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Analysis of the Use of Ocean Wave Power Generation Technology as an Environmentally Friendly Energy Alternative in Indonesia

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Abstract

Indonesia is an archipelagic country that is geographically located between two continents and two oceans. As a country blessed with vast ocean expanses, Indonesia has great potential for marine energy sources. Ocean Wave Power Plants (PLTGL) are a type of energy that has advantages compared to other energy sources, namely that they are available throughout the ocean and are considered more environmentally friendly. However, in its use, Ocean Wave Power Plants require quite a lot of money. Apart from that, even though it is considered more environmentally friendly, ocean wave technology also has environmental impacts. This research aims to analyze the use of ocean wave power generation technology. The method used in this research is a qualitative research method with a literature study approach. The results of this research show that ocean wave power plants are a renewable energy source that has great potential to be used as an environmentally friendly alternative energy source in Indonesia

Keywords: PLTGL, Ocean Waves, Alternative Energy, Environmentally Friendly

INTRODUCTION

Energy is a vital object of special concern throughout the world. Along with population growth and increasing technological developments, energy has an important role in meeting the needs of various sectors of life globally, including Indonesia. In meeting energy needs, fossils are still very reliable in Indonesia. In anticipation of the fossil energy crisis and efforts to overcome climate change, alternative energy sources that are more environmentally friendly are needed(Setyarto, 2022).

Renewable energy is an environmentally friendly energy potential that has only been used in Indonesia at 0.3% or around 11.6 GW(Alghaffar et al., 2022). Based on Indonesia's 2022 energy outlook, the total renewable energy potential for electricity generation reaches 3,643 GW. Judging from its geographical location, Indonesia is a maritime country with an ocean area of 3,257,357 km2(Saksono, 2013) . Therefore, marine energy sources have great potential as renewable energy that can be converted into electrical energy by utilizing developed technology(Alghaffar et al., 2022).

There are several types of marine power generation technology, namely ocean current power, wave power, and Ocean Thermal Energy Coversion (OTEC) (Junihartomo, Zakky, 2022). Based on data from the National Energy Council (DEN) in 2021, Indonesia's total marine energy potential reaches 17.9 GW. As a maritime country flanked by two oceans and two continents, Indonesia has potential sea wave energy.Ocean wave energy occurs due to wind blowing on the sea surface (EBTKE, no date). So far, ocean wave energy conversion technology has been developed by the National Research and Innovation Agency (BPPT BRIN) Technology Assessment and Application Agency. However, in Indonesia, development is still limited to research and research has not yet reached the stage of commercial use. However, as renewable energy, ocean wave energy is considered more environmentally friendly because it does not cause pollution. Based on these conditions, it is deemed necessary to carry out research to

analyze the use of ocean wave power generation technology as an environmentally friendly energy alternative in Indonesia.

RESEARCH METHODS

The research method used in this research is a qualitative research method with a literature study approach which produces descriptive data where the findings are obtained through data.(Sugiyono, 2022) The data obtained comes from various sources including books, scientific journals, online news from official government websites or other online media that are believed to be accurate.

RESULT AND DISCUSSION

Ocean Wave Power Plant

Ocean waves are one of the large marine energy potentials available in Indonesia. As long as there is a difference in temperature between one area and another, gusts of wind will arise which will then form waves as they pass through the sea(EBTKE, 2015). This means that ocean wave power is produced by utilizing the rising and falling movements of ocean waves. To utilize the enormous potential of ocean wave energy as a more environmentally friendly alternative to fossil energy, it is very possible to build an Ocean Wave Power Plant (PLTGL) to support the fulfillment of electrical energy needs in Indonesia. PLTGL is a technology used to produce electrical energy in the form of ocean wave conversion energy machines, turbines, and generators that are driven by utilizing ocean waves as a kinetic energy producer.(Wayan Arta Wijaya, 2010)Ocean wave energy, as a renewable energy source, can produce significantly higher energy than wind and solar energy. Even though it is intermittent, ocean wave energy is more stable and has good consistency throughout the day and night. Technology usedIn Ocean Wave Power Plants, so far several have been developed, including: Overtopping, Absorbers, Attenuators, and Oscillation Water Columns.(Junihartomo, Zakky, 2022).

1. Ocean wave overtopping technology isa device with a long structure designed to utilize the height difference between the height of ocean waves and the height of water structures to produce energy. The pressure difference between the water in the reservoir and the water at the surface forces the fluid through a low-head turbine coupled to a generator. This process then produces potential energy which can be converted into electricity.

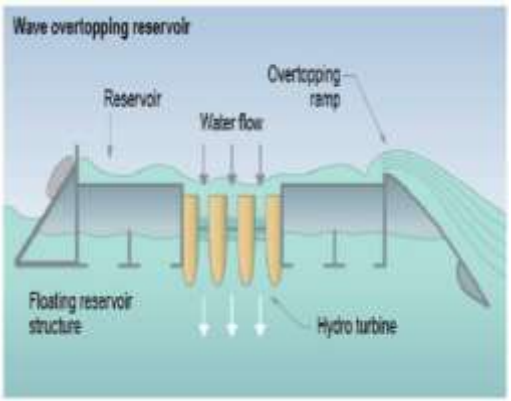


Figure 1. Wave Reservoir Overtopping Technology
Source: http://en.openei.org/wiki/Marine_and_Hydrokinetic_Technology_Glossary

2. Absorber technology is a wave energy technology that has the potential to provide large amounts of power in relatively small devices. The way this technology works is that wave absorbing technology works by absorbing energy from the vertical or horizontal movement of sea waves. This movement is converted into rotational movement of the generator which produces electrical energy.

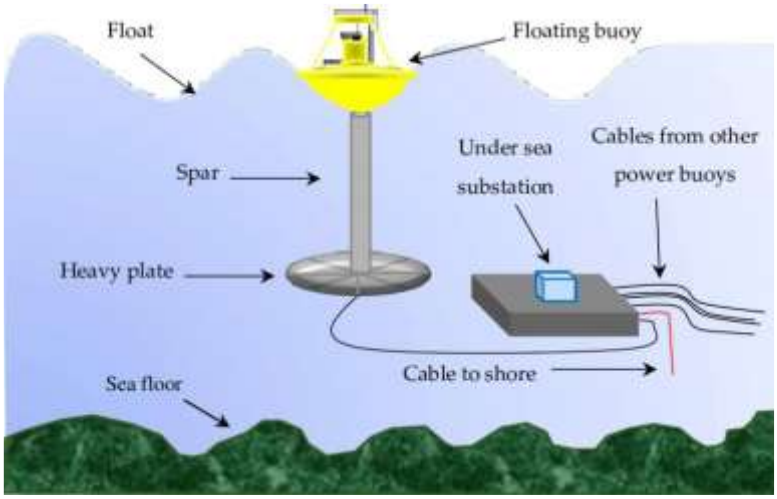
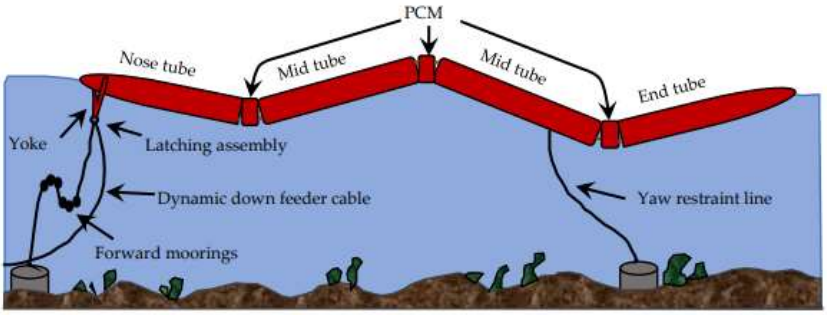
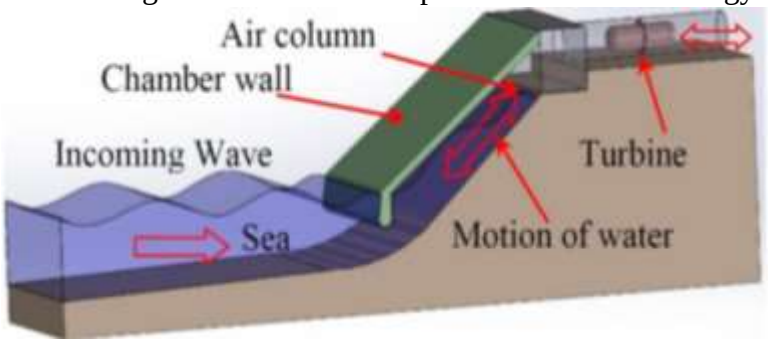


Figure 2. Absorbers Technology
Source:https://www.researchgate.net/publication/340084822

3. Attenuators technology is a floating device that operates parallel to the direction of the wave and effectively moves with the wave. The way this technology works is designed to reduce the amplitude or height of the surrounding waves. This device is held in a certain place that has good wave potential by planting a mooring on the seabed. This device captures energy from the relative movement of the two arms when waves pass through it.



4. Oscillating Water Column Technology is a technology with a hollow structure that is partially submerged in water. This technology works by utilizing the pressure difference between the water and air columns in a closed cavity. This oscillation is then used to drive a turbine or air generator which then produces electrical energy.



Potential for Ocean Wave Power Plants

The potential wave power worldwide ranges from 8000 - 80,000 TWh/y (Khan et al., 2017). Based on the world energy resources report in the 2016 World Energy Council regarding wave energy potential, the Asian region has a total wave power of 6200 TWh/y. Some places that have an annual average offshore wave power flux of more than 10 kW are Hawaii, Rarotonga Cook Islands, Fiji, Majuro Marshal Islands, Federated States of Micronesia, Nauru, Samoa, Tonga, Tuvalu, Vanuatu, South-Coastal India, Maldives , Sri Lanka, Luzon and the Babyan Islands of the Philippines, including the South Java region of Indonesia (Mork et al., 2010).

The strength of sea waves in each location in Indonesia is different with quite a large potential in the range of 10-20Kw/m. In fact, several studies state that there are several locations in Indonesia that have the potential for ocean wave energy reaching 70kW/m(Satriawan et al., 2021).Effectively, the use of ocean wave energy could possibly reach 49,000 MW.(Wayan Arta Wijaya, 2010). The difference in potential wave strength in each location is influenced by several factors, namely: wave height, wave length, wave period, locations with different temperatures and ocean depths, and technological developments.(Syach, Ayasy and..., 2020)

Development Constraints Ocean Wave Power Plant

Ocean wave energy as oneRenewable energy has the same properties as other renewable energy that comes from nature, namely it is intermittent. Therefore, the energy produced depends on the natural conditions that occur, especially waves. The development of ocean wave power plants so far is still limited to the research and research stage and has not yet reached the stage of commercial use. There are several reasons that cause obstacles to the development of ocean wave power plants. Some of these reasons include: There is no technology that is proven enough to be able to utilize the potential of existing wave energy. As a supporter of energy security in Indonesia, ocean wave power plants have not yet become a priority(Vidura et al., 2022). From an economic perspective, due to the immaturity and unavailability of commercial marine energy conversion technology, the price of energy from ocean wave energy conversion is still not competitive enough compared to other clean energy technologies such as solar, hydro, wind or geothermal energy. Apart from that, the development of sea wave energy conversion technology is also faced with difficult natural conditions where the conditions of installation areas located at sea have a high level of difficulty so that both installation and maintenance require high costs.(Vidura et al., 2022).

Installation and Maintenance of Ocean Wave Power Plants

Installation of ocean wave energy technology it is necessary to look for a suitable location with the potential for strong waves that can appear consistently. In addition, reliable conversion devices capable of withstanding harsh marine environmental conditions are also needed. In operations,ocean wave power plantmay be subject to extreme events due to significant wave impact on the external device structure, or high acceleration from moving water masses that may damage the structure, its electrical or mechanical components(Vidura et al., 2022). Therefore, it is important to design structures that are able to efficiently harvest the energy transmitted by ocean waves and that are able to withstand significant increases in wave strength due to storms (Rusu & Onea, 2018). Furthermore, to ensure the technology can operate optimally, maintenance is required. Maintenance is a preventive step that needs to be taken rather than more expensive repairs. This is also done as a step to prevent damage due to overloadocean wave power plantis a marine structure with moving parts such as articulations or cables Felix et al., (2019).

Advantages of Ocean Wave Power Plants

Aris Subarkah, M.Si said that ocean wave energy is an alternative in providing clean energy because waves as a generator of electrical energy are always renewable continuously and do not cause significant environmental problems.(Vidura et al., 2022). The advantage of ocean

wave energy is that it easily converts electrical energy from mechanical energy into waves with greater kinetic energy. Ocean wave energy will never run out and can be used at any time. As renewable energy, ocean wave energy is low-emission energy so it is more environmentally friendly. This ocean wave energy does not cause pollution because it does not produce solids, liquid waste or gas(Satriawan et al., 2021). Apart from that, ocean wave power plants are also plants that produce renewable energy with predictable profits from several days in advance, consistent throughout the day and night, and significantly higher energy yields than wind and solar energy.(Junihartomo, Zakky, 2022).

Environmental Impact of Ocean Wave Power Plants

In general, equipment located on the high seas has the lowest potential impact.Even though it is minimal, ocean wave power plants have a negative impact on the environment(Rahman, Baeda and Umar, 2016). For this reason, the impact it hasas a result of construction, operation, maintenance, decommissioning and disposal of marine energy converters must be considered.(Satriawan et al., 2021). When considering various cohesive environmental impacts, wave energy devices are recorded to be much lower than traditional methods such as oil and gas (Douziech et al., 2016).PChanging wave energy does not have a significant impact on climate change, but installed wave energy converting devices have a significant impact on marine biota(Satriawan et al., 2021).As fordThe negative impacts that arise include: effects onbenthic communities, response species-specific impacts on habitat change and mammal attachment sea, turtles, fish and sea birds.(Azzellino et al., 2011)

CONCLUSION

Power of Indonesia's sea waves being quite large, around 10-20Kw/m and its effective utilization can reach 49,000 MW, it is important to develop sea wave power plants. As a renewable energy source, ocean wave energy is considered more environmentally friendly than other energy sources. This is because ocean wave energy does not cause pollution because it does not produce waste.

However, even though it does not produce waste, it is necessary to consider the development, operation, maintenance and deactivation and disposal of converters in the development of ocean wave power plants because they still have a negative impact on the environment, especially on the sustainability of marine biota

REFERENCES

Alghaffar, MD et al. (2022) 'Potential Integration of Renewable Energy Ocean Power Technologies and Wind Power Plants to Realize Energy Independence', International Journal of Innovative Science and Research Technology, 7(7).

Azzellino, A., Lanfredi, C., Contestabile, P., Ferrante, V., and Vicinanza, D. (2011). “Strategic environmental assessment to evaluate WEC projects in an environmental cost-benefit analysis perspective,” in 21st International Polar and Offshore Engineering Conference.Maui: International Society of Offshore and Polar Engineers.

Burgess, C. and Biswas, W.K. (2021) 'Eco-efficiency assessment of wave energy conversion in Western Australia', Journal of Cleaner Production, 312(May), p. 127814. Available at: https://doi.org/10.1016/j.jclepro.2021.127814.

Douziech, M., Hellweg, S., Verones, F., 2016. Supporting Information for "Are Wave and Tidal Energy Embedding New Green Technologies?". Environmental Science and

Technology. ETH Zurich, Switzerland.
EBTKE, D. (2015) 'RENSTRA (Strategic Plan) DG EBTKE 2015-2019', p. 99.
EBTKE, D. (no date) 'RENSTRA (Strategic Plan) Directorate General of EBTKE 2015-2019', (1), pp. 1–14.
Junihartomo, Zakky, SS (2022) 'Renewable Energy Technology Ocean Power Technologies', Journal…, 6(2), pp. 2547–2554. Available at: http://download.garuda.kemdikbud.go.id/article.php?article=3034766&val=20674&title=Renewable Energy Technology Ocean Power Technologies.
Patrizi, N. et al. (2019) 'Lifecycle environmental impact assessment of an overtopping wave energy converter embedded in breakwater systems', Frontiers in Energy Research, 7(APR), pp. 1–10. Available at: https://doi.org/10.3389/fenrg.2019.00032.
Rahman, S., Baeda, AY and Umar, H. (2016) 'The Potential of Wave Energy as an Alternative Energy Source on the Outer Islands of the Republic of Indonesia', Journal of Engineering Research (JPE), 20(2), pp. 32–38. Available at: http://cot.unhas.ac.id/journals/index.php/jpe/article/view/18.
Saksono, H. (2013) 'Blue Economy: Regional Development Solutions with Island Characteristics. Case Study of Anambas Islands Regency', Bina Praja Journal, 05(01), pp. 01–12. Available at: https://doi.org/10.21787/jbp.05.2013.01-12.
Satriawan, M. et al. (2021) 'Unlimited energy source: a review of ocean wave energy utilization and its impact on the environment', Indonesian Journal of Science and Technology, 6(1), pp. 1–16. Available at: https://doi.org/10.17509/ijost.v6i1.31473.
Setyarto, A. and W. (2022) Steps towards an Energy Transition, ppsdmaparatur.esdm.go.id. Available at: https://ppsdmaparatur.esdm.go.id/seputar-ppsdma/angkat-menuju-transisi-energi (Accessed: 24 March 2023).
Sugiyono (2022) Qualitative Research Methods. 3rd Edition. Bandung: Alphabeta.
Syach, MF, Ayasy, MF and ... (2020) 'Mapping Estimates of the Potential of Ocean Waves as a Wave Power Plant Using a Pelamis System in Waters...', ... Climatology and Geophysics, 7(3), pp. 11–19. Available at: https://jurnal.stmkg.ac.id/index.php/jmkg/article/view/198.
Vidura, A. et al. (2022) 'Potential Utilization of Ocean Wave Power Plant in South Waters of Java Island for Supporting Energy Security', Energy Security, 8(1), pp. 32–48.
Wayan Arta Wijaya, I. (2010) 'Ocean Wave Power Plant Using Oscillating Water Column Technology in Bali Waters', Electrical Technology Scientific Magazine [Preprint]. Available at: https://doi.org/10.24843/10.24843/MITE.