Sustainable resources management to support Sei Mangkei SEZ as an eco-industrial park

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Abstract. Sei Mangkei SEZ as an eco-industrial park with the development of downstream of natural resources resulting from plantations in North Sumatra, especially oil palm and rubber, emphasizes the principle of sustainability and environmentally friendly in exploring natural resources into quality ready-made products. The need for energy is very necessary to support the development of the region, region’s ability to provide energy independently is still limited to using of oil palm empty fruit bunches as an alternative source of electricity in the palm oil mill. The use of by-products is one aspect of sustainability that has been done in the Sei Mangkei SEZ. However, a more comprehensive analysis is needed to meet the energy needs of the Sei Mangkei SEZ as a whole so that the area's operations can proceed as expected. This paper is written with a qualitative approach and then analysed descriptively to obtain renewable energy management to be applied to the Sei Mangkei SEZ. The research informants were the managers of the Sei Mangkei SEZ, namely: the administrator of the Sei Mangkei SEZ, PTPN III, and PT. Kinra. This paper will present the available energy sources, energy management problems, and appropriate energy management advice. Primary data were obtained from interviews and documents, as for secondary data obtained from previous research reports, articles from relevant journals, and regulations that support the application of sustainable energy management in the Sei Mangkei SEZ. This paper concludes that SEZ Sei Mangkei has implemented the principle of the eco-industrial park and can develop as planned. An alternative to meet the needs of electrical energy in Sei Mangkei SEZ are obtained from biomass power energy, namely: shells, empty fruit bunches, palm oil mill liquid waste, and domestic solid waste. This research suggests that biomass energy as an alternative source of electrical energy needs to be applied as soon as possible before the area operates optimally, and the demand for electrical energy is increasing.  
Keywords: Sei Mangkei SEZ, eco-industrial park, renewable energy management.

1. Introduction
Sei Mangkei Special Economic Zone (SEZ) is a business development approach in the form of a particular area for industrial centers based on oil palm and rubber. The uniqueness of KEK Sei Mangkei is its location in the agro-based raw material center, which is not owned by other industrial estates in Indonesia. Sei Mangkei SEZ has an area of 1,933.8 ha and is expected to be able to absorb 83,304 people by 2031. The philosophy of Sei Mangkei SEZ as "Eco-Industrial Park" with the development of downstream of natural resources resulting from plantations in North Sumatra, especially oil palm and rubber, with an emphasis on the principles of sustainability and environmentally friendly in exploring natural resources into quality ready-made product.

Sei Mangkei SEZ is located in Simalungun Regency, North Sumatra Province as one of the projects of the Master Plan for the Acceleration and Expansion of Indonesian Economic Development (MP3EI) and officially opened in 2015 by President Jokowi. In 2020, the palm oil industry is still a significant activity in the Sei Mangkei SEZ. Supporting businesses such as: logistics, energy, electronics, supporting industries for production, various industries, and tourism, have not run as expected. The Sei Mangkei SEZ development seems slow, one of which due to the limited energy for regional operations.
Besides the distribution of gas as a source of energy has problem due to the high price. As well as, industrial activities that are expected to develop, have not experienced significant progress.

Energy needs are necessary to support the development of the region. The ability of the region to provide energy independently only limited to the use of oil palm empty fruit bunches as alternative electrical energy in the palm oil mill. The use of by-products is one aspect of sustainability has been done in the Sei Mangkei SEZ. However, a more comprehensive analysis is needed to meet the energy needs of the Sei Mangkei SEZ as a whole so that the area's operations can proceed as expected.

Palm oil-based production activities produce waste and cause environmental issues, such as: energy consumption, disposal of solid and liquid waste (POME), greenhouse gas emissions, and water pollution [1]. Sei Mangkei SEZ, as palm oil and rubber-based business center, is expected to produce renewable energy sources from waste generated from activities in the region. Based on this background, it is important to formulate renewable energy management efforts, to support sustainability of Sei Mangkei SEZ as an eco-industrial park.

2. Method
This paper uses a qualitative approach and then analyzed descriptively to obtain renewable energy management that can be applied at the Sei Mangkei SEZ. The research informants were the managers of the Sei Mangkei SEZ, namely: the administrator of the Sei Mangkei SEZ, PTPN III, and PT. Kinra. This paper will present the available energy sources, energy management problems, and appropriate energy management advice. Primary data were obtained from interviews and documents. In contrast, secondary data comes from previous research reports, articles from relevant journals, and regulations that support the application of sustainable energy management in the Sei Mangkei SEZ.

3. Results and discussion
Sei Mangkei SEZ management consists of: Administrators, PTPN III, and PT. Kawasan Industri Nusantara (Kinra). Administrators have a duty to carrying out monitoring and control activities with the assistance of technical personnel from: the Office of the Environment, Labor offices, and, the Department of Spatial Planning and Settlements of the Government of Simalungun Regency. The office has a role in providing technical recommendations to prospective investors who want to invest in the SEI Mangkei SEZ.

PTPN III as the owner of oil palm and rubber plantation land, which is currently a Sei Mangkei SEZ. PTPN III was established as the development and management body of the Sei Mangkei SEZ according to the Decree of the Simalungun Regent No. 188.45 / 193 / BPPD in 2012. Then in 2015, PTPN III received the approval of Sei Mangkei SEZ’s Land Management Rights (HPL) covering an area of 1,933.80 ha under the Decree of the Head of the Republic of Indonesia's National Land Agency (BPN) No. 27 / HPL / BPN RI / 2014 dated June 23, 2014, as a building body.

Infrastructure development in the Sei Mangkei SEZ has now entered the second phase with a 2016-2021 timespan and a development plans covering area of 640 hectares. In 2018, the area has been developed and used by tenants is 212 ha, or still one-third of the target for the second phase of development. The infrastructure that has been provided by PTPN III for the interests of managers and the region, namely: roads within the area; electric network; gas pipelines; telecommunications networks and information technology; water treatment center; wastewater treatment center; dry port; and, storage tanks. Furthermore, all infrastructure that has been provided by PTPN III, is managed by PT. Kinra.

PT. Kinra is a business entity owned by PTPN III with business in the marketing and management services of SEI Mangkei SEZ. The establishment is aims to optimizing the utilization of the company's power so that it produces goods and/or services that are of high quality and are highly competitive to obtain/pursue profits to increase value following the company's principles. Institutionally PT. Kinra is under the Sei Mangkei KEK Administrator in reporting and developing investments in the Sei Mangkei KEK.

The management of SEI Mangkei SEZ is carried out by marketing plots; maintenance; security; and, logical. The activity was carried out by a subsidiary of PT. Kinra by the respective fields. Management of the storage tank, dry port, and warehousing is carried out by PT. Kinra Logistik. Then for the management of electricity, natural gas, and new renewable energy, is carried out by PT. Kinra Energy. Management of clean water, liquid waste, solid waste, and firefighting is carried out by PT. Kinra.
Utilities. PT. Kinra Property manages hotels, golf courses, tourism, housing, apartments, schools, hospitals, shopping centers, as well as sports centers.

In 2018 there are three tenants have operating, namely: Sei Mangkei palm oil mill; Sei Mangkei kernel oil factory; and PT. Unilever Oleochemical Indonesia. The lack of operating tenants compared to an area of 1,933.80 Ha, makes the carrying capacity and capacity of Sei Mangkei SEZ at a level that can be tolerated and has not affected the area negatively.

Referring to the Sei Mangkei SEZ master plan, the entire land has the following designation: palm oil industrial zone; various industry zones: production infrastructure facilities zone: rubber industry zone; electronic industry zone; commercial area; office area; logistics and warehousing; public facilities; housing; and, tourism. The diversity of activities in the region requires adequate resources to function optimally.

In 2019 the source of electricity used in the Sei Mangkei SEZ was provided by PT. PLN with a capacity of 150 kV 60 MVA. There is one tenant who does not use electricity from PT. PLN. Namely palm oil mill that uses electricity derived from biomass energy, in the form of palm oil shells. The electrical energy generated is used only for the needs of palm oil mills. The Palm Biomass Power Plant (PLTBS) has a capacity of 2 x 3.5 MW. In comparison the fulfillment of electrical energy sourced from gas is considered inefficient due to the high price. The distribution of electricity in the Sei Mangkei SEZ is carried out by PTPN III as the manager of the area and owner of electricity business area permit.

The operation of PLTBS experiences constraints from the aspect of biomass sources, i.e. oil palm shells. The price of expensive palm shells results in limited electricity generated. So, the use of empty fruit bunches as a source of energy is more recommended. The alternative that will be carried out by the manager is to optimize the electrical energy from palm oil waste, namely by handing over the management of PLTBS to third parties with biomass sources from empty fruit bunches because the price is relatively lower.

Palm oil biomass waste such as empty fruit bunches, shells, and fiber are resources which can be converted into energy. Based on the results of research taking samples at the Palm Oil Mill in North Sumatra, 30 tons of empty fruit bunches can produce electricity with a power of 20 - 35 MW [2]. In addition to selecting renewable energy sources, optimization of palm oil waste as a source of biomass energy can be through torrefaction. Torrefaction process on palm oil waste is a slow roasting process to remove oxygen and produce the final result in solid form. The stages of the torrefaction process are preheat, pre-drying, post-drying, and intermediate heating, torrefaction, and cooling. The advantages of using the torrefaction process are: reducing fossil fuel consumption, improve waste management systems, reduce contamination to the environment, and, increase energy sources [3].

![Figure 1. Properties changes of oil palm solid wastes before and after torrefaction [3]](image)

In addition to palm oil solid waste, activities at the SEI Mangkei SEZ also produce solid waste and liquid waste from tenants, and domestic waste. PT. Kinra manages all liquid waste in the SEI Mangkei SEZ, except liquid waste from palm oil mills. Liquid waste management at PT. Kinra is adjusted to UKL-UPL documents, then flowed to the river body. At the same time, management of domestic solid waste is still done conventionally, by providing garbage trucks to transport solid waste to the landfill.
Until 2020, KEK Sei Mangkei does not have land that can be used as a landfill. Therefore, an alternative of domestic waste management is needed to avoid decreasing of environmental carrying capacity.

Based on these facts, there are potential renewable energy sources from domestic solid waste to be used as renewable energy sources. Domestic waste management is an efficient method to both increase resource efficiency (material and energy recovery instead of landfill disposal), and to replace fossil fuels with renewable energy sources (waste is renewable in itself to a large extent as it contains paper, wood, food waste, etc.) [4].

In general, activities at the SEI Mangkei SEZ have implemented the philosophy of eco-industrial park. Because they have used the symbiosis industry approach to achieve regional competitive advantage. The hallmark of the symbiosis industry is the physical, material, energy, water, and by-product exchanges [5]. The symbiosis industry concept that has been running at the SEI Mangkei SEZ, namely:

a. Kernel produced by palm oil mill is used by kernel oil factory to produce oil and meal.
b. Crude Palm Kernel Oil (CPKO) produced by kernel oil factory is used by PT Unilever Oleochemical Indonesia as raw material;
c. Crude Palm Oil (CPO) produced by palm oil mill can be used by PT. Industri Nabati Lestari after the company has completed its construction and can begin its operational activities.
d. Empty fruit bunches are planned as raw material for the power plant after the power plant construction is complete.
e. Liquid waste of palm oil mill with high chemical oxygen demand (COD) is planned to use as source of biogas power generation.

The concept of industrial symbiosis is also emphasized by [6], which states that the use of by-products is one of the characteristics of the eco-industrial area. Sustainability is also a vision of the Sei Mangkei SEZ’s management to create a modern industrial city that is highly competitive and environmentally sound through the development of optimal processing of local natural resources in 2031.

The principle of sustainability that is promoted by the Sei Mangkei SEZ, is one of the environmental performance evaluation variables that include: material used by weight or volume; the percentage of recycled material used; direct energy consumption from primary initiative resources; energy savings; renewable energy supply; water consumption taken from its source; and, the percentage of water that is recycled and reused. Research results of [7] concluded that most of managers in Sei Mangkei SEZ understood that sustainability variables should be used in environmental performance assessment to support the philosophy of eco-industrial park.

4. Conclusions and recommendations
Sei Mangkei SEZ has implemented the principle of the eco-industrial park and can develop as planned. Alternative fulfillment of electrical energy needs in Sei Mangkei SEZ come from biomass power energy, namely: shells, empty fruit bunches, palm oil mill liquid waste, and domestic solid waste. The use of biomass energy as an alternative to electrical energy must be done as early as possible before the area operates optimally and the demand for electrical energy is increasing.

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