"Riven" (Trivergent Energy), Maximizing Climate Potential as a Renewable Electrical Energy Source to Optimize the Electricity Supply of Tsunami Early Detection System

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Abstract—
Indonesia is located between 3 world tectonic plates such as the Indo-Australian Plate, Eurasian Plate, and Pacific Plate. these conditions make Indonesia prone to tectonic and volcanic earthquakes that can cause fatal damage and even tsunamis. the vast waters of Indonesia and the land in the form of islands make Indonesia very vulnerable to tsunamis. this increases the need for tsunami early warning system tools in large quantities and efficiently. Indonesia has a tropical climate characterized by exposure to sunlight and high rainfall, which can potentially be a source of renewable energy to generate electrical energy. Therefore, the researchers made an innovation called Riven, Trivergent Energy, an environmentally friendly electrical energy generation tool that can maximize the potential of the Indonesian climate so that it can meet the electricity needs of the tsunami early warning system. testing was carried out by testing the effectiveness in various weather conditions and the results were obtained 22.3V in sunny day conditions, 16.7V in rainy day conditions, 4.4V in night conditions, and 7.3V in rainy night conditions. With these results, it is expected that Riven can fulfill the needs of the tsunami early warning system.

Keywords: Tsunami, Tsunami early warning system, Climate, Renewable energy

I. Introduction

Indonesia is located between three world tectonic plates, the Indo-Australian Plate, the Eurasian Plate, and the Pacific Plate. This causes Indonesia to be a country prone to tectonic plate collisions and to be one of the countries traversed by the Ring of Fire. These conditions result in Indonesia having the potential for earthquakes due to tectonic and volcanic activity caused by active volcanoes. Until now, no technology can predict when an earthquake will occur. Tectonic or volcanic earthquakes with high amplitudes on the seabed can cause large-scale damage, and can even cause tsunamis. Based on the results of a disaster risk assessment by BNPB in 2015, it is known that the number of people threatened by tsunamis exceeds 4 million people and the threat of asset losses is approximately 71 trillion rupiah (Amri et al., 2016). Earthquakes that cause tsunamis can only reduce the number of victims by using tsunami early warning systems that are spread across several areas that have previously been marked as tsunami-prone areas based on research into the geological conditions of the soil structure. However, areas marked as not prone to tsunamis do not rule out the possibility of a tsunami occurring, as was the case with the Palu tsunami in 2018. For this reason, it is important to add a tsunami early warning system for tsunami-prone and non-tsunami-prone areas.

Indonesia's vast waters and archipelago need many tsunami detectors. These devices are based on the concept of sea level so that when the sea level suddenly rises, the device will send a signal to the land and will activate the tsunami mitigation alarm. To send signals to signal receivers on land, tsunami detectors need an electricity source. Until now, tsunami detectors still rely on solar panels as the main source of electricity. A battery with a large capacity is required to store electrical energy for use at night or during cloudy weather because solar panels can only be used during sunny weather. Bad weather conditions that last for a long time can result in the performance of solar panels not being able to convert energy and the energy stored in the battery will run out. Making batteries with a larger capacity will require expensive costs, this can increase the burden on equipment and increase the potential for battery theft by irresponsible parties. For this reason, an alternative solution is needed to meet the electrical energy needs of the tsunami detection device.

Indonesia is located on the equator with a tropical climate. These conditions make Indonesia a country with 2 seasons, the rainy season and dry season with sun exposure, strong winds, and always receives rain throughout the year so that it has high rainfall, which is 2000-3000 mm/year (Kharisna et al., 2017). This condition has great potential as a renewable energy source. For this reason, researchers are innovating an environmentally friendly power generation tool with a combination of solar panels, dynamo turbines, and piezoelectrics that can convert electrical energy in various weather conditions to reduce battery procurement costs and can also fulfill electricity needs in tsunami early detection devices. Solar cells can convert energy from exposure to sunlight into electrical energy. Solar cells are semiconductor elements that can convert solar energy into electrical energy using the photovoltaic principle (Suryana, 2016). A dynamo coupled with a windmill can convert kinetic energy from windmill movements moved by gusts of wind into electrical energy. Piezoelectricity can convert the pressure of the waterwheel moved by rainwater into electrical energy. This produces an electric voltage if the material is exposed to pressure or vibration (Wijanto et al., 2018).

This innovation is called Riven (Trivergent Energy), an alternative solution to fulfill the electricity needs of tsunami early warning system devices by maximizing the use of energy from the Indonesian climate. With a flexible and adaptable design, this tool can be implemented at sea practically and efficiently. This innovation combines three alternative energy sources that are converted into electrical energy used for tsunami detection. This tool consists of three components of equipment used in this innovation, namely: wind turbines, solar panels, and piezoelectricity. Wind turbines convert wind kinetic energy into electrical energy, while solar panels capture sunlight energy and convert it into electricity. And piezoelectric can generate electricity from raindrops that push the fan so that the fan rotates and generates electricity. By maximizing the use of renewable resources, it helps to reduce greenhouse gas emissions and carbon monoxide periodically.

II. Material and methods

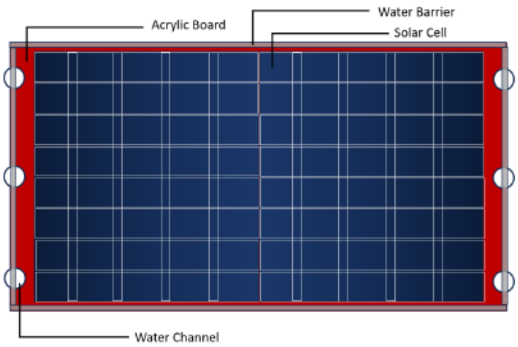


Figure 1. Top View of "Riven" (Trivergent Energy)

In this research, researchers combined solar cells with dynamo and piezoelectric to maximize Indonesia's climate as an energy source to produce electrical energy efficiently and environmentally friendly. The materials used in this research are 2 solar cells (150 x 144mm), 6 (35mm) piezoelectrics, 12v 6000 RPM DC dynamo, 2mm thick acrylic board, PVP pipe (3/4 inch), 8mm and 10mm diameter ABS pipe, 2 breadboards, 4 diodes 1N 4007, cable, 4 bearings size (8x22x7 mm) and 1 bearing size (15x32x9 mm), 24 marbles, Arduino uno. 3 voltage sensors and tools such as solder, hot glue, electric drill, acrylic cutter, sandpaper, scissors, duct tape, ruler, and saw. The design of the tool is depicted in the following illustration.

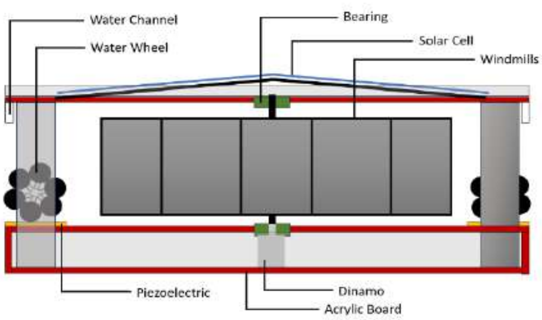


Figure 2. Front View of "Riven" (Trivergent Energy)

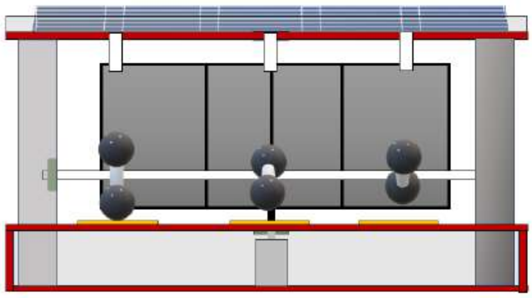
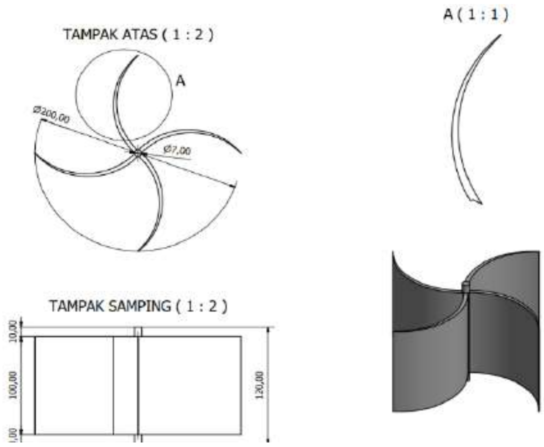


Figure 3. Side View of "Riven" (Trivergent Energy)

In this tool, researchers designed 3 renewable power plants in 1 practical and efficient tool, the placement of solar cells in an inclined position aims to drain water into the water channel which later the flowing water will fall and rotate the wheel made of marbles and ABS pipes to apply repeated pressure on the piezoelectric, this aims to give enough pressure to the piezoelectric so that the piezoelectric can generate electricity efficiently by changing the kinetic energy of the marbles. The horizontal fan design aims to streamline the shape of Riven, the fan is designed and printed using 3D printing.

Figure 4. Riven horizontal fan design



For the manufacturing step, researchers cut acrylic boards with a size of (18cm × 30cm) 3 pieces as a layer on the framework and sizes (2cm × 30cm) 2 pieces, (4.5cm × 30cm) 2 pieces, (2cm × 18cm) 2 pieces, (4.5cm × 18cm) 2 pieces, and an isosceles triangle shape with a height of (2cm) and a length of leg ribs (12cm) 2 pieces as an additional structure and cut using an acrylic cutter. The base of Riven was made by gluing 2 layers of acrylic (18cm × 30cm) with acrylic (4.5cm × 30cm) and (4.5cm × 18cm) using hot glue. The top layer of the Riven base was drilled at 4 points beside the corners with a hole diameter of ¾ inch using an electric drill as a place for the ¾ inch PVP pipe. And drilled in the center with a diameter of (1cm) as a place for the windmill axis and also drilled 6 holes with a diameter of (0.5cm) on the side. as a piezoelectric cable place. PVP pipes were cut using a saw with a height of (17cm) 4 pieces and drilled at the top and bottom as a place for the cable to enter. At the bottom of the pipe, a hole was also drilled (2cm) using an electric drill for the bearing size

(8x22x7 mm). The finished pipe is glued to the base layer using hot glue. The piezoelectric is glued to the top layer of the Riven base with hot glue and the wires are inserted in the previously prepared layer holes. Making waterwheels is done by gluing marbles with 10mm diameter ABS pipes with a length of 1.9cm and glued using hot glue and made as many as 12 pieces and then glued with cross position and spaced on the axis of the wheel, which is 8mm diameter ABS pipe. At each end of the wheel is glued bearing size (8x22x7 mm) and glued to the PVP pipe hole that was previously prepared. At the top of the top acrylic layer, the right and left end sides are drilled using a drill for the water channel. in each hole is glued 10mm diameter ABS pipe with a length of (2cm) as a water channel to move the waterwheel. at the middle of the acrylic layer is also drilled with a diameter of (23cm) as a bearing size (8x22x7 mm) for the upper windmill axis while at the bottom of the windmill axis is glued to the dynamo in the hole that has been prepared beforehand in the lower top acrylic layer. For the position of the solar panel, it is made oblique using triangular acrylic with a height of (2cm) and a foot rib length of (12cm). at the top of the top acrylic layer, acrylic is glued with a size of (2cm × 18cm) and (2cm × 30cm) on the sides as a water barrier. the cable from the solar panel will be inserted in the PVP pipe hole that has been previously prepared and then connected to the bottom of the Riven so that the cable is protected from water. In simple words, the utilization of climate as an energy source for electricity generation on Riven can be illustrated as shown below.

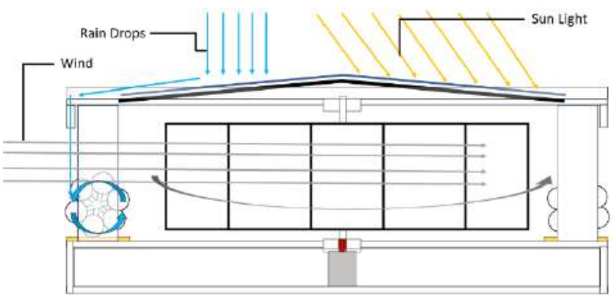


Figure 5. Energy conversion mechanism

The electricity generated from the solar cell and dynamo will be directed by cable to the bottom of Riven, which is designed to be waterproof to keep electrical equipment dry and safe so that it is more durable. Electricity is put together using a breadboard. The electricity from Piezoelectric is converted first from AC voltage to DC voltage using a rectifier bridge composed of 4 diodes and then put together on the breadboard with electricity from other sources.

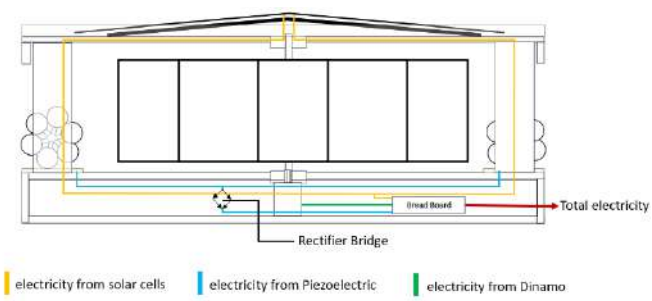


Figure 6. Electrical energy distribution mechanism

To test the effectiveness of Riven, researchers tested 4 conditions: a sunny day, rainy day, night, and rainy night. After obtaining all data in voltage (V) and comparing the results.

III. Discussion

After the data is obtained and the average is obtained. The data is presented in graph form as follows

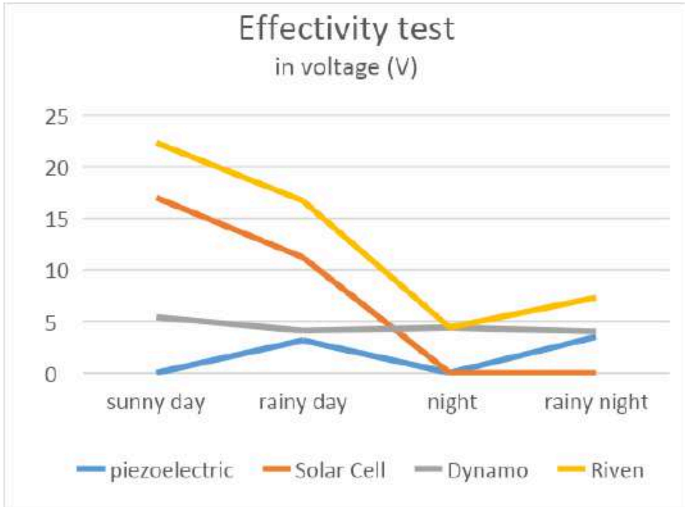


Figure 7. Effectivity test Measurement of Riven in Voltage

From the data it can be seen that on a sunny day, the solar cell can produce 17V of electricity, the dynamo produces 5V, and Riven produces 22V. On the rainy day, the solar panel decreased to 11V, the dynamo 4V, piezoelectric 3V, and Riven 16V. At night, the solar panel cannot produce electricity so only the dynamo generates electricity at 4V so Riven also produces 4V. On rainy nights the dynamo produces 4V, the piezoelectric produces 3V, and Riven 7V. From all tests in various conditions, Riven which is a combination of 3 power sources has better effectiveness than other sources.

IV. Conclusion

Based on the results of the data that has been obtained, it can be concluded that Riven, Trivergent Energy has the highest effectiveness in voltage when compared to other sources in various weather conditions, which are: sunny day, rainy day, night, and even rainy. The best results generated by Riven during testing are 22.3V in sunny day conditions, 16.7V in rainy day conditions, 4.4V in night conditions, and 7.3V in rainy night conditions. With these results, it is expected that Riven is able to supply electricity needs for the Tsunami early warning system.

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