME which is allowed to be discharged into the water through Environmental Ministerial Decree number 51/1991. In addition to the utilization of POME, the Government of Indonesia (GoI) enacted a decision from the Ministry of Environment through Decision of the Ministry of Environment 28/2003 regarding Technical Guidance for Wastewater from Palm Oil Mill Effluent (POME) Utilization by Palm Oil Industries on Palm Oil Plantation along with its Guidance and Permit Procedure. Additionally, for air pollution, during 2017 - 2018, KLHK evaluated 1906 companies from different industries from which 29 of them were palm oil mills with methane capture facilities. These 29 facilities were registered as CDM projects [41].

Benefit of POME treatment

Various benefits of POME treatment are still an attraction for the biogas industry implementer. Digestate from anaerobic process can be utilized as liquid fertilizer [20]. Besides, the utilization of methane-capture facilities can reduce GHG emissions [40]. By covering the ponds with covered lagoon technology, the GHG emissions can be reduced to 25 kg CO2eq/MT CPO [15]. In addition, [31] also found that reducing GHG by biogas plant can be done by converting biogas to electricity using CSTR application at fermentation in 55ºC for 42 days. Rajani et al (2019) found that if POME is treated with biogas technology, during 2015-2017, from its 27,963,000 m³, 32,013,000 m³, 37,782,000 m³ of POME production/year, Indonesia theoretically had the potential to generate 150.93 MW, 173.37 MW, and 203.92MW of POME-to-energy plant capacity respectively. Moreover, researchers and scientists have been actively working on finding better POME treatments in order to meet regulatory requirements set by the environmental authority [19].

3.6 Legal Aspect

Renewable Energy (including Biogas) Regulations

In Indonesian Regulations regarding Renewable Energy, it does not explicitly regulate Biogas. In the Regulations, they included Biogas and other Renewable Energy Technology in the Renewable Energy sections. Institutionally speaking, the energy sector of Indonesia is mainly controlled by the state-owned enterprise State Electricity Company (PLN), Ministry of Energy and Mineral Resources (ESDM), the National Energy Council (DEN), and House of Representative (DPR-RI). Regarding the authority of Renewable Energy, it belongs to at least four ministries and one institution, inter alia, Ministry of Energy and Mineral, Ministry of Industry, Ministry of Environment and Forestry, Ministry of Agriculture, and PLN.

Regulations regarding the incentives and certification

The Government of Indonesian is not leaving the renewable energy industry unattended. It is shown by the enactment of Government Regulation 18/2015 regarding tax facilitation for investment in certain industries and/or certain regions, later specified by the Ministry of Finance Regulation No. 159/PMK.010/2015 regarding the tax reduction for renewable energy industries and the Ministry of Finance Regulation No. 154/PMK.011/2012 regarding import tax exemption for new renewable energy industries. In these regulations, the Government of Indonesia (GoI) emphasized its intention to develop more new and renewable energy industries by giving incentives, such as tax deductions and exemption, and getting prioritized due to their investment in a certain region and/or a certain industry. To attract more investors in developing renewable energy in Indonesia, Ministry of Industry, Ministry of Energy and Mineral Resources, Ministry of Agriculture and the Ministry of Environment and Forestry being pushed to simplify the conditions and recommendation for permits across sectoral institutions, since these 4 ministries are the core of the development of renewable energy, especially Biogas from POME.

In certifying sustainable Palm Oil, both for commercial use and industry use, including for renewable energy, there are four types of certification that Palm Oil Industry can apply, inter alia, Sertifikasi Perusahaan Perkebunan (Certification for Plantation Company); Sertifikasi Usaha Perkebunan Plasma (Certification for Palm Oil from Plasm Plantation), Sertifikasi Usaha Perkebunan Swadaya (Certification for Palm Oil from Private Plantation); and Sertifikasi Minyak Kelapa Sawit untuk Energi Terbarukan (Certification for Renewable Energy-purposed Palm Oil) (Lampiran I, Permentan Sistem Sertifikasi Kelapa Sawit Berkelanjutan Indonesia (Indonesian Sustainable Palm Oil Certification System/ISPO), 2015). For renewable energy-purposed, crude palm oil needs to be calculated as its GHG based on a separated calculation guide.

In answering the needs of consistent regulation regarding Renewable Energy, the Government of Indonesia (GoI) currently working on Draft Regulation on New and Renewable Energy. The urgency of this regulation is about the dependence on coal, petroleum, and natural gas to fulfil the national energy demand, and knowing that the fossil energy may be depleted in no time could cause vulnerability of energy security, if continuously used [54]. According to the government's plan, these future regulations will be discussed in October and be synchronized with other regulations and Provincial as well as lower Government. In this Draft Regulation, it will become an object of regulation for several regulations, such as Principles of Agrarian Regulation, Environment Regulation, Regional Government Regulation, Electricity Regulation, Forestry Regulation, and other regulations regarding sources of Renewable Energy.

Regulatory Challenges

There are various reasons behind the stagnant There are various reasons behind the stagnant development of renewable energy industry in Indonesia, such as time-consuming permit procedures ([22, 49], vague responsibility due to lack of inter-ministerial coordination and overlapping responsible between ministries [48, 49], penalty for the perpetrator cost cheaper than investing in CSTR or Covered Lagoon (UU Perlindungan dan Pengelolaan Lingkungan Hidup, 2009; 48). Inconsistency of Regulation is reflecting the concern of RE Developers. It is shown through Article 2 of the Ministry of Agriculture Regulation Number 11/Permentan/OT.140/3/2015. In this Article, it stated that the implementation of Indonesian Sustainable Palm Oil (ISPO) certification can be done voluntarily or mandatorily. In a sense, ISPO Certification becomes mandatory only if the corporation is with the Palm Oil Plantation, and for those who do not have a Plantation and relying upon the supply of Palm Oil from Plasm Plantation and Private Plantation, this certification is voluntary. In terms of the development of RE in Indonesia, the Ministry of Agriculture stated that Renewable Energy-purposed Palm Oil does not necessarily apply to ISPO. If the government wanted to implement ISPO Certification, it should be implemented to all corporations, whether they do have Palm Oil Plantation or not, in order to ensure the consistency of the regulation.

Table V: The results of the PESTEL analysis

Aspect	Factors
Politic	- National energy priority and lack of proactiveness from key stakeholders - Fossil fuel dominance
Economy	- Feed-in Tariffs - Type of investment
Social	- Employment opportunities, skilled worker, and equality - Remuneration - Public concern
Technology	- POME characteristics - POME-to-biogas technology
Environment	- Impact of global warming and the environment - Pollution and Environmental Risk Control - Benefits of POME treatment
Legal	- Renewable Energy (including Biogas) Regulations - Regulations regarding the incentives and certification - Regulatory Challenges

4 BIOGAS MARKET SIZE AND MANDATORY B100 PROGRAM

Indonesia is an agrarian country that has rich bioenergy potential, such as biodiesel and bioethanol. The Government of Indonesia (GoI) has set the target to achieve 23% of renewable energy utilization into the national energy mix by 2025. Indonesian biodiesel development started in 2006 through the ratification of the Presidential Regulation No. 5/2006. The regulation contained the Indonesia National Energy Policy which targeted to increase biofuel to more than 5% and decrease fossil-based oil to less than 20% in the 2025 energy mix. The target was further reinforced through the Regulation of the Minister of Energy and Mineral Resources No. 12/2015, where a minimum of 30% biodiesel blend is mandated to be achieved by January 2025 to be used across various sectors, including small businesses in fishery and agricultural sector, public and non-public transports, commercial industries, and power plants. The Ministry of Energy and Mineral Resources acts as the main governmental body responsible for regulating the supply and demand of Indonesian biodiesel, including setting biodiesel prices, supporting biodiesel production infrastructure, and developing the blueprint of Indonesian energy use.

In general, Indonesian biodiesel production increases throughout the years. In 2018, Indonesia produced a total of 4,706 thousand kL of biodiesel, with around 32% of the total biodiesel exported. The biodiesel blend progressively increased from B2 in 2009 to B20 starting in 2017, as shown in Fig 1. Indonesian biodiesel mostly originates from crude palm oil (CPO) as feedstock due to Indonesia's large production of palm oil. The demand for Indonesian biodiesel is also expected to keep growing significantly until 2025, reaching 11.6–14.6 million kL and 20.4–25.8 million kL in B30 and B50 scenarios, respectively [26].

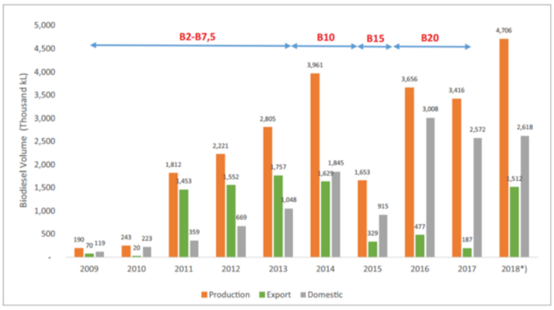

Figure 1: Indonesian biodiesel production, export, and utilization growth in 2018 [17]

Despite its prospective growth, the Indonesian biodiesel development faces several challenges from many stakeholders, including the Indonesian government, palm oil producer, biodiesel producer, traditional farmers, and environmental non-governmental organizations (NGOs). The sustainability of CPO as the main Indonesian biodiesel feedstock is still considered problematic, since around 20% of palm oil plantations in Southeast Asia are located on peatlands and the CO_2 emissions from these plantations are estimated to be much higher. The increasing demand of CPO will certainly increase the risk of environmental issues if not properly mitigated [26].

The involvement of independent oil palm farmers, especially traditional landowners, is not yet clear in the general perspective of Indonesian biodiesel development. The implementation of the biodiesel program caused financial losses to traditional farmers because of the increasing price of CPO. In general, the biodiesel program has not provided benefits for farmers, especially smallholders. In addition, there are also issues on the transparency and accountability in management of palm oil funds, and there are no sustainability standards applied on the downstream of biodiesel production supply chain. Therefore, the Government of Indonesia (GoI) plays a key role in resolving these issues to meet the increasing demand of biodiesel while still ensuring the economic and environmental sustainability of biodiesel production [26].

Seeing from the great obsession on mandatory biodiesel programs (B100), biogas technology development should be a good strategy along with this program for maximising the potential of palm oil and achieving the national bioenergy mix target without neglecting the environment preservation. Alternative process for treating the increased volume of POME is turning it into biogas with anaerobic digestion plants [14]. Recycling POME to new energy sources in the form of biogas aims to capture methane for reducing GHG emissions and providing energy substitution to generate electricity and steam or heat consumed in palm oil plantation, biodiesel production process, as well as biogas production itself. [14] proved in his study that applying methane captures to produce biogas has reduced the GHG emissions by 63%. Given these facts, however, growth of the biogas sector in Indonesia has been concluded as not significant and are being negatively affected by several factors analysed by the PESTLE framework in previous discussion. A vast majority of biogas developers only utilize biogas for electricity generation – be it internal or to be bought by the state-owned enterprise State Electricity Company (PLN). Benefits of biogas implementation tends to be a 'saving' than creating additional income, which is a lost opportunity for companies.

In addition, technical knowledge and high capital are a must have for entering biogas business, so not everyone can just jump ship and become a biogas Engineering-Procurement-Construction firms (EPCs). The capital costs for biogas development in Indonesia remains high, with costs mainly incurred for technology components i.e., digesters, engines, and auxiliary components. In the context of substitute biogas components, once a project is initiated, technology can rarely be replaced. Substitute biogas technologies for projects can be provided by other EPCs (bundled with their own services) or by pure tech supplier/reseller—this poses a low risk for new biogas suppliers. Furthermore, concentrations of major international manufacturers (whose products are used in Indonesia) are all foreign products – US, Europe, China, India – means that Biogas technology is almost exclusively imported. This will inevitably cause additional cost and time for EPCs or suppliers to stock up (or start a project). Simply, it appears that technology exporters also found value in the Indonesian market as no EPCs, or suppliers have experienced a debilitating shortage of technology.

Regarding imported technology, trade routes are also prone to disputes, taxation, and exchange loss from dealing with a foreign currency. To deal with this, regulatory incentives are available for the biogas sector as well as import tax waiver which are applicable for renewable energy construction including biogas plants. Other than economic policies and incentives, obtaining Environmental Impact Assessment is also mandatory for palm oil mill and biogas plant for preserving the environment. Indonesian Sustainable Palm Oil Certification System (ISPO) should also be met by the palm oil industry as a standard to ensure the sustainability of the plantation business. Meanwhile, regardless of the efforts made by all institutions involved in renewable energy sectors in making the regulations, the law enforcement of these regulations is still questionable due to inconsistent penalties for the act of law violations. Public opposition also still exists due to weak law enforcement and lacking special regulations for the workers of oil palm plantation, including wages, gender, and risks for indigenous people.

5 CONCLUSIONS

The ambitious Indonesia biodiesel mandates (B100 program) are pursued in combination with a strategy for increased productivity in palm oil production as well as utilization of its abundant residues. POME-based biogas therefore stands as an alternative to deal with sustainability. Even though biogas received less priority as potential renewable energy compared to biofuel, its market now strongly depends on the prominence of B100 program. Referring to the macro-environmental aspect from the PESTEL framework, the Government of Indonesia (GoI) still needs a strategy that can overcome the dominance of coal and increase the development of renewable energy in Indonesia. Instead of focusing only on the electricity sale-scheme, the market-based approach can be an alternative to generate biogas technology development and its product utilization. In the economy aspect, renewable energy financing is also considered as an important key in increasing the development of biogas projects including the cost for its technology and selecting the right type of investment. Renewable energy project development, including biogas, attracts significant investment risks due to its capital-intensive nature and high operational costs.

6 NOTES

(1) Data 2017 & 2019 from Directorate General of Estate Crops
(2) Preliminary
(3) Estimation

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8 FURTHER INFORMATION

We are available to assist you. Please, do not hesitate to contact us for any query; please address your e-mails to elisabeth.rianawati@rdi.or.id .

9 ACKNOWLEDGEMENTS

This work is supported by Digital Global Biogas Cooperation (DiBiCoo), a project funded by European Union's Horizon 2020 research and innovation program under grant agreement No.857804.