THE PROSPECT OF WAVE ENERGY USING OSCILLATING WATER COLUMN SYSTEM IN BAWEAN ISLAND SEAS INDONESIA

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Overview

The Intergovernmental Panel on Climate Change (IPCC) has pointed to the large role of renewable energy meeting the ultimate goal in replacing fossil fuels, noting that "in the longer term, renewable energy sources could meet a major part of the world's demand for energy". At this time the growth of energy demand is recorded by 7% per year. The people have difficulties in accessing to the electricity that is shown by the electrification ratio in Indonesia of 85% because of power grid limitation for rural areas and small islands. Dependence on oil remains high while utilization of the renewable energy is relatively small. The potential of ocean energy in Indonesia is so enormous about 94 GW, because Indonesia as an archipelago with an area of 1,904,556 km^2 consists of 17,508 islands and 95,181 km of coastline. Unfortunately until now realization of this huge potential is only amounted to 0.94 MW.

This paper discusses the study potential of ocean energy, especially wave energy power plant using Oscillating Water Column (OWC) system in remote islands, precisely in Bawean Island Seas, Indonesia. Oscillating Water Column system is chosen due to its location just on the shoreline and easy installation and maintenance. In addition, The OWC is very suitable to build for the electricity needs of small islands. Bawean Island has low electrification ratio, start from 2012 the ratio electrification is 34.35 %, then in 2013 the electrification ratio is 42.23 % and in 2014 the electrification ratio increased by 71 %, because the Indonesia Electrical Company has been built CNG Power Plant. But the CNG Power Plant has been not able to meet electricity for all houses in Bawean Island. Therefore, after the introduction section gives a brief overview about the power grid problem and renewable energy development for small island that are necessary to provide electricity access to meet all houses in Bawean Island, Indonesia. To find out how much the potential and the power output generation which generated by wave energy with Oscillating Water Column system.

Methods

The potential of wave energy was calculated by using Kim Nielsen Law, World Meteorological Organization's suggestion and Abbasi's suggestion. The density of sea is assumed 1,024 kg/m^3 and the acceleration of gravity is 9.81 m/s^2. The width of Oscillating Water Column chamber was assumed 2 meters. After the calculation of wave energy potential, the power output calculation can be calculated by Farahi's suggestion. This research was conducted in twelve months or one year, start from January 2015 until December 2015 with the point of data collection is 7 kilometers from shoreline. The data was collected from some sources, such as National Oceanic and Atmospheric Administration (NOAA) and Meteorology, Climatology and Geophysics Council (BMKG) which provided satellites for wave height measurement, because there is no the altimeter for wave height directly. And data collection is divided into four regions, including northern part, southern part, eastern part, and western part of Bawean Island.

Results

Month	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Wave Height (meters)	2.04	1.53	0.98	0.88	1.63	1.76	2.27	2.29	2.26	1.98	0.81	1.52

Table 1. Wave height on Northern part of Bawean Island

Month	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Wave Height (meters)	1.94	1.51	0.98	0.82	1.48	1.57	2.02	2.04	2.01	1.82	0.75	1.46

Table 2. Wave height on Southern Part of Bawean Island

Month	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Wave Height (meters)	1.98	1.48	1.01	0.88	1.59	1.73	2.2	2.21	2.13	1.87	0.81	1.47

Table 3. Wave Height on Eastern part of Bawean Island

Month	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Wave Height (meters)	2.04	1.59	1.02	0.88	4.11	1.64	2.15	2.16	2.11	1.94	0.75	1.54

Table 4. Wave height on Western part of Bawean Island

First, the average wave height over the year on northern part of Bawean Island was 1.67 meters, southern part was 1.55 meters, eastern part of was 1.64 meters, and on western part was 2 meters.

Second, the total wave energy from Oscillating Water Column on northern part of Bawean Island was 145.06 kJoule, southern part was 110.51 kJoule, eastern part was 130.15 kJoule, and on western part was 265.12 kJoule.

Third, the average power over the year on northern part, southern part, eastern part, and western part of Bawean Island was 29.21 kW, 23.41 kW, 26.76 kW, 44.89 kW respectively.

Fourth, based on the result of power output calculation the biggest power is on western part of Bawean Island. Because in May 2015, the wave height are 4 meters. Even though in April 2015 the wave height just 0.88 meters and in June 2015 only 1.64 meters of wave height. Furthermore, the western part seas of Bawean Island dealing directly with Indonesia Ocean which known has high waves.

Conclusions

The potential energy of wave energy was already calculated by using the movement of wave in up and down direction of the waves while for the movement of forward and backward waves did not produce energy. The electrical power generating by Oscillating Water Column was affected by the dimensions width of chamber, wave height and the wave period. Wider chamber dimension is greater generated electrical power. Likewise with the higher of wave height, the power generated will be greater too. Based on the Indonesia Electrical Company regulation, which the power plant has power output less than 100 kW, it is categorized small power plant. Hence, the development plan of Oscillating Water Column in Bawean Island Seas is feasible to built and help to cover the lack of electricity beside from other source such as the CNG Power Plant to meet electricity needs for all houses in Bawean Island.

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