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Prospect and policy of palm oil mill effluents for future electricity in east kalimantan (utilization of pome as renewable energy)

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Abstract. East Kalimantan economy for four decades was mainly based on natural resources extraction and dominated by primary sector with the six highest GDP in 2013. But, the contribution of oil and gas were decreasing production due to the absence of new wells. One of the mission was create natural resources and renewable energy based economic people oriented. The Government of EK Province chose a strategy of socio-economic transformation based on renewable natural resources. This strategy has been applied in the regional development plan by mainstreaming climate change issues. Data related to energy source and its potential, remote rural electrification, bioenergy feedstock, etc including from the Palm Oil company was collected and subsequently analyzed in line with the EK Governor Letter. Currently (2014) available of Biogas-Pome as bioenergy feedstock is 162 million m³year⁻¹, where as currently utilized is only 22 million m³year⁻¹. Power demand supply status in January 2015 indicated as available capacity is 467 MW where the peak demand is 444 MW. About 22% of households without electricity are difficult to be electrified without breakthrough efforts. About 215 thousand households are un-electrified, with more power need about 150 MW in total capacity. As business opportunity, high demand for rural electrification, particularly in Kutai Kartanegara, Kutai Timur, Kutai Barat, Berau and Paser.

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1. Introduction

Energy often known as the catalyst for development is an important element to support the population growth, urbanization, industrialization and tourism. Fossilized energy has contributed the most impact of the economic development in the world through the transportation sector and energy conversion sector. Palm oil mill effluent (POME), agro-based industries and farming industries are identified as potential sources of biogas. It was studied that more than 500 kt of biomethane could be produced yearly if all the POME is treated anaerobically. The utilization of biomethane has remained unexplored for its injection into natural gas grid. Middle East region has supplied about half of oil production in the world and the rest come from the central Asia region and America continent [2]. The economics of depending mostly on imported fuels have grown in recent years as oil prices have come unstable, doubling in less than two years the price of 2004 and reaching in 2006 oil prices [3]. Moreover, in the environmental side, the use of fossilized energy especially in the transportation where at least 25% has contributed to the increasing of toxic gas and affected and greenhouse emission. With the growing awareness of energy-pollution and a climate change consequence, as well as complying to the Kyoto Protocol that targets the use of less energy pollution from emitting energy



1 source which is a clear message to the global for a change towards more sustainable energy production and conservation [4 - 6].

There are astonishing efforts to promote the use of solar power, hybrid with less consumption of fuel, hydrogen fuel cell, biofuels and others to the people. Still not many people are ready to the complete changing where the cost is still expensive in terms of cost, not truly practical and lots more researches needed to improvise those methods [7]. Nevertheless, the suitable replacement and quite similar to the fossilized fuels is the biodiesel fuels that extracted from the plants and animal fats in term of characteristics, properties and without any modification of the engine. In recent years, there are two main types of biofuels which refer to first of generation biofuels called bioethanol, which is derived from starch or sugar such as cane, corn and sugar beet, and second generation biofuels is biodiesel, derived from animal fats and vegetable oils, for example from palm oil, jathropa, soy bean, rapeseed oil, neem oil and others [7] [8].

Significant sustainability concerns are also associated with palm oil production at plantations and mills. The environmental impacts are mainly due to open lagoon treatment of palm oil mill effluent (POME) and fertilizer and pesticide use. The potential use of palm oil residues was reviewed for the first time in 2006. Quantified the potential GHG emissions and benefits from residue use and concluded that use of residues may significantly improve the environmental performance of palm oil production. Socioeconomic aspects of sustainability, such as plantation worker safety and health and land tenure rights have also been researched [9].

Indonesia has the potential of renewable energy sources such as biofuel, biomass, geothermal, water, solar wind, ocean waves to tidal energy of sea water. The president of the republic of Indonesia keeps the ambition so that renewable energy can be maximized as possible to release the dependence of fossil energy. Therefore in 20125 the use of renewable energy is expected to reach 23% of total energy. For now, fossil energy still dominates the supply of energy needs. Noted, fossil energy contributes 95% of the total available energy 47% of which are petroleum, 24% natural gas and 24% coal. While the use of renewable energy has only reached % [10].

Palm oil as biofuel potential of renewable energy have waste when they process. There are two types of waste generated from oil palm plantations in the form of liquid waste which is the residue of the process of producing CPO or in the form of solid waste derived from empty bunches or from palm shells. Indonesia currently has 850 oil palm plantations annually capable of producing liquid waste reaching 28.7 million tons and 15.2 million tons of solid waste. If a palm oil plantation capable of processing 30 to 45 tons of fresh fruit bunches per day will be able to generate 1 megawatt of electricity from liquid waste and 3 megawatts of solid waste. The palm oil industry is ready to utilize renewable energy through biogas power plant (PLTBg). This is to welcome the government's plan which will require the waste of palm oil to be utilized for power plant raw material [11].

In this review, a brief outlook has been conducted on the potential of palm oil mill effluents for future electricity in East Kalimantan Province (utilization of pome as renewable energy). The survey cover general overview of East Kalimantan prospect of POME, business opportunity, rational for pome to electricity investment, key challenges, business risk and multi stakeholder cooperation to debottleneck investment pome to electricity.

4 General Overview East Kalimantan and Power Supply Crisis

As a developing country, Indonesia has been constantly trying on its toes to meet with the ever increasing energy demand by finding source of energy like Palm oil. East Kalimantan Province on utilization of Palm Oil Mill Waste for electricity in the context of policy and its investment opportunity in EK. As you know that East Kalimantan is the second largest island in Indonesia after Papua with total area of 12.7 million Hectares, with population approx. 3,3 million people. We have approx 12 million hectare of area, and blessed with biodiversity and resources that support our economic growth in the previous decades. Whereas total area of East Kalimantan was 12.532.799,52 ha, with total population 3.3 million and have potency of natural resources like forest, oil and gas, Mineral Mining, Ecosystem Services, etc. For four decades, East Kalimantan economy was mainly based on natural resources extraction and dominated by primary sector. With this natural resources, we develop our province and country and its been made East Kalimantan Province as province with the

siz highest GDP in Indonesia in 2013. But, the contribution of oil and gas were decreasing due to the absence of new wells and degreasing due to the absence of new wells and the last decide the role of non- oil sector in East Kalimantan has increased, particularly driven by coal mining, while the contribution of renewable resources into the economy such as agriculture and service are remain small. With structure we can see that our economic growth rate was decrease sharply [10].

East Kalimantan Province have power supply crisis. Power demand-supply status in East Kalimantan per January 2015 indicated available capacity is 467 MW where the peak demand is 444 MW. PLN power sales growth in Kalimantan 2009-2014 is 10.5% (PLN 2015) 22% of households without electricity are difficult to be electrified without a breakthrough efforts, About 215 thousand households are un-electrified, with more power needs about 150 MW in total capacity (Source: Electrification Ratio 2015, East Kalimantan Mining and Energy Agency) [11].

Remote rural electrification is the key to reach the 80% electrification target. Most of non-electrified households are in remote rural areas. Cheap coal power plant cannot help remote rural areas because coal power plant is only feasible in a big scale operation, i.e. >10 MW; low number of inhabitants in remote rural areas, thus unable to absorb a big scale power plant and the distance between urban and remote rural areas is too far for stretching power grid resulting significant power loss.

The standard solution for electrifying rural areas is diesel generator but high operation cost (IR 2,000 - IR 4,000 per kwh) and High GHG emissions (1 kwh = 0.9 kg CO²) and increase the pressure on fiscal (fuel subsidy) and trade balance.

3. Potency and Prospect POME

The potential of palm oil plantation waste as renewable energy includes palm oil shell of 5-6% is used as boiler plant, 60%-65% POME shifts have not been used optimally and empty bunches of 20-22% as fertilizer or mulch. POME (palm oil mill effluent) contains methane gas (50-75%) and carbon dioxide (25-25%). POME processing in open ponds causes methane gas. The effect of methane on global warming is 21 times that of CO₂. Methane is a flammable gas and can be used as a fuel for renewable energy.

The benefits of POME for EBT/rural electricity for plantation companies are to become new business opportunities ie electric energy with feed-in tariffs, lower diesel / diesel consumption, support government regulation in achieving ISPO criteria and local government policies, increase social support with low-cost electricity supply by cooperation with PT PLN and improving the bargaining position of CPO domestically and the downstream industry.

The benefits of POME for EBT / rural electrification for governments and communities is a low-cost solution for improving rural electrification, promoting rural economic activity, saving fuel subsidies, reducing the value of fuel imports, helping achieving East Kalimantan energy targets by 3% by 2020, GHG emission reduction targets from industry and industrial waste sectors and mitigate business disruptions and plantation conflicts [10].

3.1 Resource Potential and Current Development of Bioenergy Development

Based on Table 1 we can explained that potential resources of biogas and biomass. Bioenergy feedstock biogas from POME, but bioenergy feedstock biomass from palm oil solid by product and vegetation on ex-mine land. Bioenergy from biogas-POME have currently available 162 million m³ year⁻¹ but currently utilized just 22 million m³ year⁻¹. There are mean that currently unutilized for 140 million m³ year⁻¹. It means having power generation potential amount 34 MW. While palm oil solid by product have currently available 3.9 million ton year⁻¹ but currently utilized just 2.8 million ton year⁻¹. There are mean that currently unutilized for 1.1 million ton year⁻¹. It means that palm oil solid having power generation potential amount 117MW. Bioenergy feedstock from vegetation on ex-mine land have currently available 234,000 ton biomass potential year⁻¹ but none are used for bioenergy. There are mean that currently unutilized for 31 MW.

Table 1. Bioenergy development as resource potential

| Re- Resources | Bioenergy feedstock | Currently available (2014) | Currently utilized (2014) | Currently Unutilized | |
|---------------|---|--|-----------------------------|----------------------------|---------------------------------|
| | | | | Volume | Power Generation Potential (MW) |
| Biogas | Biogas-POME* | 162 million M3/year | 22 million M3/year ** | 140 million M3/year (2014) | 34 MW (2014)*** |
| Biomass | Palm oil solid by-products (shell, Fiber, EFB)* | 3.9 million ton/year | 2.8 million ton/year | 1.1 million ton/year(2014) | 117 MW (2014) |
| | Vegetation on ex-mine land (available land)* | 36,000 ha → 234,000 ton biomass potential/year | None are used for bioenergy | 36,000 ha (2014) | 31 MW (2014) |

Sources:

* GE-LAMA-I 2016

** utilized by 3 POMs

*** including 13 potential POMs

While current development, from available data could be seen at following Table 2.

Table 2. Bioenergy development as current development.

| Feedstock Resources | Feeding to PLN | | Self-used (biogas) |
|----------------------|-----------------------------|-----------------------------|-----------------------------|
| | Biomass | Biogas | |
| Palm Oil (60+ mills) | 4 units, 0.8 MW (operating) | 1 unit, 4 MW (operating) | 2 units, 1.8 MW (operating) |
| | 1 unit, 3 MW (construction) | 2 unit, 4 MW (construction) | |
| | Forest plantation | 1 Unit, 9.5 MW (plan) | |

Note : Data Biomass provided from some Palm Oil Company, as followsn : 1. PT Tanjung Buyu Perkasa; 2. PT Teladan Prima Sawit; 3. PT Telen; 4. PT Hutan Hijau Mas (Operasional), than Biogas: REA Kaltim (sold to PLN) dan PT Prima Mitrajaya Mandiri + PT Indonesia Plantation Synergy (self used).

Table 2 explains that feedstock resources from palm oil and forest plantation. Palm oil have feeding to PLN from biomass as much 4 units operating with 0.8 MW and 1 unit construction with 3 MW. But from biogas provide 1 unit operating with 4 MW and 2 unit construction with 4 MW. While self - used (biogas) as much 2 units operating with 1.8 MW.

3.2. Business Opportunity

Business case for POME to electricity could be figured out as follows : (1) potential for power generation: over 34 MW (based on table 1), (2) viable investment: IRR from 12 to 20%, (3) high demand for rural electrification, especially in Kutai Kartanegara, Kutai Timur, Kutai Barat, Berau, and Paser[10] [12][13].

3.3. Rationale for Pome to Electricity Investment

Regulatory and market pressure to electricity investment were (1) Indonesia Sustainable Palm Oil (ISPO) standard compliance requires methane capture; (2) draft of EK sustainable plantation regulation/Raperda, 2016: Palm oil mills must develop renewable energies for rural electrification; (3) market pressure for 100% RSPO-certified sustainable supply chains and (4) early mover sustainability premium.

CSR have advantages like electrification for rural areas, secure social license to operate, government relation can support to EK Government efforts towards rural electrification and GHG emission reduction.

GHG emission reduction can contribute to the regional GHG emission reduction ambitions East Kalimantan regional target of 19% reduction in GHG emission by 2020 Production of 1 tonne of CPO can generate over ½ tonne of CO₂eq if methane is not captured

Financial viability must operational efficiency, continued electricity generation (currently electricity is produced only when the mill operates), reduced diesel consumption, generation of new revenue streams, potential IRR estimated between 12 to 20% depending on capacity and flexibility regarding financing needs and risk exposure (EPC versus IPP models).

3.4. Key Challenges and Business Risk

Key challenges for this program were regulatory risk (Burdensome and uncertain licensing procedures), PLN off-take (Uncertainty regarding off-take: is there enough demand in the area? Is the mill close enough from the grid or Will PLN commit to buy or not.

Oil palm companies are exposed to technical and financial risks. The main risks are due to insufficient human resource capacity for operation and long-term survival risks due to inadequate maintenance practices, as well as the lack of engine supplier support for individual site support.

Business risk this program were the development of a POME to electricity facility requires significant investment and electricity generation is not palm oil companies' core business.

3.5. Multi Stakeholder Cooperation to Debottleneck Investment Pome to Electricity

Regulatory risk, strong political commitment and multi-stakeholder cooperation:

- a) Governor letter No 671.2/4753/Distamben dated 13 May 2013 instructing Bupati to facilitate the construction of biogas power plant in their region to increase rural electrification services
- b) POME Biogas Partnership signed on 22 May 2014 between Provincial Government, PLN, District Governments, GAPKI, and GIZ to cooperate in promoting investment in POME to electricity in 3 Districts
- c) Governor letter No 050/2726/Bapp/2015 dated 17 April 2015 on Proposed policy to four ministries to regulate access to POME-biogas
- d) Support districts to draft a regulation to optimize the palm-oil waste utilization
- e) Coordination with PLN to identify priority locations for POME to electricity
- f) 20 mills have been identified for further assessment
- g) Provincial Government will provide assistance to conduct Pre-Feasibility Studies

Business risk, The Provincial Government, through its partnership with GIZ [13] [14] and GGGI [15] has mobilized technical and financial assistance to conduct Pre-Feasibility studies in priority locations:

- a) Palm Oil Companies can be accompanied all the way through project development, from Pre-FS to financial close
- b) Detail engineering design (DED) and power grid construction;
- c) Proactive promotion to the potential POMs;
- d) Business-to-business partnership facilitation

4. Conclusion

Sustainable palm oil development in east kalimantan has become a fact as a driver of locomotive economy in the region. The development of palm oil and its derivatives and its products are encouraged to produce environmentally friendly products. Every palm oil plantation company in east kalimantan is expected to support the greenhouse gas emission reduction program, one of which is a liquid waste processing system (POME) for electricity. In the long run to become a new business source that can supply PLN as a source of electricity through the sale and purchase cooperation of electric energy with excess power scheme

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