PAK Publishing Group
Growing Knowledge for Future

Handbook on Economics, Energy,
Environment and Agricultural Sciences
ISBN: 978-969-9952-08-1

Indonesian Palm Oil Industry in Supporting Energy Securities in Indonesia

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ABSTRACT

Indonesia is blessed with rich in natural resources to provide energy for the world and Indonesian people. However, nowadays Indonesia faces problems in importation of fossil fuel that challenging national energy security. In other side, Indonesia exportspalm oil products i.e.palm oil mealand palm kernel meal those mostly used for world's oil/fat based food products, feedstock for supporting animal husbandry as well as feedstock for energy production likes biodiesel. Palm oil industry produceswastes (by-products)and residues both from plantation as well as at the mill which might use as feedstock for renewable energy in form ofbiomass, biodiesel and biogas.Palm oil biomassin this casefibres, shell and EFB which refer to CPO production in 2013 would be able togenerate electricity around 2 GWh, 4 GWh and 2.16 GWh respectively.Thisbioenergy is potentially good as energy feedstock compared to fossil fuel. A large amount of biomass from palm oil industry might contribute to support energy security in Indonesia.

Keywords: Biodiesel, Biofuel, Biogas, Energy security, Renewable energy.

1. Introduction

In the future, energy supply might be a problem that attracts attention of all nations, because human welfare in modern life is closely related to the amount and quality of energy used (Hasan et al., 2012).Energy crisis is one of modern world vital challenges. Energy is a key component for all sectors of modern economy and plays an elementary role in improving the quality of life (Bari et al., 2002; Gupta et al., 2014; Setyawan, 2014). Nowadays, about 80% of world energy supplies from non-renewable fossil fuels. The sourceof energy such as crude oil, natural gas and liquid fuels were expected to last for around 60-120 years (Koh and Hoi, 2003; Hasan et al., 2012).Global energy demand has been largely satisfied over the last few decades with the aid of technological advancements in the energy sector. However, the truth remains that people live in a world of scarcity. It is a truth that strikes especially hard in the area of conventional energy resources.

Global energy consumption is growing faster than population growth(Irhas and Suryaningsih, 2014). For Indonesia,energy supply is a very important factor for all-around development. Along with the increased development especially in the industrial sector, economic growth and population growth, demand for energy continues to rise steadily(Hasan et al., 2012; Setyawan, 2014). Total primary energy consumption in Indonesia has increased by more than 50% between 2000 and 2010. Despite its declining significance over the years, oil still makes up 30% of Indonesia's total primary energy consumption in 2011. However, oil production, which currently supports the bulk of energy needs, has declined below its production peak of more than 1.6 million barrels per day to roughly just 861.000 barrels per day in 2012 (PERTAMINA, 2013). It means that the energy consumption trend, however, has been increasing over the years.

Indonesia still depending on non-renewable energy sources such as crude oil, coal and natural gas. Utilization of fossil fuel continuously contributesin a largeamount of greenhouse gases emission that leads to climate change. Facing such an unfavorable situation, the government of Indonesia prioritizes on energy supply securities by diversification of energy resources(Hasan et al., 2012; Purba et al., 2014).

Indonesia has barriers and challenges of renewable energy, which are related to demographics, policy framework, economics and business models. Demographics in Indonesia as archipelago are located in the poor, remote and isolated areas. Indonesiastill has no specific policy framework for off-grid

especially for rural electrification(Situmeang and Rauch, 2013). High level of initial capitals investments and customers which have lessability or willingness to afford are the major issues to develop a business models.

Improving quality of life and growing economic global have been motivatingthe researcher to find suitable alternative source of energy. The alternative bioenergy sources are still widely open to explore based on agricultural products and wastes particularly oil crops (e.g. palm oil) and it is scientifically suitable as renewable energy sources. This energy sources would be able to substitute or even replace fossil fuel due to its potency and availability. Moreover, energy from crops especially palm oil is projected to support biofuel demand for the country.

Indonesia is projected to achieve 25% ofsharing of new and renewable energy target in the national mix-energy by 2025. It is listed in a new National Energy Policywhich established by the National Energy Council (DewanEnergiNasional/DEN). Renewable Energy (RE) projects with capacity below 10 MW on Small and Medium Scale Power Generation which based on grid connectivity and location are tariffed. The Government is borne the VAT of geothermal project during its exploration stage as the incentive policy. Government guarantees for Indonesia State Electricity Corporation (Perusahaan Listrik Negara/PLN) payments to power developers on a case-by-case basis.

Indonesia, as the biggest palm oil producer in the world after over taking Malaysia in 2006(Hasan et al., 2012).Further, palm oil exports from Indonesia has jumped to the highest level in at least five years in early 2013 after China and Pakistan boosted purchases tobenefit from a slump in prices. However, crude palm oil (CPO) exported to others countries still in the form of raw which has low value-added industries(Association, 2013). Therefore, the government finallyrealized the important of improving diversification palm oil products not only for food but also focused on oil palm-basedrenewable energy.

2. Cleaner Production in Palm Oil Industry

Palm oil industry producesCPO, palm oil mill effluent (POME) as well as biomass as its by product. Recently, all products from palm oil industries can be used as bioenergy therefore it is well known as zero waste industries (cleaner production model). Zero waste industries can achieve by zero waste concept program. IOPRI has developed a zero-waste concept. This concept is illustrated at Figure 1. Principally, IOPRI zero-waste concept is apply concept on the basic of 4Rs i.e. reduce, reuse, recycle and recovery. Concerning to EFB compost, this product can beutilizedto improve soil condition as well as biofertilizerin plantation. While, the obtained energy can be used to supply power to household or sell it to the grid.

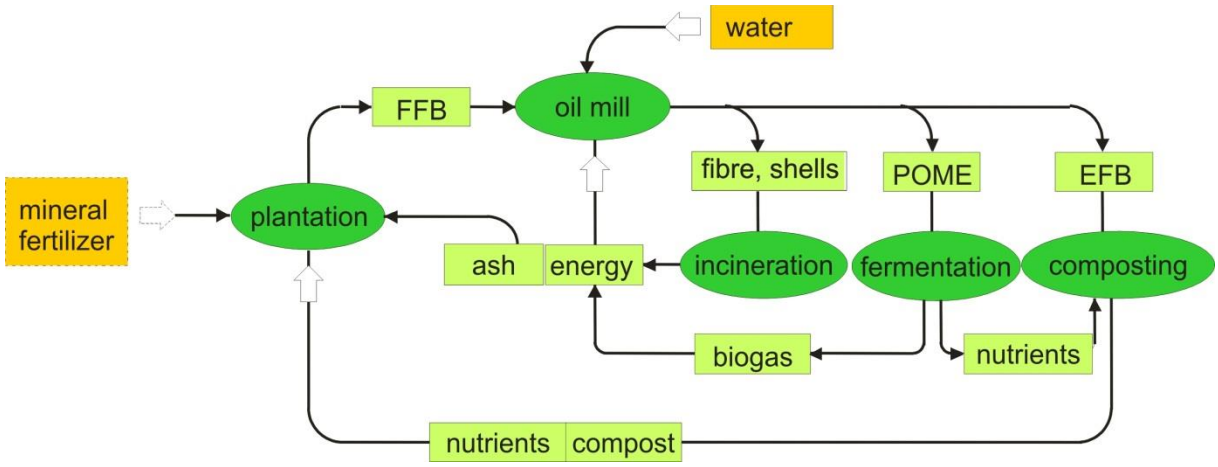

Figure-1. Zero waste concept by IOPRI

3. Bioenergy for Energy Security

Current bioenergy research is focused on unused by-products and growing energy crops allowing environmental benefit. Bioenergy can be obtained from crops residue and processing wastes from mill and etc. Based on residue, potential bioenergy can be competitive as energy feedstock comparedto fossil fuel. Therefore, research about bioenergy towards to reduced production cost, higher energy conversion efficiency and greater cost effectiveness of biofuel.

Energy security is concerned for both net energy importers and exporters this includes the effective management of primary energy supply from domestic and external sources, the reliability of energy

infrastructure, and the ability of participating energy companies to meet current and future demand. For countries which are net energy exporters is also related to an ability to maintain revenues from external sales markets(Situmeang and Rauch, 2013).

Research and development (R&D) institutesencourage through international cooperation and collaboration focusing on low-carbon & carbon-free energy technologies and taking into account of the role of intellectual property rights, and to promote demonstration project in key areas. Deployment of low-carbon and carbon-free energy technologies has greater role of renewable to promote greater efficiency in energy production (supply side) and energy use (demand side), and provide efficient transmission and distribution systems. This is one of routes to enhance energy security.

4. Source and Form of Bioenergy in Palm Oil Industry

Processing of palm oil for CPO extraction leads to the formation of several by-products and residues that have an economical potential. However, by-products have to convert to energy such as biomass (fibre, shell and EFB) and palm oil mill effluent. The common energy which can be converted from oil palm is electricity, biogas, biodiesel, bioethanol and bio-oil by applying cracking technological process(see Figure 2).

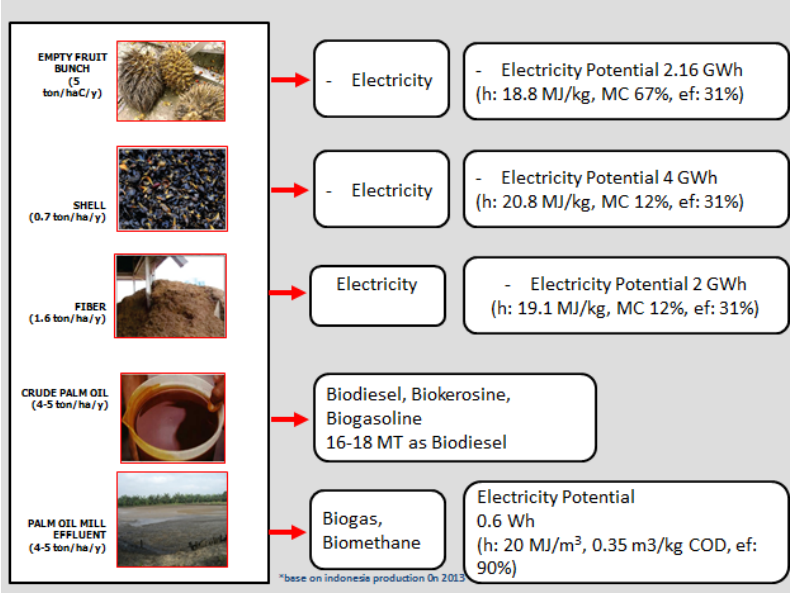

Figure-2. Potency and application of palm oil mill products, by-products and residues as energy.

4.1. Crude Palm oil

CPO and its derivative product can be generated as bioenergy in formsofbiodiesel. As fuel, biodiesel is nontoxic, biodegradable and generally better than petroleum diesel(Bari et al., 2002; Nasution et al., 2006). Biodiesel can be used itself or blended with petro diesel. Indonesia, through PT Pertamina supplies biodiesel as "Bio-solar", blends around 2% biodiesel (B2). Pertamina biodiesel feedstock made from palm oil product. However, there is a disadvantage for palm oil (as we know for food) as biodiesel feedstock: wide scale production biodiesel can cause an increase in worldwide food and CPO process (Gupta et al., 2014).

For this case, Indonesia might use biodiesel from CPO for reducing import petro diesel. Likes in Malaysia, the palm oil industry is required of 5% of biodiesel for transportation while preserving the supply of palm oil used as food (Hassan et al., 2011). Biodiesel is commonly produced by trans-esterification reaction(de Almeida et al., 2002; Nasution et al., 2006; Alamsyah and Loebis, 2014). Currently, IOPRI is developing biodiesel, bio-kerosene, bio-gasoline through cracking process. IOPRI so far has developed a trans-esterification process with a variety of catalysts and feedstock. Whereas cracking process is still conducted in high pressure and temperature.

4.2. Biomass

Empty fruit bunch, fibre and shell isknown as biomass from palm oil mill (POM). More CPO produced means more palm biomass wastes. A POM wastes around 12 to 15% fibre, 5 to 7% shell, and 20 to 23% EFB based on its capacity (Nasution et al., 2014). However, this biomass waste has to use in

proper way to overcome its disposal problem concerning to environment problems and issues. Referring to use oil palm biomass as bioethanol feedstock,it is a bioconversion process of lignocellulosic into fermentable sugars. Bioethanol can be used in petrol engines as a substitution for gasoline. However, bioethanol technologies from biomass especially oil palm biomass are under development and have not been yet established commercially (Demirbas, 2008). Oil palm biomass as feedstock in firing biomass power plant has some ways to firing. For example, biomass direct to firing; biomass convert to bio-pellet; and co-firing to coal as well.

Actually, palm biomass is utilized for many purposes. Fibre and shell are the main source of energy input in a POM. The obtained energy production is more than enough for energy requirement at the mill. EFB and POME were also commonly applied for mulching at palm oil plantation since they contain nutrients or even just disposed in the landfill at the peak harvest season. On the other hand, thesematerials have potentially high as biomass to generate energy.

Power sector in the industrialized is dominated from fossil fuel and its demand is increasing very rapid in line with globalization. Therefore, fossil fuel is subjected to the carbon emission and environmental pollution. By this fact, it is highly recommends that energy from palm biomass can be used as substitution.

Whole palm biomass has been long identified and utilized as Renewable Energy (RE)(Chang, 2014). Various studieshave developed and evaluated the feasibility of palm biomass for power plant. SREP (Small Renewable Energy Power) is a concept to support government electricity demand by supplying the excess energy to the State Electricity Company (Perusahaan Listrik Negara) by the closest gridline from POMs.

CPO production on 2013 is 25 Mt ton, if this product can be convertedinto biodiesel, there is about 16-18 Mt ton of biodiesel can produce as energy. However, CPO as food product on 2013 is 6 Mt and the excess can convert to biodiesel. Biomass can generate electricity as well as fibre, shell and EFB based-CPO production on 2013 around 2 GWh, 4 GWh and 2.16 GWh respectively.

Bioethanol can be used as a petrol fuel engines to substitute gasoline. This biofuel is produced by fermentation from sugar or starch sources. Bioethanol feedstock can be divided into three major groups, that are sugar-based, starchy and lignocellulosic(Gupta et al., 2014). While, oil palm contains more biomass and this biomass contains approximately45% oflignocellulosic (in this case EFB). The potential of bioethanol production on the basic of palm oil industry is currently necessary to develop and implementation.Further, the bioethanol production process is conducted through converting of lignocellulosicin EFB into bioethanol. Use bioethanol and blending with fossil fuel can significantly reduce the petroleum fuel consumption as well as reducing GHG emission.

4.3. Palm Oil Mill Effluent (POME)

Palm oil mill produces palm oil mill effluent as by product and this waste can be converted into biogas through anaerobic fermentation of organic materials in anaerobic reactor. The main chemical compositions of biogas are methane (CH4), carbon dioxide (CO2) and sulphuric acid (H2S)(Harsono et al., 2014). The component with high economic value is CH4due to high calorific value of this gas. While, CO2 is zero calorific value and H2S is corrosive. Biogas production comprises three steps i.e. hydrolysis, acetogenesis and methanogenesis. In this production, type of digester/reactor is one of important equipment considering to chemical composition of biogas.Related to this reactor, IOPRI has developed the reactor and it divided into twotypeof digesters, i.e. above ground and in ground level.

Concerning to use of biogas from POME, IOPRI has intensively focus on the use of biogas as fuel for vehicle. Therefore, improving methane content through purification process is needed. After 3 years, IOPRI has developed a technology to package biogas for commercial purposes by using biogas tank through high compression processing (approx. 200 bar). This compressed biogas is namely "CBG Sawit" (compressed biogas palm oil). Other purpose of biogas application is for electricity. In this caseaPOM can generate 1 to3MW electricity. The potency of electricity production from POME on the basic of CPO production in 2013 is about 0.6 GWh. This value is assumed that 35 m3 methane for 1 kg COD and 50.000 ppm COD concentration.

In addition to methane, another type gas can be also produced from POME i.e. hydrogen. IOPRI is currently developing a technology to produce hydrogenfrom POME using electrocoagulation technology, algae cultivation and its combinations. Preliminary, this technology has two advantages such as wastewater pre-treatment and energy generated.

5. Conclussion

Decentralized energy generation is as solution for Indonesia energy crisis as well as palm oil mills are as satellite energy generation. Oil palm industries not only produce CPO as main product but also biomass and POME as by-productwhich have potentially high as renewable energy source to support energy security in Indonesia due to its characteristics and availability. CPO and its derivatives, generally used for food, but it can be converted as biodiesel, bio-kerosene and bio-gasoline as well. Biogas and electricity from POME can be use at the mill for energy,for housing and/or sell it to state gridline. Indonesia, as one of the largest palm oil producer in the world is projected to explore the potential palm oil as source of energy alternative.

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