Design of a Sea Mushroom Wave Converter For 15kw/M Wave Energy Flux

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Abstract— Philippines' geographical location has potential to harness electricity from its ocean waves. When it comes to acquiring renewable energy, the country has slow progress given its abundant source. Studies about implementing ocean wave converters in the Philippines are limited. Creating a design of an ocean wave converter suitable to the country's ocean waves will help to progress on harnessing its wave energy potential. Locations for potential sites are presented in this paper along with their wave force - a key factor on obtaining electricity from the wave in this study. The results that were gathered in May 2022 shows that The 9.2477 kW/m of Calicoan Island, Samar is the highest recorded wave power, followed by Caridad, Siargao Island- 8.8874kW/m. Barrio, Siargao Island - 8.1759 kW/m, Burgos, Siargao Island- 7.7514 kW/m. Cauit Point, Surigao Del Sur, Caraga - 7.1331 kW/m, Big Star, Surigao Del Sur- 7.0499 kW/m, Guitagican, Samar - 7.0097 kW/m, Majestics, Catanduanes - 7.0542 kW/m, Lucky Point, Catanduanes - 7.0481 kW/m, Charlie's Point, Baler, Aurora and Cobra Reef - Cemento, Baler, Aurora have the same value of 4.1191 kW/m. Last is the Malaking Gasang, Baler, Aurora recorded the lowest wave power which is 3.1807 kW/m. The data gathered will be used to test the created design and dimensions along with the parameters of a linear generator. The Sea Mushroom is a wave energy converter that utilizes an existing 7 kW linear generator to harness the wave power in the Philippines. The gathered wave power data from different locales in the country are integrated to the parameter of the sea mushroom and calculated via Excel. The aspect that was considered on computation is the stroke length whereas the maximum length that the translators can travel is 40mm. Once the condition of 40mm stroke length is achieved, the four (4) linear generators inside the sea mushroom which are connected in parallel will generate 28 kW of electrical power. Despite having different wave power, all the locales achieved 100% 40mm stroke. Meaning that the wave power can move the buoy attached to the translator of the converter 40mm upward proving that the design can harness electricity from the Philippines' Ocean waves.

Indexed Terms— Ocean wave, Linear Generator, Sea mushroom, Stroke length, Wave power, Translator, Converter

I. INTRODUCTION

Ocean wave energy is widely introduced around the globe as a source of renewable energy that produces electricity. The early records of machines that are used to capture energy from ocean waves were patented shortly before the turn of the 19th century. When the 1870s ended, California introduced four patents of wave motors related to power boats and self-propelling vessels making the state the leader in ocean powered technologies. Later in the century, innovation of wave energy converters and motors were widely done by people to solve their local problems. Meanwhile, the European countries had the first record of proposing a design of ocean wave generator in 1973 as a solution to the resource shifting due to the oil crisis, but unfortunately the project was shut down. The most successful record of producing electricity from ocean wave energy generators was recorded in 2012 when Jørgen Hals Todalshaug invented the Wavespring, the most important piece that innovates his professor's project that was neglected during the 1970s (Corower Ocean, 2021). According to Taeihagh 2021, the Southeast Asian (SEA) area is bordered by open space, which offers enormous opportunities for energy harvesting. Alternative sources of clean and dependable energy in the region might include wave, tidal, and ocean thermal energy conversion. Beyond its technical features, this study contributes to the expanding academic literature on ocean renewable energy (ORE) in Southeast Asia by improving knowledge of the prospects and constraints of ORE growth in the region. Turbine design must take into consideration the flow velocity, which ranges from 1 to 2 m per second on average, across approximately 60% to 80% of the whole region. In addition, SEA's seabed bathymetry is not flat, and the slopes are steep even close to the shore. These are a few of the technical considerations that need to be investigated when developing a tidal current system that is suitable for the SEA conditions. Currently, the SEA region accounts for 4.3% of total global energy demand. Fossil fuels meet most of this demand. Oil contributes 37% and natural gas 21% to the total regional energy mix. In addition, regional greenhouse gas emissions (GHG) have also increased over the last two decades, reaching an increase of around 5% per year due to rapid economic growth in the region. In short, the region is faced with a growing energy demand because of the increasing population, coupled with the pressure to achieve economic development in a sustainable and environmental way. As such, most of the SEA countries have pledged to lessen their carbon emissions and intensity under the Paris Climate Change Agreement, through the development and deployment of renewable energy. This highlights the potential of Ocean Renewable Energy to be utilized in the region not only as an alternative source of energy but also to address the growing energy demand in the region.

II. BACKGROUND OF THE STUDY

Philippines' geographical location is one of the best spots when it comes to conducting water activities and one of these can be the harvesting of electricity from the ocean wave. When it comes to acquiring renewable energy, the country has slow progress given that it has an abundant source compared to its neighboring countries. Making the implementation of ocean wave generators as a renewable source is new to the country. Countries from the southeast will start developing ocean renewable energy as one of their contributions to the upcoming regional energy mix by 2030, including the Ocean wave energy generators that can work from up and down motion on the ocean waves (Deloitte, 2017). The movement of the water is used in wave energy systems to generate electricity. Breaking waves are used in several of these technologies. Others utilize swells. Others make use of the pressure of waves at the ocean's surface. Despite this, the aim is to convert wave energy into electrical energy. This electricity can be used to keep the grid running. This is the system of wires that transports power to our homes and businesses. Wave energy has the potential to make a significant contribution to our renewable energy demands in the future. Energy has become increasingly important to humans over time. In recent years, the search for low-cost, renewable, and clean energy sources has intensified, primarily to reduce the negative effects of degrading nature, allowing scientists and engineers to develop new technologies. Many energy sources have been investigated for adequate funding, with some standing out for their ease of acquisition, others for its low cost, and others for their renewable nature. When compared to hydro, nuclear, coal, and thermal energy, this energy is 100 percent renewable and has no environmental impact (Stevens, 2019).

III. REVIEW RELATED LITERATURE

The ocean wave generator consists of mechanical structures that capture continuous wave energy and then transmit and convert that captured energy into mechanical energy. As a result, the float is in close contact with the ocean wave, and as the wave passes through the system, the float will capture energy while the gear is activated and begins to rotate in response to the wave's intensity. Consequently, the associated gear transmits energy to the generator, which creates electricity that can be stored or used directly; and the system continues to work in the same cycles. As the demand for energy grows, other methods may become more useful in the future. The point absorbers method, oscillating water column, wave overtopping reservoir, Tidal lagoon power, Ebb & Flood generation and many other methods are established but have limited working features. With a large-scale design to meet both household and commercial power demands. The reliance on nonrenewable resources will be reduced, as will greenhouse gas emissions. (Solanki et al., 2021).

(Faizal et al, 2014) The most common wave energy converter is a heaving and pitching bodies, these two are classified as a Point Absorber Wave Energy converter. The Point Absorber WEC can swing back and forth with either one or more degrees of freedom to capture energy from ocean waves. Below are some examples of Point Absorber WECs.

PS frog MK5 (Figure 1) consists of a large buoyant paddle that can accept forces of ocean waves, meanwhile beneath the point absorber is the ballast that provides a reaction whenever there's an action happening in the paddle. With no moving parts outside, the device is enclosed with a steel hull.

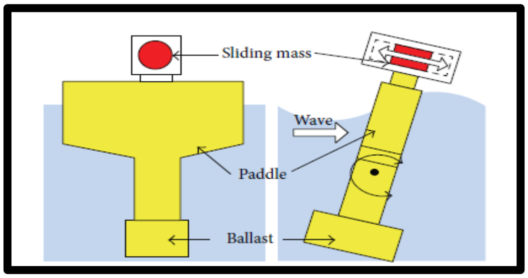

Figure 1: Schematic diagram of the PS frog MK 5

A floater which keeps the system afloat can be seen on the Aquabuoy (Figure 2) connected below it is a large cylinder known as the accelerator tube. In the center of the accelerator tube, the piston can be found and using a hose pump that is connected in the top and bottom of the buoy. The hose pump will stretch and compress when a relative motion between the buoy and piston is applied. The process will be in turns which can drive the water into the Pelton turbine.

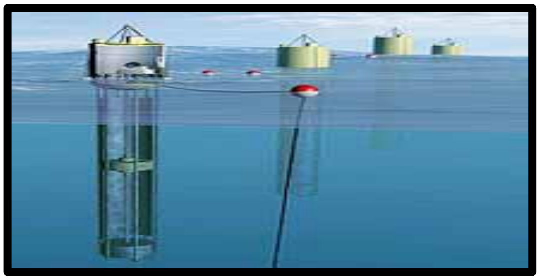
Figure 2: Schematic diagram of Aquabuoy

The Uppsala Point Absorber (Figure 3) using line and piston, the buoy is connected into the moving part of the generator. To store energy, springs are connected beneath the translator of the generator and at the same time, it will act as a restoring force during wave troughs. This Point Absorber has a permanent magnet linear generator that is directly driven on the seabed.

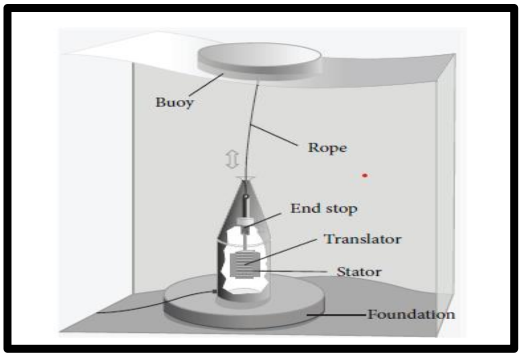

Figure 3: Schematic diagram of the Uppsala point absorber WEC

"Design of Energy Wave Converter for 15 kW/m Wave Energy Flux" is a proposal of Point Absorber wave energy converter design that's more suitable on the natural characteristics of ocean waves in the Philippines.

According to the International Trade Administration, U.S. Department of Commerce, the Philippines has established a target to use renewable energy (RE) as part of its low-carbon development strategy to solve issues such as energy sustainability, security, and equity. The Renewable Energy (RE) Act of 2008, also known as Republic Act (R.A.) 9513, establishes an ambitious national goal of increasing renewable energy installed capacity to 15,304 megawatts (MW) by 2030, bringing the RE sector's contribution of the country's energy generation mix closer to 35%. The Department of Energy is developing policies and processes to attract private domestic and foreign investment, which will help the industry grow and lessen its reliance on costly energy imports. However, there are many aspects of considering the use of ocean wave energy generators that includes the compatibility of it on where the apparatus will be installed.

As a solution, one of the Philippines development plans for 2017-2022 targets to achieve universal electrification by 2022 by implementing more renewable energy farms. Unfortunately, as of 2021 some areas in the country still experienced a shortfall in the electrical supply due to power plant shutdown and outages it still frequently felt yearly when the summer season hits (Staff, 2021).

Waves are appealing on harvesting because of the high-power density compared to many renewable energy sources. If successful in harnessing the maximum potential of this source, the problem of the lack of power supply that were experienced in some areas of the country can be lessened, that is almost 30% of Filipinos suffer from electrical outage that occurs when the demand on the electricity is too high (Bostwick, 2020).

According to Waves 4 Power, "Compared to wind and solar energy, the power density of waves is much higher. It is also predictable and consistent compared to two renewable energies. Waves can go through hundreds and even thousands of kilometers without losing the consistency of its energy; it acts as an energy reservoir charged by the wind. making it the most concentrated form of renewable energy on the earth." And since the Philippines is surrounded by a vast ocean, it will be easy to find a suitable construction place.

(Quitoras et al., 2018) shows that there is around 10 – 20 kW/m of wave energy flux scattered in various coastal areas in the country. AquaBuoy, Pelamis and Wave Dragon are three WECs that were assessed in consideration of their advanced Technology Readiness Level (TRL). Data needed for estimating the resource potential of each site came from Atmospheric Administration (NOAA) Wave Watch 3 (WW3) model and Surf-Forecast – a website providing wave profile forecasts based on National Oceanic. Data were gathered for one year on a 3-hour interval per day.

IV. STATEMENT OF THE PROBLEM

There is an existing study which intends to construct and test the first large-scale ocean energy generator in the Philippines. Ramuel Maramara, the founder of the engineering business Brimes Industrial in Long Island, New York, has successfully designed "The Jellyfish," a small-scale wave energy-generating device (Rainier Allan Ronda, 2016). Up until the present there are no wave energy converters implemented in the Philippines due to limited design of ocean wave energy converters that can adapt the 10 – 20 kW/m wave energy flux.

V. OBJECTIVES

The primary objective of the study is to provide a design of ocean wave energy converter that is compatible with the physical parameters of a linear generator that can adapt to the average 15 kW/m wave energy flux produced on the most part of the saltwater surrounding the Philippines.

VI. SCOPE AND LIMITATIONS

Since the topic about ocean wave energy converters is broad. This study is intended only to introduce a design that can be used to harness ocean wave energy in the country.

VII. SIGNIFICANCE OF THE STUDY

Design of a Sea Mushroom Wave Converter for 15 kW/m wave energy flux will be significant and beneficial to the following: To the people that usually suffer from electrical shortage, it will lessen the problem by generating electricity from the ocean wave. As a result of this study, the researchers inside and outside the campus of Don Honorio Ventura State University could use this thesis paper as a reference to anything related to it as a foundation to make their study more credible. To develop projects to convert energy from ocean waves into carbon free electricity, the Department of Energy can also make the study as a basis for future projects related to generating energy from renewable sources.

Conceptual Framework

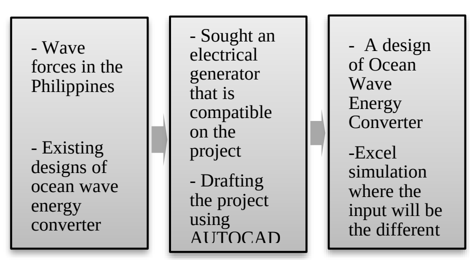

Figure 4: Conceptual Framework

Figure 4 shows the conceptual framework of the study. The input will be the data gathering on existing relevant design of ocean wave converters and the collected data of wave forces in the country that can be the main reference of the researchers on visualizing the draft that will be presented in this paper. Drafting of the project and designing of the schematic diagram using AUTOCAD is the process of this study with the research on a compatible generator for the design of the project. Alongside the drafting will be the simulation of the wave force and the given parameters of a linear generator to prove that the chosen generator will work under the researcher's design. Lastly, a new design of ocean wave energy converter will be presented, and to support the claims of the researchers, an Excel simulation will prove that the wave force of selected locations in the Philippines can utilize the four 7kW linear generators inside the new design of ocean wave energy converter.

VIII. METHODOLOGY

First step is to collect information about existing ocean wave converters. Then gather sources that indicate the different wave power in the Philippines. This will be used for determining the different locations that can generate around 15 kW/m wave energy flux using the generator's design using either of the formula: Wave Power formula for deep water where P = $\frac{pg^2TH^2}{64\pi}$ where P is the wave power, p is density of seawater, T is wave energy period, H is wave height and g is gravity. Or the wave power formula regardless of water depth where P = 0.577TH^2 (Quitoras et al., 2018). Creating a design based on different existing ocean wave converters, the researchers will present a new design in AUTOCAD using an existing linear generator with parameters that is suitable with the Philippines' wave power. A 7kW Tubular Permanent Magnet will be utilized in this study to convert mechanical to electrical energy. The researchers will provide a schematic diagram of the 7kW Linear Generator inside the design. (Cheng et al., 2021) One of the key applications of linear generators is harvesting wave energy; the improved physical parameter of Permanent Magnet Linear Alternator (PMLA) can provide a 210 W to 7116 W from a stroke length that varies from 5 mm to 40mm. The physical parameters of the linear generator will be the basis of the researchers to make a design that can pull the translators of the linear generator upward when an ocean wave is in contact with the researcher's design. A simulation will be presented to prove this claim using the formula for Power: P = Fv where P is the total power of the wave, F is force of the wave and v will be the velocity of the wave. Together with the displacement formula: d = $\frac{1}{2}at^2$ where d is the possible distance the translator can cover based on the applied wave power on the generator, a is the acceleration of the translator and t will be the time it will take for the translator to reach the end point of the translator. After computing the possible wave forces that can pull the translators, the researchers will use an Excel simulation that will prove theoretically that the new design of ocean wave energy converter can generate the 28kW of total power produced by the four Tubular Permanent Magnet Linear Generator when installed on the salt water of the Philippines. To sum up all the data acquired, the researchers will conduct a presentation to introduce the Design of a Sea Mushroom Wave Energy Converter for 15 kW/m Wave Energy Flux as a new source of renewable energy in the country. The results will include the design of the ocean wave energy converter in 3D (AUTOCAD). The researchers will also present the sum of all gathered data showing how the design will work on generating electrical load in selected areas of the Philippines, together with the Excel simulation to support the data presented.

IX. RESULTS AND DISCUSSION

The Philippines' archipelago is surrounded by bodies of water. And to make this project possible in the future, the researchers selected places that can represent the 15 kW/m wave energy flux that are scattered all over the coast of the country. The selected areas are as follows: Malaking Gasang, Baler, Aurora, Charlie's Point, Baler, Aurora, Cobra Reef - Cemento, Baler, Aurora, Lucky Point, Catanduanes, Majestics, Catanduanes, Guitagican, Samar, Big Star, Surigao Del Sur, Cauit Point, Surigao Del Sur, Caraga, Burgos, Siargao Island, Barrio, Siargao Island, Caridad, Siargao Island, Calicoan Island, Samar. Based on the study of Quitoras et al. the waves are far more powerful during the month of December to April. Due to the time of the research being conducted in the month of May, a sample data is shown below to picture the gathered data on https://www.surf-forecast.com/. The site provides real time data of ocean wave activity worldwide. From the data acquired by the researchers, the average wave height and wave period that are needed to complete the computation for wave energy flux per meter or also known as wave power is indicated.

The group monitored the wave event in two weeks in the month of May to gather data that are required on acquiring the wave power produced by ocean waves. The fourteen-day data gathering of twelve selected areas are compiled and computed in a manner to produce the average wave power.

Figure 6 is a representation of gathered data on the site of surf-forecast. The highlighted data is the wave height and the wave period of the selected location on May 03, 2022, the Calicoan Island, Samar.

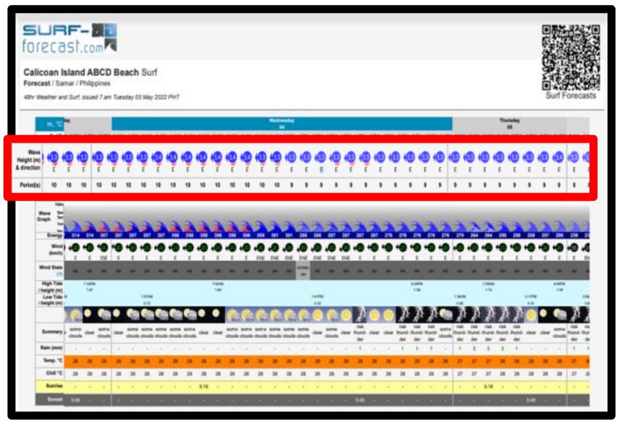

Figure 6: Surf forecast- Calicoan Island, Samar, May 03, 2022

Surf-forecast shows the wave height and the wave period that are produced every hour. To sum up the needed data the researchers decided to get the average data of the wave height and wave period to make data gathering easier.

From garnering the average results on wave height and wave period the next step is providing the wave power. Table 1 shows the average wave height and period and the corresponding wave power (kW/m) in selected places in the Philippines.

Table 1 Average wave power in two weeks

Location	Average Wave Period (s)	Average Wave Height (m)	Average Wave Power(kW/m)
Lucky Point, Catanduanes	9.11	1.16	7.24
Barrio, Siargao Island	8.91	1.26	8.64
Burgos, Siargao Island	8.93	1.23	8.02
Caridad, Siargao Island	8.97	1.31	9.37
Big Star, Surigao Del Sur	8.29	1.21	7.84
Cauit Point, Surigao Del Sur, Caraga	8.29	1.22	7.92
Calicoan Island, Samar	8.89	1.34	9.62
Charlie's Point, Baler, Aurora	9.45	0.87	4.19
Cobra Reef - Cemento, Baler, Aurora	9.45	0.87	4.19
Guitagican, Samar	8.90	1.17	7.27
Malaking Gasang, Baler, Aurora	9.38	0.77	3.26
Majestics, Catanduanes	9.12	1.16	7.25

Computation for the average wave power (kW/m) for a fourteen-day period was done by the formula P = $0.577TH^2$ where the factors to be considered to compute for the wave power (kW/m) of a certain location are its wave height (H) and wave period (T).

This table shows that the twelve selected locations in the Philippines produced a below average wave power compared to the expected 15 kW/m. Based on the study of Quitoras et al. the waves are far more powerful during the months of December to April. Due to the time when the research was conducted in the month of May, the wave forces acquired from the selected areas were seen below their average wave power compared to other months of the year. The 9.62 kW/m of Calicoan Island, Samar is the highest recorded wave power, followed by Caridad, Siargao Island with a wave power of 9.37 kW/m. The third highest wave power data with an average of 8.64 kW/m is the Barrio, Siargao Island. Next to it is the Burgos, Siargao Island with an average wave power of 8.02kW/m. With a wave power of 7.92 kW/m, Cauit Point, Surigao Del Sur, Caraga comes next. After that is the 7.84 kW/m wave power of the Big Star, Surigao Del Sur. Guitagican, Samar, Majestics, Catanduanes, and Lucky Point, Catanduanes comes respectively with an equivalent value of 7.27 kW/m, 7.25 kW/m and 7.24 kW/m. Charlie's Point, Baler, Aurora and Cobra Reef - Cemento, Baler, Aurora produced the same value of 4.19 kW/m. While the Malaking Gasang, Baler, Aurora in Baler recorded the lowest wave power which is 3.26 kW/m.

Following the data about the wave power, the design and parameters of the whole project is presented in this section. The project will be called Sea Mushroom due to the shape of the aqua buoy- one of the parts of the design.

The figures presented below are the different perspectives of the Sea Mushroom. It is designed on the AutoCAD software, containing Aerial perspective, Man-eye View, and the Bottom Perspective of the project's design.

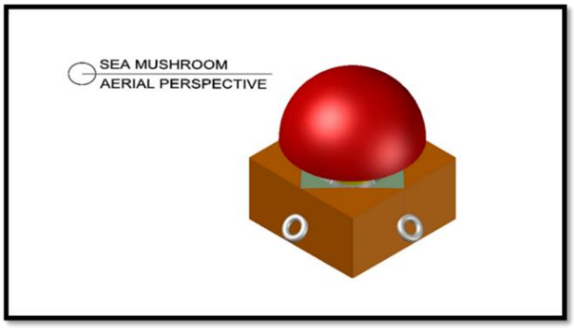

Figure 7: Aerial Perspective of Sea Mushroom

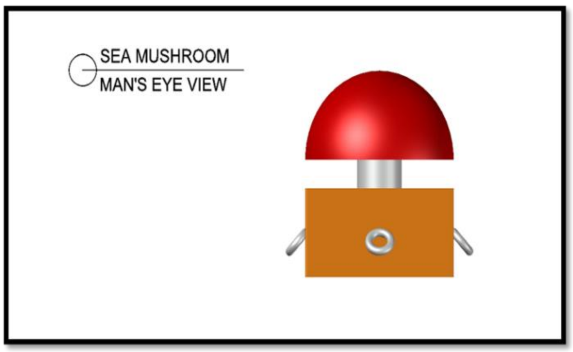

Figure 8: Man's Eye View of Sea Mushroom

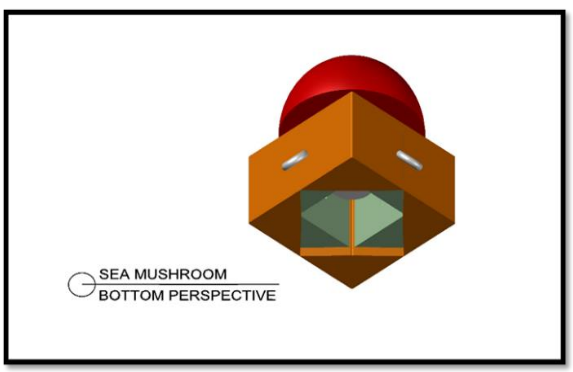

Figure 9: Bottom Perspective of Sea Mushroom

To better understand the sea mushroom, Figure 10 indicates the physical parts of the design. As stated above, the name "Sea Mushroom" originated in the shape of the aqua buoy of the project.

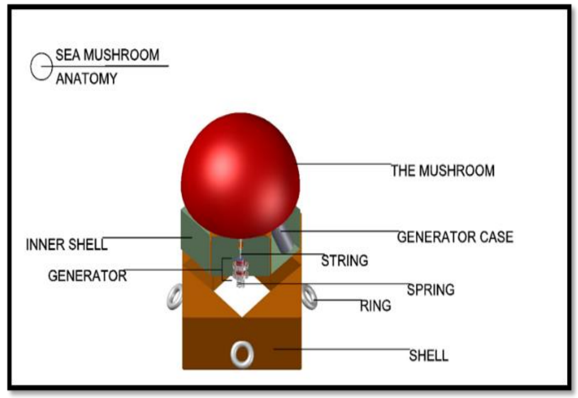

Figure 10: Anatomy of the Sea Mushroom

The important part of the project is the generator where a linear type of generator is used in the project. The generator converts the up and down motion of the waves from the sea into electricity. (Faiz and Nematsaberi 2017) Compared to traditional rotary generators, the linear generator is much more suitable on sea where we consider the wave speed, and the translator can vary its direction based on the motion received. As a result, the output voltage and current will depend on the frequency and amplitude, as well as the phase sequence, resulting in a considerably high peak-to-average power ratio. Therefore, the generator must have a rated power that is significantly higher than the average power. A 7kW Tubular Permanent Magnet Linear Generator is to be utilized in this project. All the parameters needed for the 7kW Tubular Permanent Magnet Linear Generator in the study are presented. A generator case will protect the linear generator. The inner shell of the sea mushroom is another layer of protection on the generator. The gap between the inner shell and the generator case can be filled with materials that can make the sea mushroom achieve the buoyancy required to alter how the project will float on the ocean. The rings are located on the four sides of the sea mushroom. With these rings the generator can be attached to another generator on any face. A concrete foundation below the sea can act as an anchor to the sea mushroom making the project to stay in place, using connection string, it is possible to attach the concrete foundation to the ring of the sea mushroom. The shell is the outer protection of the whole ocean wave energy converter. It is a hollow plastic material acting as a buoy to help the whole project afloat on the sea. From the body of the mushroom shaped buoy, four strings are attached to pull the translator of the linear generators with a mass of 6.8kg. When the translator is pulled, it comes forward. To achieve the up-and-down effect of the linear generator, springs were connected on the other end of the translator. Lastly, the mushroom is the buoy of the generator that floats on the water. The mushroom shape buoy is a customized shape by the researchers making it unique and useful at the same time.

One of the aspects that comes with the design is the dimension of the project. The dimensions of the sea mushroom are custom-made for the compatibility of the 7kW Linear Generator. The next figures show the proposed dimensions of the Sea Mushroom and the general dimension of the 7kW Linear generator.

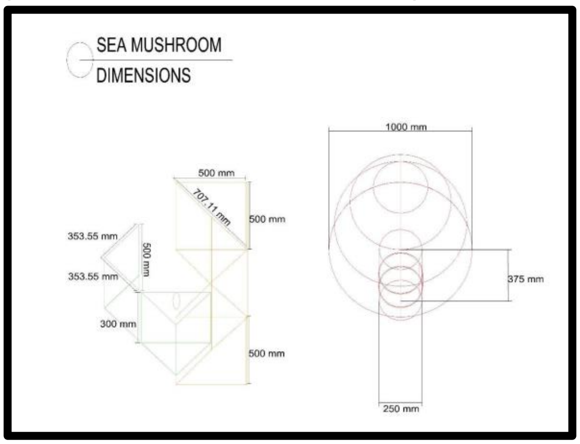

Figure 11: Dimensions of the Sea Mushroom and the generator

The 7kW tubular type PM linear generator has the general parameters of 163.5 mm for the height and the 125 mm for the diameter. The inner shell of the design has a triangular prism shape with dimensions of base sides = 500 mm, 353.55 mm, 353.55 mm, and a height of 500 mm. In comparison to the parameters given, the linear type of generator fits in the design of the Sea Mushroom.

The table below shows the gathered data whether the wave force in a certain location can pull the translators upward and produce the 40mm stroke needed to generate 7kW the linear generator can provide. The simulation was performed through Microsoft Excel. The table consists of the following: the location, average wave power (kW/m), total kW, wave force (N) and the Upward net force of the generator (N). Lastly, the indication whether the 40 mm stroke is achieved is represented in percentage.

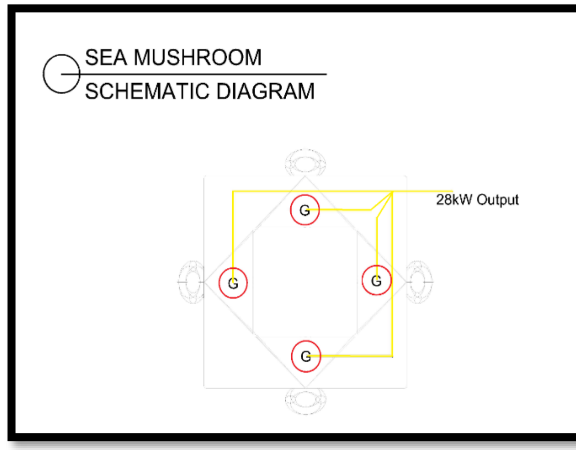

Figure 12: Schematic Diagram of the Linear generators inside the Sea Mushroom

The four 7kW linear type generator are connected in parallel, maximizing the output of the sea mushroom up to 28 kW. According to Power Temp Systems Inc 2019, Paralleling the generators produces more higher supply than the expected output of each generator. Also, it increases the flexibility in load management, reliability, and maintenance capabilities with little to almost no disruption in the power.

Table 2 Excel Simulation for 40mm Stroke Length

Location	Average kW/m	Total kW	Wave force (N)	Upward force of generator (N)	40mm stroke
Lucky Point, Catanduanes	7.24	8.38	1033.26	717.38	100%
Barrio, Siargao Island	8.64	10.89	1232.98	917.10	100%
Burgos, Siargao Island	8.02	9.83	1144.98	829.09	100%
Caridad, Siargao Island	9.37	12.28	1337.88	1022.00	100%
Big Star, Surigao Del Sur	7.84	9.52	1119.87	803.99	100%
Cauit Point, Surigao Del Sur, Caraga	7.92	9.67	1130.42	814.54	100%
Calicoan Island, Samar	9.62	12.92	1374.04	1058.16	100%
Charlie's Point, Baler, Aurora	4.19	3.64	598.68	282.80	100%
Cobra Reef - Cemento, Baler, Aurora	4.19	3.64	598.68	282.80	100%
Guitagican, Samar	7.27	8.50	1038.63	722.74	100%
Malaking Gasang, Baler, Aurora	3.26	2.50	466.14	150.26	100%
Majestics, Catanduanes	7.25	8.40	1035.48	719.60	100%

The researchers performed a series of computations to identify which location can achieve a 40mm stroke upward of the translator using each location's wave power. The average wave power or average kW/m is the wave power per unit of wave-crest length. The wave power was computed through the formula P = 0.577TH^2. Factoring the wave-crest length, a wave's total kW along with its celerity or wave velocity will dictate its wave force. To calculate for the wave force, the formula F_w = P/v is used where F_w is the force of the wave (N), P will be the power of the wave (watts) and v will be the velocity of the wave (m/s). Calculating the downward force or the weight of the four translators is done using the formula w = mg where: w is the total weight of the translators; m is total mass of translators and g is gravity. To identify whether the wave force is enough to pull the weight of the four (4) translators integrated in the ocean wave generator, the researchers computed the upward net force (f_{up}) on the translators by summation of forces acting on the translators ($\sum(forces\ on\ translator)$). The $\sum(forces\ on\ translator)$ will be computed by the equation $F_w - w\ where\ F_w$ is the wave force and w is the total weight of the translators. Having computed the upward net force f_{up}, the researchers were able to calculate the possible distance the translator could travel by using the formula d = $\frac{1}{2}(f_{up}/m)t^2$ where d is the possible distance the translator can cover based on its upward net force f_{up} and t will be the time taken for the translator to reach the end point of the translator. Having computed the possible distance that the translators can cover, the researchers identified if the translators were able to achieve an upward stroke of at least 40mm with regards to each location's wave power.

CONCLUSION

1. With the design of the Sea Mushroom Ocean Wave Converter along with the four linear generators connected in parallel, the resulting electrical power for one (1) Sea Mushroom is 28kW.
2. The selected locales can maximize the four 7kW linear generator based on the data gathered in the Excel simulation.
3. The design of the sea mushroom and the parameters of the 7kW Linear Generator are compatible in terms of dimensions.

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