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Design System Energy Sustainable Using Wind Turbine for Public Fish Cages Lightning at Belang Village in Southeast Minahasa

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Abstract. These paper present the designing system of wind turbine for public fish cages lighting at Belang Village in Southeast Minahasa. Belang is one of popular destination to find a fresh fish in north sulawesi, but the problem is the efficiency of electricity is not sufficient for the fish farmer. Propeller helps in the motor to generating electricity. Comprehensive research studies are carried out in order to measure the lighting resistances. The generated data from wind turbine can be seen using LCD 2x16 which connected with microcontroller Arduino Uno. Finally, conclusions are fully drawn.

Keywords : Fish cages lighting, Microcontroller, Wind Turbine.

1. Introduction

The energy requirement is increasing every day. This increasing requirement can be met by a new and renewable energy source which are considered as a sustainable clean energy source to lead the clean operation and sustainable living. Wind energy is one of the fastest-growing renewable energy by zero-emission. The world total wind energy production capacity was 318,510 MW in 2013 [1]. Therefore, wind energy is a prospective sector throughout the world which is mainly used in two purposes namely, electricity generation and water pumping [2]. The use of wind energy depends on average wind speed and the variation of wind speed [3]. The energy available in the wind varies as the cube of the wind speed, so an understanding of the characteristics of the wind resource is critical to all aspects of wind energy exploitation, from the identification of suitable sites and predictions of the economic viability of wind farm projects through to the design of wind turbines themselves, and understanding their effect on electricity distribution networks and consumers. From the point of view of wind energy, the most striking characteristic of the wind resource is its variability. The wind is highly variable, both geographically and temporally. Furthermore, this variability persists over a very wide range of scales, both in space and time. The importance of this is amplified by the cubic relationship to available energy [4]. A wind turbine is a machine which converts the power in the wind into electricity. This is in contrast to a windmill, which is a machine which converts the winds into power into mechanical power [5].

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Nowadays, Fish farming using the cages method is an effective method. Cages is a fish cultivation container in the form of a cage made of bamboo or wooden boards placed on an offshore. Energy consumption for cages lightning is one of the problems for fish farmer particularly at Belang Village in Southeast Minahasa. The efficiency of electricity is not sufficient for the fish farmer. So that this research aims to provide renewable energy for sufficient their energy requirement. The design of the wind turbine system for offshore is an important part of the main system because environment condition in the open sea quite strong and the behavior of wind speed is also important to analyze.

2. Literature Reviews

2.1. Voltages

Voltages is defined as energy per unit of charge and is expressed as.

$$V = \frac{W}{Q} \qquad (1)$$

Where V is voltage in volts (V), W is energy in joules (J), and Q is charge in coulombs (C). One volt is the potential difference (voltage) between two points when one of a joule of energy is used to move one coulomb of charge from one point to the other.

A voltage source provides electrical energy or electromotive force (emf), more commonly known as voltage. Voltage is produced by means of chemical energy, light energy, and magnetic energy combined with mechanical motion.

An ideal DC voltage source can provide a constant voltage for any current required by a circuit. The ideal voltage source does not exist but can be closely approximated in practice [6].

2.2. Lithium-ion Battery

A Lithium-Ion Battery or Li-ion battery is a type of rechargeable battery. This is a secondary battery that is commonly used in all types of portable electronics. This type of battery is increasingly being used in defense, aerospace, and automotive application. In the batteries lithium ions move from the negative electrode to the positive electrode during discharge and back when charging. Li-ion batteries use an intercalated lithium compound as one electrode material, compared to the metallic lithium used in a non-rechargeable lithium battery. The batteries have a high energy density and no memory effect [6].

2.3. DC Generator

A DC Generator is an electrical machine which converts mechanical energy into direct current electricity. This energy conversion is based on the principle of production of dynamically induced emf. According to Faraday's laws of electromagnetic induction, whenever a conductor is placed in a varying magnetic field (OR a conductor is moved in a magnetic field), an emf (electromotive force) gets induced in the conductor. The magnitude of induced emf can be calculated from the emf equation of dc generator. If the conductor is provided with the closed path, the induced current will circulate within the path. In a dc generator, field coils produce an electromagnetic field and the armature conductors are rotated into the field. Thus, an electromagnetically induced emf is generated in the armature conductors [7].

2.4. Wind Turbine

A wind turbine or in addition appoint to as a wind energy converter is a device that transforms the wind's kinetic energy into electrical energy. Wind turbines are established in a spacious range of the vertical and horizontal axis. The smallest turbines practices such as battery charging for auxiliary power for boats or cars or to power traffic signs. Larger turbines can be used for making contributions to a domestic power supply. Wind Power Density (WPD) is a quantitative measure of wind energy available at any location. It is the mean annual power available per square meter of the swept area of a turbine and is calculated for different heights above ground. Calculation of wind power density includes the effect of wind velocity and air density. Vertical turbine designs have much lower efficiency than standard horizontal designs. Generally, more stable and constant weather conditions result in an average of 15% greater efficiency than that of a wind turbine in unstable weather conditions, thus allowing up to a 7% increase in wind speed under stable conditions. This is due to a faster recovery wake and greater flow entrainment that occur in conditions of higher atmospheric stability. However, wind turbine wakes have been found to recover faster under unstable atmospheric conditions as opposed to a stable environment [8].

3. Experimental

The experiment was performed in offshore of Belang Southeast Minahasa. We used an anemometer and Arduino for measuring wind speed as shown in figure 1 and figure 2.

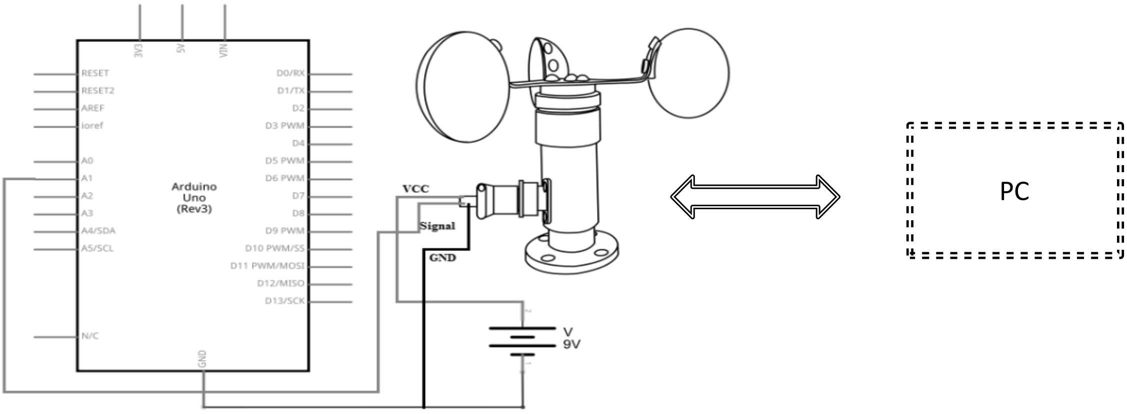

Figure 1. Anemometer Sensor Connection Scheme [9]

Figure 2. Collecting Data

We connect the anemometer device to Arduino board with a generator motor for convert into electricity. In this study, we analyze the suitable wind speed criteria for charging. To simplify the process of analysis and data retrieval, we use block diagrams as shown in figure 3.

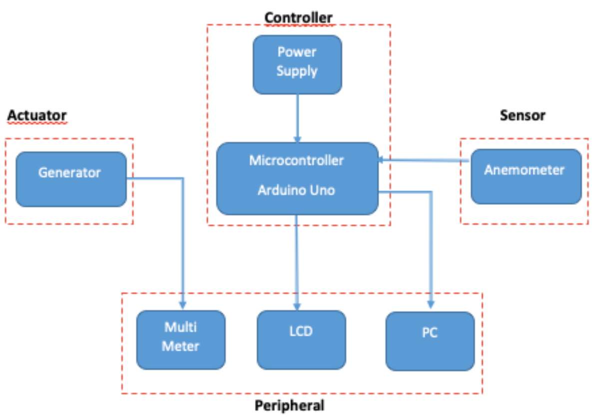

Figure 3. Block Diagrams of Anemometer Device

From the sampling results that taken in the offshore area, we obtained some wind speed and voltage data which is generated by the generator motor. The operation of a DC motor is relatively straightforward. A coil is placed in a magnetic field, and when an electric current passes through the coil, a torque is produced, causing the motor to turn. The entire process is driven by applying electrical power to the coil, with the source voltage having a direct relationship to the motor's output speed. We can see that when the load (torque) on the motor is constant, speed is directly proportional to supply voltage. And, when the voltage remains constant, an increase in the load (torque) on the motor results in a decrease in speed. For fix load, the speed of the motor is affected by applied voltage. For a fixed voltage, the speed of the motor is inversely affected by the load. The data from experimental results can be seen in the table 1.

Table 1. Wind Speed Testing

No	Time	RPM (Anemometer)	Wind Speed (m/s)	Wind Speed (Knot)
1	13:06:09	120	1.01	1.99
2	13:06:31	174	1.46	2.89
3	13:06:49	138	1.16	2.29
4	13:07:04	150	1.26	2.49
5	13:35:11	210	1.76	3.41
6	13:35:26	222	1.86	3.61
7	13:35:41	210	1.76	3.41
8	13:35:56	198	1.66	3.02
9	13:36:11	269	2.21	4.30
10	13:36:26	240	2.01	3.91

There are 10 samples of wind speed data that can be seen in table 1, the highest speed is in the 9th sample data which is 4.30 knots and the voltage obtain is 4.61 volts as shown in figure 4. While the minimum wind speed is in the first data 1.99 knots with a voltage of 0 volts.

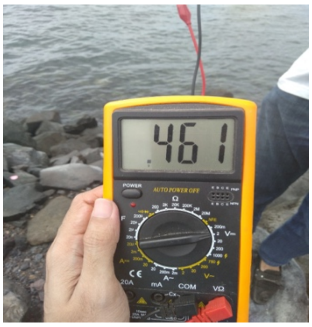

Figure 4. Wind speed conversion to volts.

The generator motor specification used in the simulation has a maximum voltage of 24 volts and current of 250 mA. The first simulation is assumed to use 1 charge 18650 battery with capacity of 3.7 volts and a current of 1345 mA. By using the maximum speed sample in table 1 which is 4.30 knots and the voltage obtained is 4.61 volts then the time period for battery can be charged by using formula.

$$LT = \frac{BC}{c} \tag{2}$$

Where LT is loading time in hours (Hr), BC is battery capacity (mA), and c is current from the generator (mA). For the calculation simulation as show in formula 3. The charging time is 28.01 hours for 1 charge 18650 battery and this test has used no load.

$$LT = \frac{1345mA}{48.01mA} = 28.01Hr \tag{3}$$

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for lightning in the public fish cages, at least 5 LEDs are needed with a voltage of 3 volts and a current of 20mA. In this simulation we still use 1 battery of 18650 that has the same specifications as the no-load simulation. The difference in this simulation is that the calculation of the charging time will be added to the load from the LED which is paralleled. So that the LED current increases to 80mA. The results of the simulation show that the discharging time is 8 hours.

4. Results and Discussion

The results of this study show that using a lot of wind turbine will reduce battery charging time. Firstly, we need 28 hours for charging time when we used only one wind turbine. Lastly, we tried using 5 wind turbine for 5 hours charging time as shown in figure 5. The results are more significant if we used a lot of wind turbine.

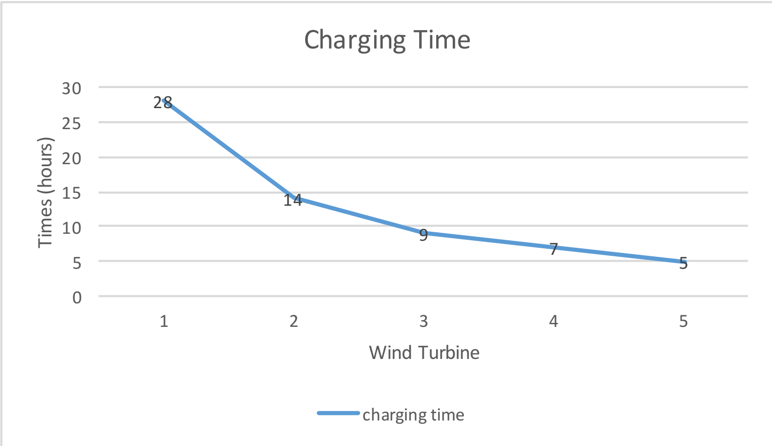

Figure 5. Charging time with no load

Different when we using LEDs as load in this experiment. Firstly, 28 hours needed when we used only one LED as load. Lastly, we used 5 LEDs for lightning in the public fish cages needed 5 hours in discharging time as shown in figure 6. The results are very helpful for fish farmers in Belang Southeast Minahasa.

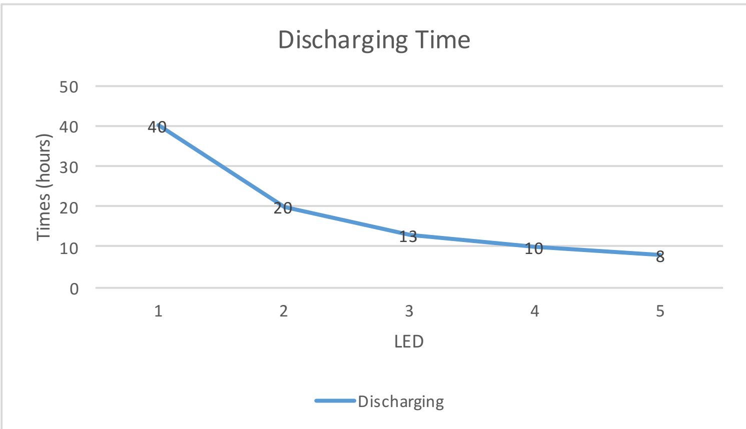

Figure 6. Discharging time with load

This study was performed to determine the amount of wind turbine needed to save battery charging time and see the battery usage time when this wind turbine used in offshore of Belang village in Southeast Minahasa for lightning in the public fish cages. The results in this study show significant results when we used a lot of wind turbine. The charging time is reduced significantly. Thus we tried in discharging with 5 LEDs as load, the results also show significant results when we using a lot of LEDs as load. Battery usage time reduced significantly.

5. Conclusion

In this study, we applied wind turbine for lightning in the public fish cages at Belang village in Southeast Minahasa. Has two aspects in this study, first we determine the amount of wind turbine needed and the lastly we tried using LEDs to find out the battery usage time. The results are show according to our expectations. In the future, we hope to increase the amount of wind turbine and we will try to design system energy sustainable using hybrid version.

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