

Smart Grid Concept as Distribution Power Solution in The Bawean Island to Improve The Marine Tourism

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Abstract. Bawean Island is one of thousands of islands that have considerable tourism potential. This island located in the Java Sea is an administrative area of Gresik Regency, East Java. It is necessary to develop infrastructure so that the tourism potential in the region can develop. Distribution of electricity networks in Bawean Island is still not evenly distributed, especially with small islands conditions. Therefore the concept of electricity distribution is needed that can reach regions with difficult geography. This concept is smart grid system. Smart grid is an electric power system that is equipped with the use of communication and information technology in the distribution and consumption of electrical energy. The smart grid system is an integrated system and reduces the use of renewable energy or natural resources such as solar energy, wind, ocean wave, etc. And this concept is considered suitable for the hilly island and small island such as Bawean Island.

1 Introduction

Indonesia is a maritime country consisting of 14,000 islands and 99,000 kilometers of coastline. This makes Indonesia a country with enormous maritime potential. One of them is in the tourism sector. Tourism is now considered as one of the important economic sectors. Even this sector is considered able to generate foreign exchange number one for the country. Aside from being an economic driver, this sector is also considered to be one solution to reduce unemployment. Therefore the development of tourism in the regions has an influence on employment, especially in areas that are profitable.

To implement good governance in the tourism sector requires changes to the public sector both in thought and in action. Countries that have implemented good tourism governance will intensively manage tourism to develop tourism potential in their region. Besides that the management will be managed professionally even into industry.

Bawean Island is one of thousands of islands that have considerable tourism potential. According the East Java Government, this island located in the Java Sea is an administrative area of Gresik Regency, East Java. The island is directly adjacent to the island of Java, has an area of about 196.7 km², with an island diameter of 12 km and a population of 70,000 inhabitants. Bawean Island consists of two sub-districts, namely Sangkapura sub-district with an area of 118 km² and a pond sub-

district with an area of 78 km². Sangkapura subdistrict consists of 17 villages, 11 of which are included in coastal villages in the province of East Java, while the Tambak subdistrict consists of 13 villages, 11 of which are also included in the coastal villages of East Java province[1]. The majority of Bawean people have livelihoods as farmers and fishermen. This island is also known as the island of women because many men work overseas or as migrant workers[2].

According to Directorate of Coastal and Small-Ocean Sea Spatial Planning, beach tourism is a tourism that prioritizes coastal resources and coastal community culture such as recreation, sports, and enjoying scenery, while maritime tourism is a tourism activity that prioritizes underwater resources and the dynamics of sea water. Social and economic criteria must be taken into consideration in determining tourist sites[3]. There are several marine tourism objects on Bawean Island that can be offered, including recreational beach tourism, snorkelling tours and diving tours. The high interest of visitors to beach tourism and maritime tourism can cause adverse effects on the environment, so it is necessary to conduct a study regarding the suitability and carrying capacity of the area so that the natural and environmental resources in the tourist sites are maintained and sustainable [2]. Therefore, it is necessary to develop infrastructure so that the tourism potential in the region can develop.

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One infrastructure that needs to be built is in the energy sector, namely electricity. Given the importance of the benefits of electrical energy for the tourism sector on the Bawean island, while the energy source of electricity generation is limited. So to preserve nature in the Bawean island, strategic measures need to be pursued that can support the provision of electricity in an optimal and environmentally friendly manner. Bawean Island itself currently has diesel and gas power plants with a total capacity of 8 megawatts. With the current capacity there are still 11 villages that have not been electrified from a total of 30 villages[4]. Distribution of electricity networks in Bawean Island is still not evenly distributed, especially for the central regions of the island which has hilly geographical conditions. Whereas for the coastal areas almost all villages have electricity networks.

Currently the need for electrical energy in the Bawean island is supplied by PT. State Electricity Company (PLN). Efforts to add power plants already exist but require a long time and a large budget. In addition, the use of energy that is not environmentally friendly causes damage to the natural environment of the Bawean island. Therefore, a strategic step is needed to resolve the energy shortage in the Bawean island. One strategic step that can be done is to improve the electricity distribution network.

The electricity distribution system used by PLN is generally an electricity centralization system. The system was found to have an adverse impact on electricity distribution in Indonesia. Among them causes the number of regions that are difficult to achieve by the electricity network are the geological factors. In addition, it can also cause shrinkage of electricity, unstable electricity voltage to the blackout of electricity that results in all areas that depend on certain substations will experience black out[5].

Therefore, it is necessary to manage renewable energy towards a system of electricity supply on the Bawean island. One of them is to use a system of electric decentralization or the use of small-scale power plants that are scattered[5]. With a hilly and coastal geographical location, it can use power plants such as solar cell, gas, wind, sea wave and etc.

The concept is currently called a microgrid system. However, there is a more advanced system built with a microgrid system that is a smart grid. The concept of smart grid is the concept of smart energy networks to meet electrical energy need. This system is considered suitable for the Bawean island with geographical conditions that are hilly, coastal, and archipelago[5].

Electrical energy is an important means that can increase tourism potential on the Bawean island. Therefore the purpose of this study is to find a solution to the lack of availability of electrical energy by implementing a smart grid system. With the existence of electrical energy that has reached the entire island, it can increase tourism potential, especially in small islands in the Bawean island[5].

2 Maritime Tourism of Bawean Island

Bawean Island has hilly geographical conditions and clear coastal waters. So that the potential as a tourist destination is quite complete as marine tourism. In addition, the number of small islands and coral reefs that surround the Bawean island also increases the potential for marine tourism on the Bawean island. With these conditions can attract both foreign and domestic tourists. Among the islands that can be used as marine tourism objects include: Tanjung Ge'en Beach, Noko Marine Park, West and East Gili Islands, White Sand Beach, and Labuan Tanjung Ori Beach and Labuhan Kumalasa[1].

Marine tourism in Bawean Island can be divided into several activities such as recreational beach tourism, snorkelling tours and diving tours.

Bawean Island has 19 coral clusters, this causes its waters to have strategic potential for shelter, shelter, foraging, migrating and laying eggs for various types of fish and other marine animals. This condition also has a positive impact on the region to be used as a marine tourism area. The area, among others, is located in 10 small islands around Bawean Island namely, Selayar Island, West Gili Island, Noko Island, East Gili Island, Bintang-Star Island, Nusa Island, Gosong Island, Batu Kebo Island, Manukan Island, and Cina Island. The average length of the coastline is 14 kilometers[6]. This cluster of small islands in Bawean Island is used as a location for snorkelling and diving tours, some of which can also be used as beach recreation tours. The total number of coral reefs in Bawean Island as a whole is 5589.52 Ha. The area of the coral reef ecosystem that can be utilized in marine ecotourism in the snorkelling category is 31.83 Ha while the diving category is 85.4 Ha. The depth of snorkelling tours is between 3-5 meters, while diving tours are at a depth of up to 20 meters[7]. A depth of 3-7 meters or more has a variety of reef and reef fish conditions that have good potential for marine tourism, especially snorkelling and diving tours.

3 Smart Grid System

Indonesia is a country that consists of many islands, therefore it has great potential to develop electricity sources based on smart grid. Smart grid is an electric power system that is equipped with the use of communication and information technology in the distribution and consumption of electrical energy. The smart grid system is an integrated system and reduces the use of non-renewable natural resources [5].

A Smart Grid is an electricity network that uses advanced digital and other technologies to monitor and manage the transportation of electricity from all power sources to meet the varying electricity requirements of end users[8]. Smart Grid coordinates the needs and capabilities of all generators, network operators, end users and electricity market stakeholders to operate all parts of the system as efficiently as possible, minimizing costs and environmental impacts while maximizing system reliability, durability and stability [9]. Smart Grid can be interpreted as a computerized system of

intelligent electric utility networks. This system generally uses two-way digital communication technology connected to the grid. Each device in the network is installed with sensors whose function is for data collection (power meter, voltage sensor, fault detector, etc.), plus a digital two-way communication device between devices installed in the field and network operation centers. The key to the Smart Grid system is automation technology that allows adjustment of utilities and control of each device. With Smart Grid technology, energy users will get better information about their energy use besides that the state electricity company can meet customers' electricity needs in a more efficient way [10].

Compared to traditional electricity networks, Smart Grid is superior in many aspects. Briefly, Smart Grid can increase energy use through: (1) energy feedback for users plus real-time information and from users of energy use; (2) real-time demand response and management strategies to reduce peak demand and overall loads through control devices and energy storage mechanisms; (3) integrating renewable energy and storage energy in the electricity network, while optimizing the use and contribution to system services and the entire sales market; (4) promote innovation, products and services related to the handling of new energy, and (5) anticipate blackouts [11].

4 Discussion

4.1 Power Condition Bawean Island

Bawean Island is one of the small islands in Indonesia that still lacks electricity supply to support its daily activities. The peak load of electricity consumption by the people of Bawean Island reaches 4.5 MW per day. At present electricity from Bawean island is produced by gas engine power plants (PLTMG-CNG) with each power plant having a production capacity of 1500 KW. This is very helpful in meeting the island's electricity supply needs. However, when there is a surge in natural gas prices in line with the strengthening of the US dollar exchange rate against the rupiah, the cost of purchasing fuel for this PLGG-CNG becomes greater[12].

Fuel price increases have made the gas plant in Bawean Island now only activated at night to meet electricity consumption needs when peak loads reach 4,300 kW. From 5:00 p.m. to 10:00 p.m., the gas generator is only targeted to supply 1,500 kW. After passing the peak load, the electricity supply from PLTMG-CNG continued to be reduced, to only 550 kW at 24.00 to 04.00. This means that the rise and fall of fuel prices greatly affects the electricity supply obtained by the local community[12].

At the beginning of the operation of the PLTMG-CNG, PLN was able to save fuel costs up to Rp. 1.5 billion per month compared to the use of fuel for diesel power plants (PLTD). Seeing the weakening of the rupiah exchange rate, saving fuel costs by PLN raises new problems, it is necessary to have a breakthrough to build renewable power plants which of course have

cheaper operating costs by utilizing the natural potential in Bawean Island[12].

4.2 Photovoltaics Power

PV technology can convert direct sunlight into electricity through semiconductor devices called solar cells. PV technology is used for solar power plants (PLTS) in the form of centralized systems, stand alone systems and hybrid systems. Centralized PV systems are solar power plants (PLTS) that supply electricity centrally for various locations / loads that are on grid and off grid. Stand alone systems only supply electricity specifically for the load needs that are scattered in each location and are off grid[5].

A battery is an object of chemical storage of electric current. Batteries are an important tool that is very helpful in smart grid systems. In this case the function of the battery is as a storage device for resources that have been produced both from electrical energy and diesel fuel (BBM); solar energy sources, wind energy sources, coal energy sources, energy sources for water, sun, wind energy and other sources of energy that are used as sources of energy generation for the sake of electricity generation. In a solar cell system, the electrical energy in a battery is used at night and on days where conditions are low in sunlight (cloudy). Because the intensity of sunlight varies throughout the day, the battery provides constant energy. Batteries are not one hundred percent efficient, some energy is lost like heat from chemical reactions, during charging and discharging. Charging is when electrical energy is given to the battery, discharging is when electrical energy is taken from the battery. One cycle is charging and discharging. In a solar cell system, one day can be an example of a battery cycle (all day charging, night discharging)[5].

4.3 Wind Power Kite

One system that can be used in generating electricity is using kite power. Kite power is a term for a wind power technology using kites. In the conversion of wind into electrical energy, the upper air wind has potential because the strength level is different from the surface wind. In the kite power system, the stronger the air winds above, the greater the electrical energy produced[12]

At a flying height of 500 meters, the potential electricity that can be produced reaches 10-20 kilowatts. But in the electricity demand that reaches megawatt scale the height of kite flying must be set at an altitude of 8 kilo meters from the ground to get a high speed and stable speed[12].

The advantage of PLTB with kite power system is that it can harvest high speed wind potential which generally lies in the upper air. Windmill technology is compared to only capturing surface winds with limited range. The kite flying maneuvered to form the number eight with a speed of about 38-48 knots, depending on the speed of the wind. Because of the high attractiveness of the kite, the roll of rope that is on the ground rotates quickly. Thus, the generator connected to the coil also

rotates and produces electrical energy. After the length of the rope reaches the maximum limit, the position of the kite changes from catching the wind (downwind) to being parallel to the wind direction. Changes to the position are done to reduce the attractiveness of the kite so as to facilitate the withdrawal process. Kite withdrawal is done by rolling back the rope using a generator that functions as a motor. The whole process is a cycle and is carried out continuously[12].

To increase the power potential generated by the PLTB, the parameters that can be changed by humans are kite area and engine efficiency. The size of the kite greatly affects the speed of the wind that will be captured, so that the greater the kite, the greater the wind speed that can be captured. By modifying the shape of the kite so that if it expands the kite, the skeleton remains strong to keep the kite from being damaged considering the upper air wind speed is greater than the surface air wind. The generator engine must be designed to approach 100% efficiency so that all power can be utilized without loss of power[12].

4.4 Ocean Wave Power

Ocean wave power plant technology in Indonesia was first developed in 2002 by Zamrisyaf (Staff of the Center for Research and Development of PLN), using a pendulum system. This generator can be categorized in an Oscillating scheme Bodies with transmission or energy conversion systems with using a hydraulic motor, hydraulic turbine or linear generator. In this technology, ocean waves move with period parameters and certain wave heights that hit Pontoon hull wall (hull) and cause movement[4].

This is due to the momentum of seawater particles on the pontoon hull. The pendulum above the pontoon will move because of the pontoon movement and produce a rotational motion (horizontal position pendulum) and alternating movement (position pendulum vertical). The generator connected by the pendulum will come along move and get electrical energy with a direct system or indirectly, or by using a hydraulic system or mechanic. All pontoon support equipment is placed on on pontoons, so that maintenance will be easier [13].

Based on BMKG's observation of the Meteorological Station Maritime Perak II Surabaya in the Bawean Island economy shows Significant wave height ranges from 0.1 to 3 m, so requires power generation technology that can capture minimum wave height that occurs in the Bawean coastal area [3]. The technologies that can be used include Oscillating Water Column (OWC), pendulum system, and Tapered Channel (Tapchan). This technology can convert high minimal sea waves 0.2 - 0.5 m into electrical energy. On This final project will be discussed about energy utilization ocean waves use pendulum system technology as renewable energy to design power plants sea waves on the coast of Bawean Island Gresik [13].

On the PLTGL-SB tripod model applied at the northern coast of Bawean Island is able to produce maximum electricity power of 9658,546 Watts or

9,658546 kilowatts. Where on the design of a tripod which will be applied there are 4 generator pendulum so that the electrical power produced is 38634.184 wattage or 38,634184 kilowatts. On average, in one year the PLTGL-SB is a tripod model applied in the northern coast of Bawean Island only able to supply 7 units of electricity house. But in December the PLTGL-SB model This tripod is capable of supplying maximum electricity needs as many as 42 housing units[4].

4.5 Control and Energy Management System

Control system (control system) is the process of regulating or controlling one or several quantities (variables or parameters) so that they are in a certain price or range. While the Energy Management System (EMS) is an innovation that combines hardware and software that can save up to 30% of users of electricity used by consumers. EMS works as a dynamic control within the broad scope of applications and conditions, this tool is applied in custom made orders tailored to each case faced by consumers. EMS can manage the amount of power needed in a very short time[5]. Broadly speaking, the smart grid master control project integrates PV generators into PLN's main electricity network which is currently supported by two CNG gas power plants in the Sangkapura sub-district (3 MW cap unit). Control of the smart grid will be carried out by the master controller installed in Sangkapura together with the Remote Terminal Unit (RTU) installed in each of the generating systems.

5 Conclusion

Bawean Island is an island with great wealth in the field of maritime tourism. Among the maritime tourism which is the main destination of tourists is beach and diving tourism. With the potential in coastal areas and small islands, facilities are needed to accommodate the area. One of them is the need for electrical energy. Some tourist destinations include Tanjung Ge'en Beach, Noko Marine Park, West and East Gili Islands, Pasir Putih Beach, and Labuan Tanjung Ori Beach and Labuhan Kumalasa.

Bawean Island has two gas-powered power plants with a capacity of 3 MW. however, they cannot meet the needs of the island itself. Especially for the development of tourism on the Bawean island. Besides this the topography of the Bawean island is hilly and consists of small islands affecting the inequality of the existing electricity distribution. Therefore, the need for an optimal concept of electricity distribution and can reach all regions. The concept of the smart grid is a pinar electricity distribution concept that is integrated with information and communication networks. In addition, the smart grid concept uses environmentally friendly renewable energy as a source of electricity supply.

Basically the concept of smart grid is a concept of centralized power generation. in general, the source of electrical energy is in one centralized region with a large enough capacity. So that in the process of electricity distribution will experience problems in areas that are

difficult to reach. Meanwhile, the smart grid concept will divide small-scale power plants in areas that are difficult to reach such as in hills and small islands. In this study can be seen with the problems that exist in the Bawean island, the smart grid concept is considered appropriate.

The power plant used is a power plant with the concept of renewable energy using gas power plants and solar power plants. With a gas power plant as the center of a power plant on the Bawean island and a solar power plant as a small generator that will supply electricity in small islands. However, the concept of electricity distribution will remain integrated with the existing system in the main generator. The hope is that the smart grid concept can be developed and can be applied on the Bawean island and small islands with similar topography. In addition, it does not only use solar energy but also other renewable energy.

6 Reference

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