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Study on Potential Utilization of New Renewable Energy to Support the Electricity System in Warudoyong Area

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***Abstract*—Energy is one of the most basic human necessities for supporting activities that continue to expand in number as the population and economy rise. On the other hand, the majority of today's energy originates from fossil-based electricity, which has non-renewable qualities, meaning that its reserves will deplete if consumed indefinitely. In particular, Indonesia and the Warudoyong region of West Java Province have a diverse range of new and renewable energy (EBT) possibilities dispersed across the majority of their territory, ranging from solar energy, wind energy, bioenergy, marine energy, and geothermal. The goal of this study is to map the potential of EBT in the Warudoyong area in order to aid the government's goal of achieving the national energy mix and supporting energy diversification in the power system. The findings of the study show that there is a lot of renewable energy potential in the Warudoyong area, which can be converted into electrical energy.**

Keywords—New Renewable Energy, Potential, Warudoyong

I. Introduction

Energy is one of the most basic human requirements that may support a wide range of activities in all parts of the world. With population growth and the increasingly complicated economic activities carried out by humans in the modern era, the demand for power is growing. Several sectors, including the industrial, transportation, commercial, and residential sectors, all demand large amounts of energy. In general, Indonesia's energy consumption is still based on traditional energy sources. This situation indicates that fossil-based energy resources will run out due to limited reserves and a lengthy formation process. Demand for fossil-based energy resources, on the other hand, is increasing, resulting in higher oil prices [1].

Fossil-based fuels currently account for the majority of the energy mix used to meet national energy demands. Currently, 50 percent of power plants are coal-fired, 29 percent are gas-fired, 7% are oil-fired, and 14% are a combination of various types of new and renewable energy (EBT) [2]. With the present rising demand for energy [3], it is vital to diversify energy sources by creating alternate energy sources to meet domestic energy needs.

Indonesia has a wealth of energy resources, ranging from solar energy, wind energy, bioenergy, marine energy, and geothermal energy to other types of EBT. According to their qualities and geographical conditions, the potential of NRE resources tends to be dispersed among Indonesia's many regions. It is well known that Indonesia has a tropical climate, which means the sun shines all year [4]; countries with long coastlines and vast oceans as a source of energy from waves flowing in the middle and deep seas, differences in sea layer temperature, offshore wind energy, and floating solar electric energy; densely populated large urban areas as a source of energy from household waste and waste; a variety of volcanoes With effective cross-sectoral cooperation, transitioning to new and renewable energy is surely possible.

Based on this context, this literature review will examine several types of NRE potential inside the Republic of Indonesia's sovereignty, notably in the Warudoyong area of West Java Province, in order to aid the government's attempts to meet the NRE mix target in the power sector. The findings of this study are expected to serve as a guide for the government, PT. PLN (Persero), industry, and the general public in harnessing the potential of EBT and converting it into electrical energy.

II. New Renewable Energy

A. Condition of New Renewable Energy in Indonesia

Indonesia has extensive energy resources, both fossil and non-fossil-based energy sources (NRE), due to its equatorial location. However, until today, fossil-based energy has dominated the majority of energy generated and consumed. As the output of fossil-based energy, particularly oil, declines and the world commits to lowering greenhouse gas emissions, the government strives to increase EBT as part of ensuring energy security and independence. In 2025, the NRE mix should be at least 23 percent, and by 2050, it should be at least 31 percent. Indonesia has a huge renewable energy potential, with a total capacity of 417.8 gigawatts (GW). This potential, according to the Ministry of Energy and Mineral Resources (ESDM), comes from a variety of renewable energy sources, as illustrated in Table 1. For electric power system management, the productive potential of NRE is both an opportunity and a challenge to diversify energy sources by paying attention to technical factors, operations, and economics [5]–[7].

Tabel I Potency New Renewable Energy in Indonesia [2]

Types of Renewable Energy	Potency
Hydropower	94,3 GW
Geothermal	28,5 GW
Bioenergy	PLT Bio : 32,6 GW dan BBN : 200.000 Bph
Solar energy	207,8 GWp
Wind	60,6 GW
Ocean Energy	17,9 GW

Until the end of 2020, the EBT target in the national energy mix has been met to the tune of 14 percent. According to this diagram, an ideal strategy is required to meet the EBT mix objective in 2025. The Electrical Supply Business Plan (RUPTL) is a ten-year reference document released by PT. PLN (Persero) to enhance the use of renewable energy, particularly in the electricity system. Various facets of NRE growth, ranging from potential and capacity to economic issues, must be synchronized. Indonesia will work toward its NRE goal till 2030 by building power plants with energy sources ranging from hybrid solar energy, wind, bioenergy, ocean waves, geothermal, and numerous other forms of EBT.

The trilemma of energy in energy security, equity (energy equity), and environmental sustainability must all be considered while planning the electric power system [8]. Primary energy management [9], infrastructure [10]–[12] and operations [13], and the ability to satisfy current and future needs [14], [15] are all aspects of energy security. It is, of course, critical to pay attention to electricity assets in order for them to continue to function optimally [16]–[19]. Energy equity refers to the affordability of energy for all people, both physically (accessibility) and financially (affordability). Environmental sustainability refers to energy conservation in order to avoid potential environmental harm, such as climate change.

B. New Renewable Energy (EBT) in Warudoyong

Warudoyong is located in the southern part of West Java Province, namely at coordinates - 06.925157°,106.92957°. [20].

Figure 1. Map of Warudoyong

III. Potential Of New Renewable Energy In The Warudoyong Region

EBT is a sort of environmentally friendly energy that does not emit pollutants into the environment and does not contribute to climate change or global warming. This is because NRE is derived from natural processes that are both sustainable (renewable) and abundant. Non-hydro EBT has the potential to develop throughout Indonesia, particularly in Warudoyong, West Java Province, and includes solar energy sources, wind energy sources, bioenergy sources, ocean wave energy sources, and geothermal energy sources. Local renewable energy sources can also be used with a microgrid system and associated infrastructure to electrify areas that are not served by the distribution network [21–23].

A. Solar energy

On the equator, Indonesia is a tropical country. As a result, Indonesia has a large potential for solar energy, which is available all year and can be turned into renewable energy-based electrical energy [24]. Photovoltaic cells, often known as photovoltaic panels, are a technology that converts primary energy in the form of sunlight into secondary energy in the form of electricity (PV). From the time it was initially discovered in 1883 until now, PV cell technology has advanced at a breakneck pace. In recent periods, there has been an increase in efficiency followed by a large price drop.

Solar power generation, also known as PLTS, is a technique that may be used in any part of Indonesia, even 3T zones (frontier, remote, and underdeveloped). Some areas of Warudoyong are still not served by PT. PLN's distribution system (Persero). Installation, operation, and maintenance of PLTS technology are simple [25]. The selection of configurations such as domestic (small residential), industrial (middle size commercial), PLTS system (ground-mounted large scale), and PLTS floating (floating large scale) must be considered in the process of monitoring potential in order to achieve an estimated energy

expansion. It is possible to generate it once a year. According to Figure 2, the average solar radiation in Indonesia exceeds 4.80 kWh/m2 per day.

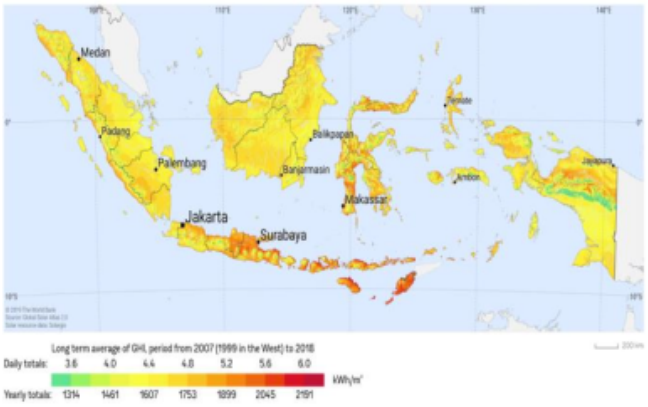

Figure 2. Potential of Solar Energy in Indonesia [26]

It is known that there is a possibility of 1.312 Mwh per year or 1.712 kWh/m2 in the Warudoyong area (-06.925157°,106.92957° with a home or domestic configuration [27]. Table II lists all of the solar energy potential metrics in Warudoyong. Table II shows these figures. Depending on the configuration and extent of land to be used, these figures will be higher.

Tabel II Solar Energy Potential Data In Warudoyong [27]

Parameter	Value
Direct normal irradiation	1.045,7 kWh/m^2
Global horizontal irradiation	1705,0 kWh/m^2
Diffuse horizontal irradiance	928,8 kWh/m^2
Global tilted irradiation at optimum angle	1.725,5 kWh/m^2
Optimum tilt of PV modules	11 / 0°
Air temperature	23,8 °C
Terrain elevation	591 m

The intermittent qualities or changes in the amount of irradiation in a short period are one of the obstacles to using solar energy on a big scale (large scale) [28], [29]. Harmonics, power factor variations [30], voltage fluctuations, current fluctuations, and system frequency fluctuations [31]–[33] can all be caused by these features. The electric power system's stability may be jeopardized due to these circumstances. As a result, the system planner must determine the intermittent NRE generator's penetration level [34] and construct a compensator to account for the system's dynamics [35]. In addition, the shading factor around the solar module must be considered to maximize the amount of energy produced [36].

B. Wind Energy

Compared to four-season countries, Indonesia has less wind potential at all altitude levels. However, as shown in Figure 3, various regions in Indonesia, such as coastal areas and hilly expanses, offer wind energy potential that may be transformed into electrical energy. Wind Power Plants (PLTB) are power plants that use wind energy as an energy source. Bayu is an air movement generated by temperature and pressure variations caused by sunshine heating.

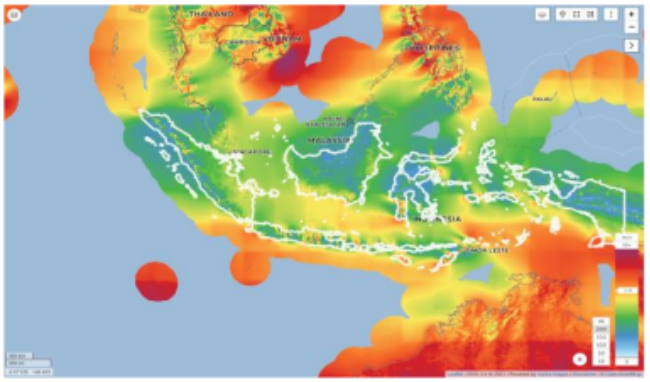

Figure 3. Wind Energy Potential in Indonesia [37]

For the Warudoyong area (-06.925157°,106.92957°), regarding the wind speed index data as shown in Figure 4, it can be seen that the wind potential is relatively high towards the end of the year and the beginning of the year [37]. It is necessary to pay attention to its operation by providing other alternative sources of NRE to meet load requirements sustainably.

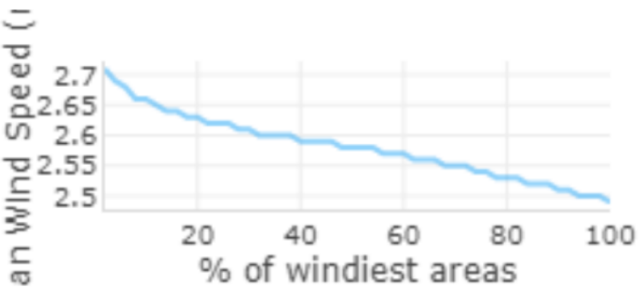

Figure 4. Wind Energy Potential in Indonesia [37]

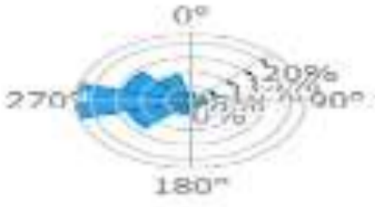

Figure 5. Wind Speed Index in Warudoyong [37]

C. Bioenergy

Bioenergy EBT is a sort of renewable energy source that is now being used to reduce the consumption of fuel oil (BBM) in a variety of important areas. Bioenergy is divided into three categories: biogas, biofuel, and biomass, which is a solid fuel. In the case of biofuels, the government encourages the use of bioethanol and biodiesel as fuel to replace gasoline and diesel for transportation, industry, commercial, and power generation through Minister of Energy and Mineral Resources Number 12 of 2015, which states that Indonesia has set a target of 30 percent biodiesel utilization by 2025 and 20 percent bioethanol utilization by

2025. Furthermore, by 2050, biodiesel usage targets will have climbed to 30% and bioethanol utilization targets will have increased to 50%.

Rice husk is a type of solid fuel bioenergy that may be used in steam power plants (PLTU) using coal as a fuel [38]. Rice husk can be processed further to produce co-firing, making it one of the most promising types of EBT in the future. As indicated in Table III, husk biomass has a lot of potential to be transformed into electrical energy in the Warudoyong area.

Tabel III Rice Rice Production Data In Warudoyong [39]

Districts	**Rice Field Production (tons)**		
	2017	**2018**	**2019**
Warudoyong	4.680	4.777	4.198

D. Ocean Energy

Indonesia is one of the countries in the world with the largest marine area. The sea covers over two-thirds of Indonesia's land area. The South China Sea, the Pacific Ocean, and the Indian Ocean are directly opposite Mainland Indonesia. As a result, the water holds enormous energy potential for Indonesia. Ocean waves, tidal streams, deep ocean currents, and ocean thermal energy conversion are all ocean energy sources.

As illustrated in Figure 4, the area of the island of Java, particularly the south of West Java, which is immediately opposite the Indian Ocean, has the potential to generate electricity from ocean waves. The year's highest tides occur in March, with heights ranging from 1.95 m to 3.1 m, and the lowest in February, with sizes ranging from 0.54 m to 1.04 m. Wind and wave characteristics based on seasonal (quarterly) patterns owing to monsoons generate the possibility for massive ocean waves [40].

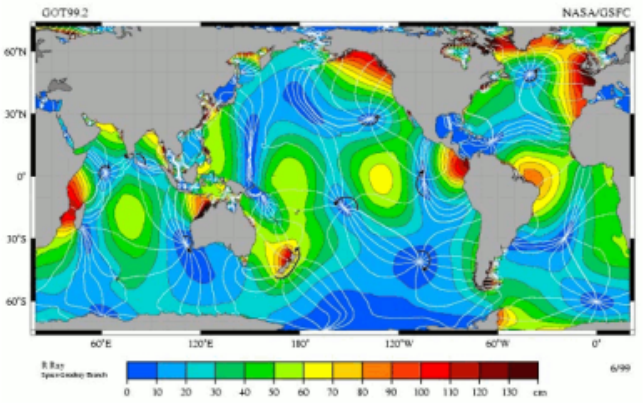

Figure 5. Ocean Wave Potential [41]

E. Geothermal energy

The majority of Indonesia's territory, as a volcanic area, is rich in geothermal energy sources, as seen in Figure 5. As depicted in Figure 5, the ring of fire runs from the north of Sumatra island and Java, via Bali, East Nusa Tenggara, and West Nusa Tenggara, to the Banda islands, Halmahera, and the island of Sulawesi. The potential for geothermal energy along the volcanic path is extremely significant.

Direct steam plant technology, double flash plant technology, and binary plant technology are the three forms of geothermal power plant technology now available. PLTP technology can be used in numerous potential geothermal working locations (WKP) in the Warudoyong area [42].

Figure 6. Geothermal Potential in Indonesia [43]

IV. Conclusion

As part of this research, a literature review of the potential of NRE in the Republic of Indonesia's administrative region was conducted. Renewable energy sources in Indonesia include solar, wind, bioenergy (bioethanol, biodiesel, biomass), marine energy, and geothermal energy. Solar energy, which is evenly distributed in the Sukabumi area and can be used as PLTS both on a household and large scale, as well as wind energy, which has the characteristic of blowing hard at the end of the year and the beginning of the year and can be used as a source of energy, are both potential sources of energy in the Warudoyong area of West Java province. The PLTB's source of energy.

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