Oil Palm Plantations as a Strategic Industry for Sustainable & Renewable Energy in Indonesia

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Introduction

The existence of the palm oil industry is considered strategic for the national economy. The palm oil industry is also considered capable of building food security and energy sovereignty and is currently being encouraged to develop downstream to boost domestic economic activity. National oil palm plantations have grown rapidly, expanding both upstream and downstream. Until now, oil palm plantations and palm oil mills have spread to more than 200 districts in Indonesia. The production of crude palm oil (CPO), palm kernel oil (PKO), and biomass has become the economic support for these central areas of the palm oil industry.

Renewable energy absolutely must be developed, because the existing energy, such as diesel, still uses raw materials from petroleum, over time it will run out because it cannot be renewed. One of the renewable energy sources available to Indonesia is biodiesel and palm-based bioethanol. As a country that has the world's largest oil palm plantation, oil palm plantations are not only a producer of edible oil and non-edible oil, but also have the potential to become a renewable energy "mine". Biodiesel itself plays a major role in reducing greenhouse gas emissions in 2020, biodiesel contributes to reducing emissions of 22.48 million tons of CO_2 equivalent and it is estimated that by the end of 2021 it will contribute to reducing emissions of 25.4 million tons of CO_2 equivalent. The contribution of biodiesel in 2020 has succeeded in reducing 22% of greenhouse gases from fossil energy use, as Indonesia's target stated in the 2030 National Determined Contribution (NDC) document.

Oil palm plantations are an important industry in the national energy transformation plan from non-renewable energy to renewable energy. In this regard, Indonesia has been developing renewable energy substitution since several years ago through the mandatory policy of palm biodiesel which has now become B30. Through the mandatory policies B15 (2015) and B20 (2016), Indonesia was able to reduce imported fuel which automatically saves imported foreign exchange. In 2015 there was at least a savings of USD 5.6 billion. Meanwhile in 2020, it was recorded that the volume of biodiesel absorbed for the B30 program reached 8.4 million kiloliters. This means that there is a saving of foreign exchange on imports of fossil diesel of USD 2.66 billion.

The government has determined biodiesel as a future alternative energy transition. This biofuel not only saves foreign exchange from fossil energy, but also reduces greenhouse gas emissions. Biodiesel is a biofuel consisting of a mixture of methyl ester compounds from long

chain fatty acids which is intended as an alternative fuel for diesel engines. Crude Palm Oil (CPO) is used as the main raw material for biodiesel. The simple technique is that 30% of processed mixed palm oil of fatty acid methyl esters (FAME) is mixed into diesel oil to produce a product called B30. This policy was initiated in 2006 starting with B5 and began to be massively produced starting in 2016 to increase diesel fuel by 20%.

Palm Oil Plantation as a Renewable Energy "Factory"

Oil palm plantations can be viewed as biological "factories" to capture and store solar energy. Through the process of photosynthesis/assimilation of oil palm plants, solar energy is captured and stored in complex chemical bonds of carbon and hydrogen. Carbon is absorbed by oil palm plants from the earth's atmosphere, while hydrogen is obtained from water that plants absorb from the soil. Therefore, oil palm plantations, like other crops, are carbon sequestration absorbers from the earth's atmosphere.

Palm oil plantations and mills produce large amounts of solid and liquid waste that have not been utilized optimally. The fiber and some of the palm kernel shells are usually used as boiler fuel in the factory, while oil palm empty fruit bunches, which account for about 23% of processed fresh fruit bunches, are usually only used as mulch or compost for oil palm plantations. Besides producing palm oil, palm oil also produces palm biomass such as empty fruit bunches, shells, midribs, trunks, and palm oil sludge. From 11 million hectares of oil palm plantations, 182 million tons of dry biomass can be produced. With the fermentation technology from the biomass, 27 million tons of bioethanol or bio premium can be produced. In addition, with biogas technology, palm mud ponds can be used as biogas to replace natural gas and produce bioelectricity.

While biomass through advanced processes (chemical and biological) can be obtained bioethanol as a substitute for premium fossils (gasoline). This biomass is often referred to as second generation biofuel. In addition to biodiesel and bioethanol, from palm oil mill waste or POME (palm oil mill effluent) through biogas technology (methane capture) energy can be harvested in the form of methane gas (biogas) as a substitute for natural gas. In contrast to fossil energy (diesel, premium, and natural gas) which cannot be renewed (non-renewable) and will eventually be depleted, palm oil biofuels (biodiesel, bioethanol, and biogas) are renewable energy.

Palm Bioethanol Production Technology

The Indonesian Institute of Sciences (LIPI) has developed a 2nd generation bioethanol production technology to support the conversion of fossil fuels. This technology is able to convert biomass waste, especially empty oil palm fruit bunches into bioethanol. It was found that empty oil palm fruit bunches, waste from palm oil mills, can be used as raw material for bioethanol. As we know that the number of empty palm oil bunches is very large, abundant in various places in Indonesia. Therefore, this condition can support the lignocellulose bioethanol industry on a large scale.

Palm oil waste consists of cellulose and hemicellulose components. To treat palm oil waste in an integrated manner, we can use the biorefinery concept that utilizes biomass as a raw material for the production process for energy sources, chemicals, foodstuffs, and medicines. By decomposing the cellulose component of palm oil waste into glucose, the glucose resulting from the decomposition of cellulose is then fermented into bioethanol. In 2014 the conversion of ethanol to bio gasoline was carried out using a solid acid catalyst and dehydration of ethanol with natural zeolite.

Chemical Research Center – LIPI has built a pilot plant for bioethanol production from lignocellulosic materials with a capacity of 10 L/day with a purity >99.5%. Several activities were carried out in 2011–2013, from preparing facilities and utilities for the pilot plant, installing, and testing it, to testing bioethanol production several times a year. In 2013, bioethanol production was carried out using a pilot plant which produced around 150 L/ton bioethanol. The efficiency of each stage of the process at the pilot plant is quite high, which is around 85–99%. Bioethanol trials have also been carried out on vehicle engines in a static state to a mixture of 25% bioethanol with premium without a decrease in engine torque and power.

Korea Investment Prospects on Bioethanol

The potential for biomass production of Indonesian oil palm plantations is around 182 million tons. If it is processed into ethanol, it can produce 23.7 million kilo liters of bioethanol every year. In addition, the utilization of 147 million tons of POME (palm oil mill effluent) can produce 4127 million m^3 of biogas. The results of the reconciliation of the national oil palm cover area coordinated by the Coordinating Ministry for Economic Affairs in 2019 have identified an area of 16.38 million ha, with the distribution of community plantations (both self-help and partnerships) of 6.72 million ha (41%), large state plantations of 0.98 million ha (6%), and large private plantations at 8.68 million ha (53%). Experts have also projected that by 2030 the distribution of oil palm area will be dominated by smallholder plantations at 60%, large private plantations at 36%, and large state plantations at 4%. As the largest producer country that controls about 55% of the world's palm oil market share and utilizes no more than 10% of the total global land bank for vegetable oil, Indonesia is able to produce 40% of the world's total vegetable oil that can convert to bioethanol.

The 1st generation bioethanol is made from food ingredients containing starch and sugar, the 2nd generation bioethanol is made from plantation, forestry, and agricultural waste as raw material. The 2nd generation of bioethanol is ready to replace gasoline which is a non-renewable energy source. This 2nd generation of bioethanol cooperation project is taking place between the Indonesian Institute of Sciences (LIPI) and the Korea International Cooperation Agency (KOICA) in the development of a 2nd generation bioethanol plant. KOICA helped fund the equivalent of IDR 30 billion. The funds were used to build a bioethanol factory at the Research Center for Science and Technology (Puspiptek) Serpong, South Tangerang. In addition, funds to finance experts, both from Korea who were brought to Indonesia and experts from Indonesia, for comparative studies to Korea.

Furthermore, ESDM (Ministry of Energy & Mineral Resources) R&D Agency and the Korea Institute of Energy Technology Evaluation and Planning (KETEP) have collaborated since 2015, especially regarding new and renewable energy. This cooperation was strengthened through a Memorandum of Understanding (MoU) signed on May 16, 2016 at the 6th Working Level Task Force RI-South Korea in Seoul. Energy has become one of the most important issues globally in the last few decades, so the problems posed by the energy sector also require global partnership solutions.

Conclusion

Indonesian oil palm plantations produce two types of renewable energy, namely 1st generation biofuel in the form of biodiesel and 2nd generation biofuel in the form of bioethanol (biomass-based) and biogas (POME-based). The energy is produced simultaneously (joint product) and is sustainable. The potential for biomass production of Indonesian oil palm plantations is around 182 million tons of dry matter. If it is processed into ethanol, it will produce 23.7 million kilo liters of bioethanol every year. In addition, it also produces about 147 million tons of POME which can produce biogas of 4127 million m^3.

Oil palm plantations are an important industry in the national energy transformation plan from non-renewable energy to renewable energy. Biodiesel is a partial substitute for diesel, premium substitute bioethanol and biogas as a substitute for natural gas. Thus, Indonesian oil palm plantations are one of the national renewable and sustainable energy strategic industries. Besides needing to be protected, it also needs to be promoted as an important part of the strategy to build national energy sovereignty, including the conversion of non-renewable energy to renewable energy.

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