Kementerian Perindustrian REPUBLIK INDONESIA

Available *online* at : http://jurnal.poltekapp.ac.id/

Jurnal Manajemen Industri dan Logistik

| ISSN (Print) 2622-528X | ISSN (Online) 2598-5795 |

POLITEKNIK APP JAKARTA

article category : Logistic Management

Green Energy Development Strategy Towards Green Logistics: Case Study At PT. Pelabuhan Indonesia III (Persero) Benoa Bali

Arif Devi Dwipayana [1*], Ni Luh Darmayanti [2]

[1,2] Land Transportation Polytechnic of Bali, Jalan Cempaka Putih Desa Samsam, Kecamatan Kerambitan, Kabupaten Tabanan 82161, Bali, Indonesia

ARTICLE INFORMATION

Article history:

Received: February 01, 2024
Revised: May 25, 2024
Accepted: May 27, 2024

Keywords:
Green Energy
Green Logistic
Strategy
Benoa Port

ABSTRACT

Implementing green logistics involves using environmentally friendly practices and technologies in the management of supply chains and transportation of goods. The potential benefits gained in implementing green logistics include, a reduction in greenhouse gas emissions, energy, and resource efficiency, reduced operational costs, reputation, and regulatory compliance. This research aims to create a strategy for developing the use of green energy towards green logistics at Benoa Port. The research methodology using a systematic literature review hybrid type then present several development strategy schemes that will be implemented. The results of the research conclude that the sea side and land side strategies can be applied to Benoa Port, the initial development strategy that has the greatest potential to be implemented is wind energy and solar energy on the land side to support the implementation of green logistics in fulfilling the Port area's electrical energy, the implications of this research will have an impact on the development of green energy for other ports in Indonesia in accordance with the government's national energy policy.

Corresponding Author:

Arif Devi Dwipayana
Land Transportation Polytechnic of Bali Jalan Cempaka Putih Desa Samsam, Kecamatan Kerambitan, Kabupaten Tabanan 82161, Bali, Indonesia
Email: arif.devi@poltradabali.ac.id

INTRODUCTION

The port sector is currently an important center for the development of maritime transportation, logistics, passenger services, tourism, a world trade center and as a link between various countries in the world. A report from the United Nations Conference on Trade and Development (UNCTAD) in 2021 stated that more than 80% of the volume of international goods trade is carried out via sea transportation routes and developing countries have a higher share [1], however high energy consumption and pollution occur due to Increasing port production and trade volumes have made the environmental impact on seas and ports even greater. Pollution and port operations will not only damage the natural ecological balance and the surrounding environment, but also have a negative impact on climate change. The Port sector is highly qualified and has a crucial role to play in the development of a green and sustainable energy transition for a better future [2]. Ports in their operations require large energy requirements, so how can they manage this energy efficiently or can use alternative fuels [3]. Port classification in Indonesia is divided into two groups; 1) Managed ports and 2) non-managed ports, with the main objective being to serve the entire process of sea transportation activities, the difference is related to the facilities at non-managed ports which are not as complete as the facilities at managed ports.

Ports are nodes in complex trade and logistics networks that include shipping companies, shipping companies, terminal operators, and other parties [4]. The port sector is composed of various stakeholders and varies in characteristics and needs, for example, it includes public and private entities, for-profit or non-profit purposes, geographic conditions, large and small organizations, and more [5]. Furthermore, this sector is characterized by a variety of activities, such as transportation, logistics, large-scale manufacturing, etc. [6]. Port authorities recognize that environmental and social performance is fundamental in dealing with the community and environment in which the port is located because they can also provide a competitive advantage. As customers increasingly emphasize the value of sustainable and environmentally friendly supply chains, initiatives are needed to improve port sustainability, especially in the green energy sector to support the creation of environmentally friendly green logistics services. Implementing green logistics involves using environmentally friendly practices and technologies in the management of supply chains and transportation of goods, some barriers include, high initial costs, lack of awareness, technology limitations and changes in business processes. The advantages gained in implementing green logistics include, reduction in greenhouse gas emissions, energy, and resource efficiency, reduced operational costs and reputation and regulatory compliance. Ways to implement green logistics include, supply chain evaluation, invest in green technology, training and education and partnerships with suppliers and business partners (Global Green Logistics Partnership).

Benoa Harbor is a business entity owned by the Government of the Republic of Indonesia through PT. Port Indonesia III (Persero). The status of Benoa Port is an International Port, with an area of the eastern pier (P=290 m; I= 20 m; D= -10 m LWS), southern pier (P= 205.8 m; I = 21.3 m; D= - 8 m LWS) and fishing pier (P= 406 m; I= 8 m; D= -3 m LWS). Building facilities consist of: 1) International passenger terminal 1,300 m2; 2) Domestic passenger terminal 1,383 m2; 3) Warehouse 1,856 m2 and 4) Stacking yard 1.5 Ha. Shipping channel with a channel length of 3.9 nautical miles, a channel width of 1,500 m and a channel depth of -9-13 m LWS with a terminal area of 1,530 m2. Benoa Port is currently under development with completed and ongoing works as shown in Table 1. There are eight areas of development work that began in stages starting in 2019 and ending in 2028.

Table 1. Development of Benoa Harbor [7]

Work	Year
Melastik Area Development	2019-2020
Construction of Retaining Wall and Revetment	2020-2022
City Forest Development	2022-2024
Jetty Construction	2020-2026
Construction of Storage Tanks	2021-2026
Pond Dredging	2020-2025
Extension of East Pier (Cruise) 160 m	2021-2022
Fishery Zone Development	2023-2028

The development of Benoa Port is currently being carried out to increase operational capacity, but not so much towards developing green energy towards green logistics. The concept of environmentally friendly port development has been put forward in the port industry. An environmentally friendly port is a sustainable port that provides a balance between environmental and economic benefits. The environmentally friendly port development strategy involves many aspects including reducing harmful gas emissions from ports and ships, which is also the most prominent factor [8]. More than 90% of ports are close to urban areas so they have a pollution impact and result in a risk of decreased health for people living in these areas [9] On the other hand, several studies discussing the use of renewable energy and smart power grids in ports, show that it not only improves the environmental performance of the port system but also save cost savings [10]. The development of logistics has greatly promoted the rapid growth of global trade and trade globalization has continuously increased the demands for international and domestic logistics. However, negative externalities of logistics have long been recognized. For instance, carbon dioxide emissions, noise pollution, resource waste, infrastructure failure and traffic congestion are generated from freight transportation and operating equipment [11].

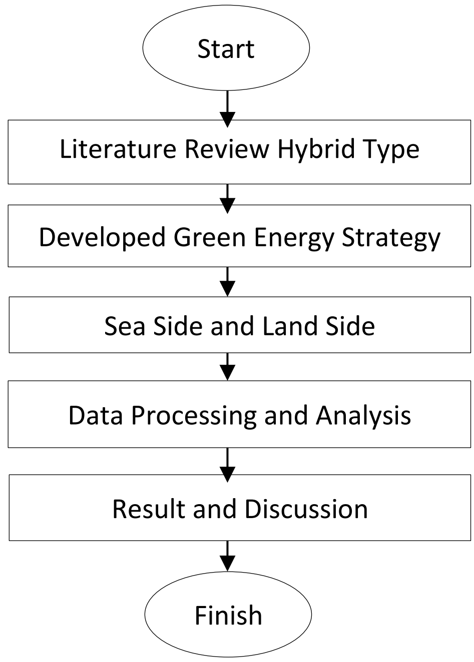
Ports have various energy needs such as electrical energy, natural gas, heat/cooling energy, and conventional fuels or renewable fuels such as hydrogen, ammonia, biofuel, etc. Energy needs are adjusted to the types of activities carried out at the port, such as loading and unloading of cargo and shipping, providing electrical power for docked ships, and providing various port facilities and infrastructure as services for commercial operators and passengers. The increasing demand for energy needs in port areas, coupled with demands to reduce pollutant emissions, has encouraged the development of new renewable energy systems that can provide various forms of energy using sustainable sources [10]. There is a lot of literature regarding energy efficiency and new renewable energy-based systems in port areas, including design, optimization, and operation strategies. Advanced technologies and management strategies to conserve energy and reduce environmental impact are reviewed in detail and comprehensive [12].

The combination of various renewable energy sources can provide major benefits for ports also in terms of the environmental impact of docked ships. Yigit *et al*. 2018 [13], studied several scenarios for harnessing solar and wind energy through electricity supply and energy storage systems at the coast. They developed MATLAB models to assess the environmental and economic performance of proposed energy management methods for ports located in Brazil, the UK, Turkey, and Japan. Benoa Port has a very strategic position in implementing the new, renewable/green energy transition process, the potential for green energy to support green logistics at Benoa Port, including from the water side, namely marine energy in the form of wave energy, tidal energy, ocean current energy, and marine thermal energy, while from the land side, namely solar energy (solar cells) and wind energy.

RESEARCH METHOD

The research used literacy study data collection techniques as well as data sources from secondary data types. The discussion in this research can be described qualitatively based on the results of data processing that has been previously collected. Literature review methodology allows researchers to implement rigorous and reliable analysis of scientific sources [14], [15]. Some scientific review methods exist as literature-based reviews, using a framework as a methodology, theory-based, reviews aimed at theory development, hybrid types, and bibliometric analysis. Considering the research gap, the author considers that the research method is carried out using a systematic literature review hybrid type. Research Methodology Scheme shown in Figure 1.

Figure 1. Research Methodology Scheme



RESULT AND DISCUSSION

Green energy development scheme towards green logistics in benoa port adopted from Arena *et al*. (2018) [16] and based on observations and calculations made by the author, further shown in accordance with Figure 2 below.

indicators, namely wavelength, wave height and time of sea waves which are used as energy in rotating turbines and generators to produce electrical energy. There are five wave energy technologies that have been applied as electrical energy generators, namely Cockerall rafts, Kayser rigid tubes, salter floats and

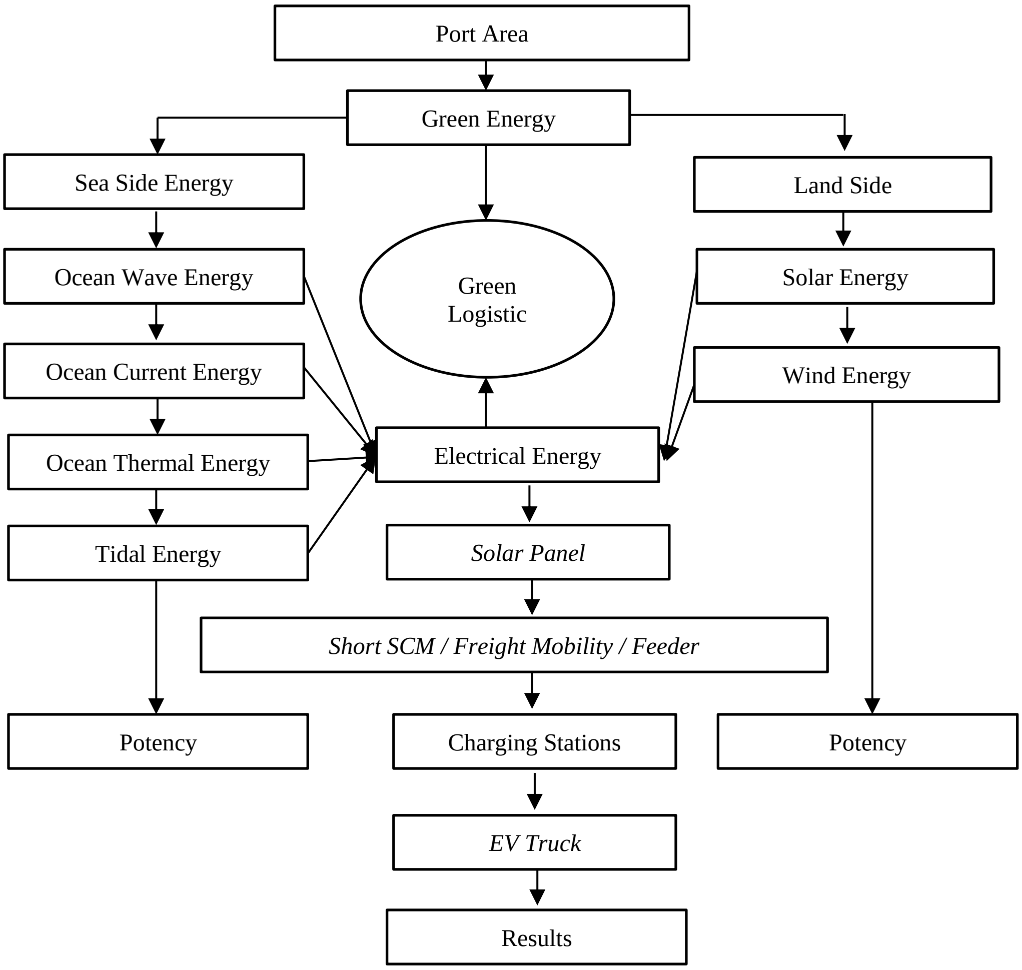


Figure 2. Green Energy Development Strategy

1.1 Sea Side

From the sea side, looking at all the potential of green energy that can be applied, some of these energies are as follows:

1.1.1 Ocean Wave Energy

Is kinetic energy by utilizing differences in sea wave height by converting energy into electrical energy through wave

Masuda tubes [17]. Figure 3 shows how the ocean wave energy scheme works. By looking at the characteristics of ocean waves in Benoa Port, such as wave height, wave period, ocean currents, water depth, and seabed topography, the most feasible implementation is salter floats due to water conditions with moderate to large ocean waves.

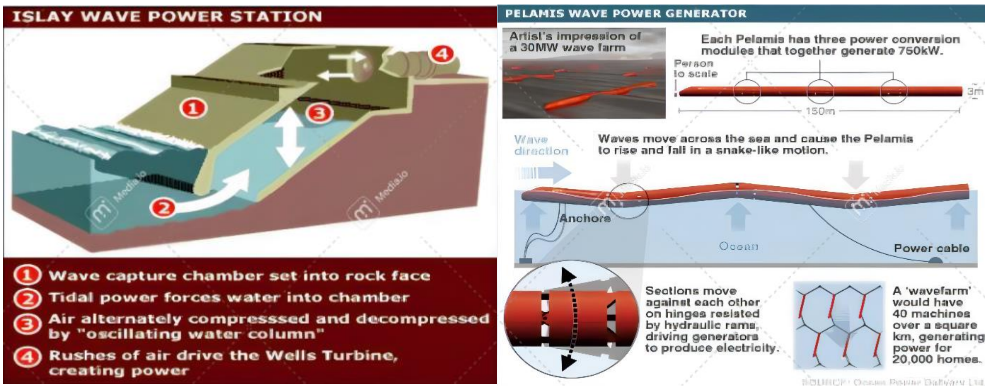


Figure 3. Ocean Wave Energy

1.1.2 Ocean Current Energy

The way ocean current energy works through power plants has the same characteristics as wind power plants which utilize the rotation of a windmill to drive a generator to produce electrical energy. The minimum ocean current speed reaches 2 m/s, with the ideal ocean current speed being 2.5 m/s [17]. Figure 4 shows how ocean current energy operates, utilizing underwater turbines, ocean current flow, generators, and transmission, however, there are technical challenges such as corrosion, maintenance in the marine environment, and ecological impacts to overcome.

Figure 4. Ocean Current Energy

1.1.3 Ocean Thermal Energy

It is a power plant that utilizes the temperature difference between surface sea water and deep-sea water, with a minimum temperature difference reaching 20 ^{0}C [18].

1.1.4 Tidal Energy

It is kinetic energy from utilizing differences in tidal and low tide heights, the working principle is the same as hydroelectric power plants (PLTA) [18]. Figure 5 shows how this tidal electricity generation works as the tide comes in and again when it goes out. The turbines are driven by the power of the sea in both directions.

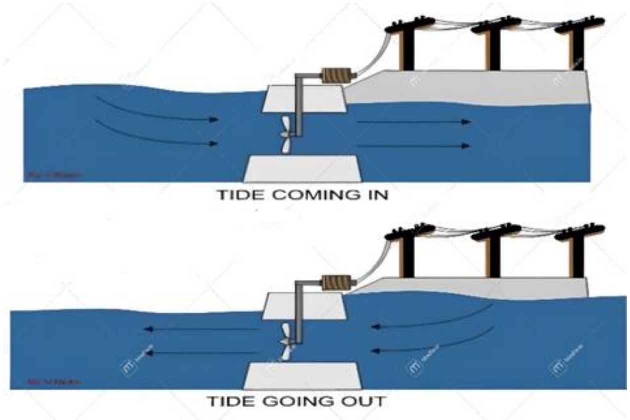


Figure 5. Tidal Energy

1.1.5 Potency

Looking at the geographical conditions of Benoa Port according to Figure 6, the potential for implementing green energy from the sea side by utilizing all the energy produced is very possible to be implemented. The indicators for ocean waves, ocean currents, ocean heat and tides have been met by Benoa Port, the calculation process in the form of a *feasibility study* must be carried out first.

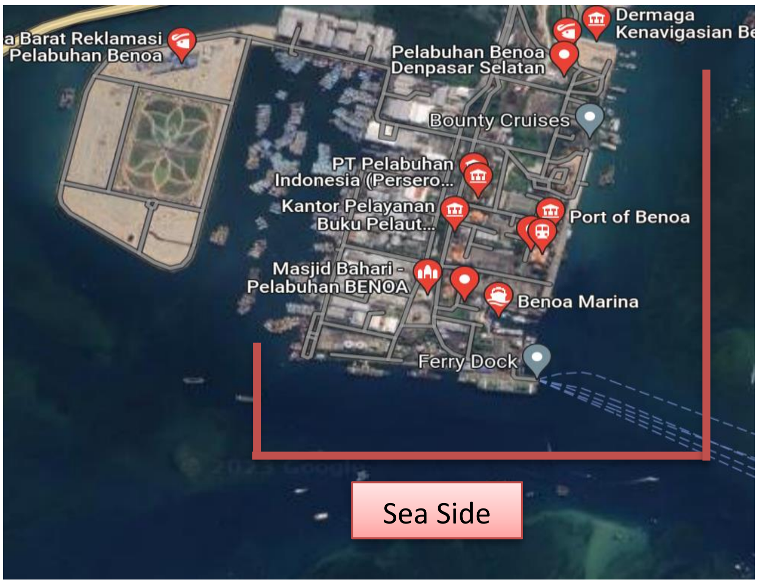


Figure 6. Application of Green Energy on the Sea Side

1.2 Land Side

The application of green energy on the land side has advantages over the sea side, because the implementation process is easier to implement. Below is a further explanation regarding green energy on the land side.

1.2.1 Solar Energy

Currently, solar energy is very popular in society. Indonesia as a tropical country has advantages in utilizing solar energy. To find out how big the potential for solar energy is in Indonesia, you can see the following graph (Figure 7). The graph shows that Denpasar and Gorontalo are the two cities with the highest value, namely 4.1 kWh/kWp. This value is obtained from a comparison of kWh/kWp using SAM software with the assumption that the panel used is the *Polycrystalline type* with a slope angle of 100, total *losses* from the system are 14%, and the average capacity factor is 15.4%. [19].

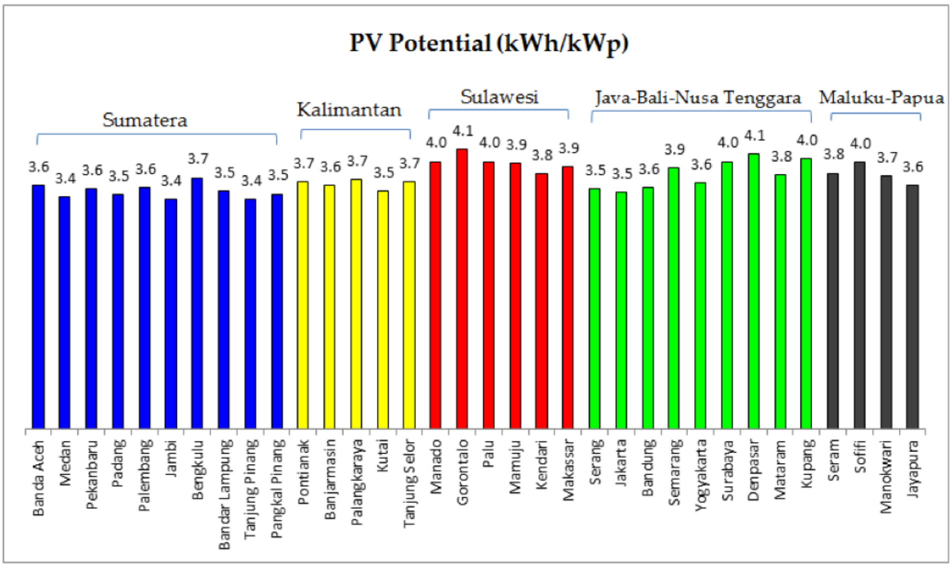


Figure 7. Potential of Solar Panels in Indonesia (kWh/kWp)

Research regarding the potential for solar energy in Bali was also carried out by a research institute called IESR (Institute *for Essential Services Reform)*. The research carried out was by simulating the installation of solar panels on several buildings in Bali. As a result, installing solar panels on 46 government buildings was able to produce 7.8 MWp of energy [20]. If you look at the light intensity in the Bali area of 4.3 - 7.5 kWh/m^{2,} if it is assumed that the *irradiance value* is 6000 W/m ^{2} in the Benoa Harbor area then the *photovoltaic efficiency value* is 10% - 15% obtained for every m ^{2} of PV = 6000 x 10% = 600 W/m$^{2.}$

The construction of solar panels can be carried out on buildings/rooftops in the Benoa Harbor area, *Solar Ground,* and vehicle parking areas. The current process of loading and unloading and delivering passengers uses conventional vehicles which causes pollution conditions around the port to increase. The following is the scheme for building solar panels in the Benoa Port rooftop position and installing solar panels in the solar ground position and parking roof at the logistics centre as shown in Figure 8 (a and b).

(a)

(b)

Figure 8. Installation of Solar Panels, (a) On the Rooftop Installation of Solar Ground and (b) Parking Roof at the Logistics Centre

The energy produced from solar panels is then stored in batteries. To support green logistics at logistics activity centres such as loading and unloading processes, shipping and passenger movement, electric vehicles can be used. Solar energy-based charging station (Figure 9) can be built as an electric vehicle charging centre.

Figure 9. Solar Energy Based Charging Station [20]

Currently, the use of electric trucks to support short distance *supply chain management processes has been carried out, several electric truck products, namely e-canters from PT.* Krama Yudha Tiga Berlian Motor and Hino Dutro Z EV from PT. Hino Motor Sales Indonesia (Figure 10) is very supportive of achieving green logistics because it does not produce exhaust emissions.

Figure 10. *Electric Truck*

The concept of using electric trucks in short-distance SCM logistics transportation at Benoa Port can be made into a scheme by adopting *Electric Trucks: Keeping Shelves Stocked in a Net Zero World (Australian Trucking Association)* as shown in Figure 11.

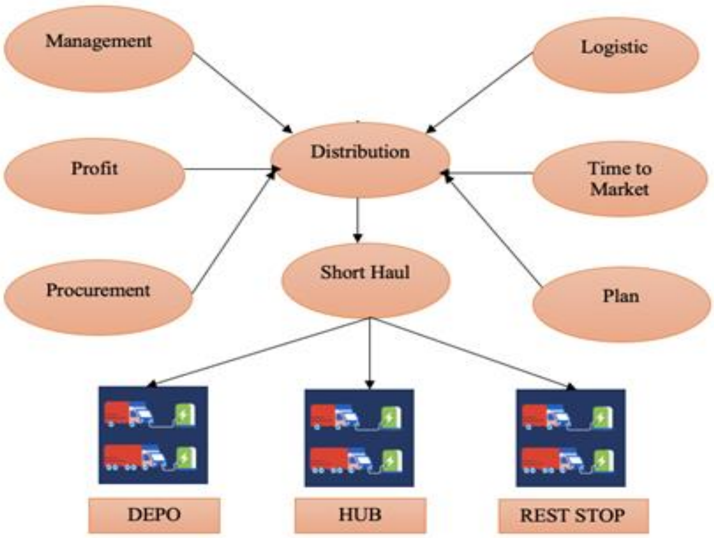


Figure 11. Concept of Using Electric Trucks in Short Distance SCM Logistics Transportation at Benoa Port [21]

1.2.2. Wind Energy

It is a very flexible renewable energy. A wind power plant is a power plant that uses wind as an energy source to produce electrical energy. Wind power plants convert wind power into electrical energy using a wind turbine. A wind turbine is a device that functions to convert kinetic energy into mechanical energy in the form of rotation of the rotor and generator shaft to produce electrical energy. The motion energy originating from the wind will be transmitted into motion force and torque on the generator shaft which then produces electrical energy. A wind turbine is a driving machine whose driving energy comes from the wind. The basic working principle of a wind turbine is to convert wind motion energy into rotational energy in the turbine, then the turbine rotation is used to rotate the generator, which will ultimately produce electricity (Figure 12) [22] .

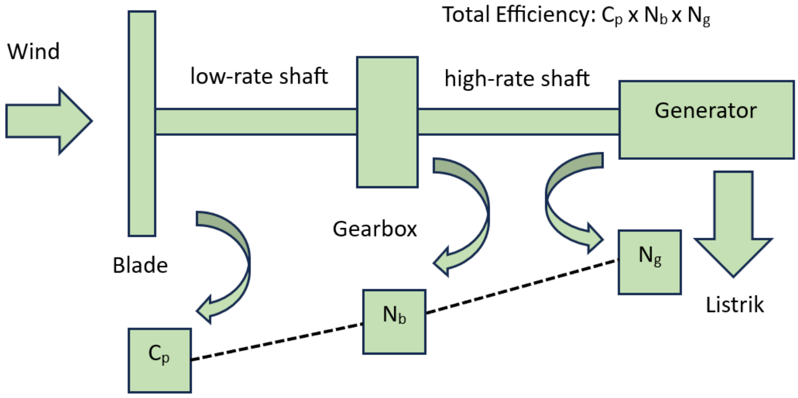


Figure 12. Working principle of a wind turbine

In the Benoa Harbor area the average wind speed is 18 km/h. The characteristics of wind that can be utilized in PLTB are wind that flows laminarly (flows regularly) with a speed of between 4 m/s to 25 m/s, so that the average wind speed is 18 km/h or the same as 5 m/s., PLTB can be implemented. PLTB can be built on the *port side of the area* as shown in Figure 13.

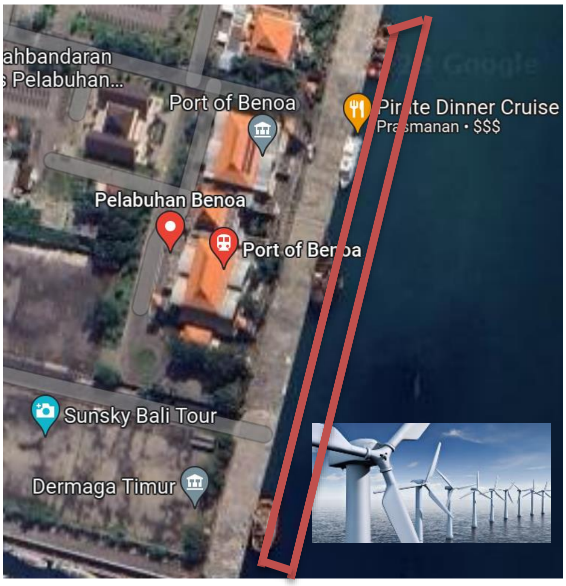


Figure 13. PLTB on *the Port Area Side*

1.2.2 Potency

Looking at the geographical conditions of Benoa Port, there is potential for implementing green energy from the land side by utilizing the electrical energy produced to be implemented. The indicators for solar energy and wind energy have been met by Benoa Port, a more in-depth calculation process needs to be carried out to ensure feasibility.

Several green energy implementation strategies already outlined above, would then be presented to port management benoa as support for the benoa harbor development program, especially in the use of green energy to support green logistics. Several] green energy implementation strategies also support the results of research conducted by Attanasio *et al.* 2023 [18]; Giuseppe *et al*. 2019 [23]; Andrzej Montwiłł 2019 [24]; Ke Du *et al.* 2019 [25]; Chengying Hua *et al*. 2019 [26]; A. Buonomano *et al*. 2023 [27]; Pivetta *et al*. 2023 [28], Syahrir, DM [29], Furqon, *et al.* [30] who have conducted research related to the application of green energy to support green logistics in the port area. The implications of implementing several green energy strategies to support green logistics at the Benoa port are reducing greenhouse gas emissions, energy efficiency, especially electrical energy, technological innovation, partnerships, and collaboration. Another potential is of course to create a positive impact in the long term, both from an environmental, economic, and social perspective. However, this also requires commitment and cooperation from the various parties involved, as well as support from government policies that support sustainable development.

CONCLUSION

The application of green energy in ports is currently a top priority in reducing dependence on conventional energy use. Benoa Port is one of the ports that has enormous potential to apply green energy to support the achievement of green logistics. The strategy for implementing green energy at Benoa Port to support the creation of green logistics is carried out on the sea and land sides. On the sea side by utilizing the energy of ocean waves, ocean currents, ocean heat and tides, on the land side by utilizing solar energy and wind energy, the initial development strategy that has the greatest potential to be implemented is wind energy and solar energy on the land side to support the implementation of green logistics in fulfilling the Port area's electrical energy. More in-depth study should be taken regarding the construction of wind power and the construction of solar cells as a first step in the implementation of green logistics and impacted on the reduction of fossil energy consumption. By prioritizing green energy initiatives at Benoa Port, we are not only investing in environmental sustainability, but also in a more efficient, innovative, and competitive port future. Our commitment to sustainable practices and green energy upgrades will bring long-term benefits to the environment, community, and the local economy. Together, we can make Benoa Port an example for other ports in implementing sustainable practices and creating a greener future for generations to come.

REFERENCES

[1] F. Maes, J.-P. Merckx, L. Jonas, H. Pirlet, and V. Thomas, *Maritime transport, shipping and ports. In: Dauwe*. 2022.

[2] O. Oloruntobi, K. Mokhtar, A. Gohari, S. Asif, and L. F. Chuah, “Sustainable Transition Towards Greener and Cleaner Seaborne Shipping Industry: Challenges and Opportunities,” *Cleaner Engineering and Technology*, vol. 13, no. March, p. 100628, 2023, doi: 10.1016/j.clet.2023.100628.

[3] M. Acciaro, H. Ghiara, and M. I. Cusano, “Energy Management in Seaports: A New Role for Port Authorities,” *Energy Policy*, vol. 71, pp. 4–12, Aug. 2014, doi: 10.1016/J.ENPOL.2014.04.013.

[4] V. Duc Bui, H. Phuong Nguyen, X. Phuong Nguyen, and H. Chi Minh city, “Optimization of Energy Management Systems in Seaports as a Potential Strategy for Sustainable Sevelopment,” *Journal of Mechanical Engineering Research and Developments*, vol. 44, no. 8, pp. 19–30, 2021.

[5] M. Langenus and M. Dooms, “Creating an Industry-Level Business Model for Sustainability: The Case of the European Ports Industry,” *Journal of Cleaner Production*, vol. 195, pp. 949–962, Sep. 2018, doi: 10.1016/J.JCLEPRO.2018.05.150.

[6] Ç. Iris and J. S. L. Lam, “A Review of Energy Efficiency in Ports: Operational Strategies, Technologies and Energy Management Systems,” *Renewable and Sustainable Energy Reviews*, vol. 112, pp. 170–182, Sep. 2019, doi: 10.1016/J.RSER.2019.04.069.

[7] Desain Pengembangan Pelabuhan Benoa Dan Pemanfaatan Dumping I Dan II. PT. Pelabuhan Indonesia III (Persero).

[8] S. Pettit, P. Wells, J. Haider, and W. Abouarghoub, “Revisiting History: Can Shipping Achieve a Second Socio-Technical Transition for Carbon Emissions Reduction?,” *Transportation Research Part D: Transport and Environment*, vol. 58, pp. 292–307, Jan. 2018, doi: 10.1016/J.TRD.2017.05.001.

[9] K. L. Rødsetha, H. Schøyenb, and P. B. Wangsnessa, “Decomposing Growth in Norwegian Seaport Container Throughput and Associated Air Pollution,” *Transportation Research Part D*, vol. 85, no. May, p. 102391, 2020, doi: 10.1016/j.trd.2020.102391.

[10] N. B. Ahamad, M. Othman, J. C. Vasquez, J. M. Guerrero, and C.-L. Su, “Optimal Sizing and Performance Evaluation of a Renewable Energy Based Microgrid in Future Seaports,” in *2018 IEEE International Conference on Industrial Technology (ICIT)*, 2018, pp. 1043–1048.

[11] S. Boglietti, M. Carra, M. Sotgiu, B. Barabino, M. Bonera, and G. Maternini, “Planning for Electric Car Charging: A Review of Technologies, Criteria and Methods,” *Electrifying Mobility: Realising a Sustainable Future for the Car*, pp. 159–187, 2022.

[12] H. M. Elnajjar, A. S. Shehata, A. H. A. Elbatran, and M. F. Shehadeh, "Experimental and Techno-Economic Feasibility Analysis of Renewable Energy Technologies for Jabel Ali Port in UAE," *Energy Reports*, vol. 7, no. May, pp. 116–136, 2021, doi: 10.1016/j.egyr.2021.08.102.

[13] Yigit, K., Acarkan, B., 2018. A new electrical energy management approach for ships using mixed energy sources to ensure sustainable port cities. Sustain. Cities Soc. 40, 126–135.

[14] J. Hulland and M. B. Houston, "Why Systematic Review Papers and Meta-Analyses Matter: an Introduction to the Special Issue on Generalizations in Marketing," *Journal of the Academy of Marketing Science*, vol. 48, no. 3, pp. 351–359, 2020, doi: 10.1007/s11747-020-00721-7.

[15] J. Paul, W. M. Lim, A. O'Cass, A. W. Hao, and S. Bresciani, "Scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR)," *International Journal of Consumer Studies*, vol. 45, no. 4, pp. 01–016, 2021.

[16] F. Arena, G. Malara, G. Musolino, C. Rindone, A. Romolo, and A. Vitetta, "From Green-Energy to Green-Logistics: A Pilot Study in an Italian Port Area," *Transportation Research Procedia*, vol. 30, pp. 111–118, 2018, doi: 10.1016/j.trpro.2018.09.013.

[17] Irfan Syarif Arif, Sutopo Purwono Fitri. 2016. Kajian Teknis Tahapan Persiapan Pengembangan Energi Laut di Indonesia

[18] G. Attanasio, C. Battistella, and E. Chizzolini, "The Future of Energy Management: Results of a Delphi Panel Applied in the Case of Ports," *Journal of Cleaner Production*, vol. 417, no. June, p. 137947, 2023, doi: 10.1016/j.jclepro.2023.137947.

[19] D. F. Silalahi, A. Blakers, M. Stocks, B. Lu, C. Cheng, and L. Hayes, "Indonesia's Vast Solar Energy Potential," *Energies*, vol. 14, no. 17, 2021, doi: 10.3390/en14175424.

[20] M. S. Alim, S. Thamrin, and R. L. W., "Pemanfaatan Pembangkit Listrik Tenaga Surya sebagai Alternatif Ketahanan Energi Nasional Masa Depan," *Jurnal Pengabdian kepada Masyarakat Nusantara (JPkMN)*, vol. 4, no. 3, pp. 2427–2435, 2023.

[21] Electric trucks: Keeping shelves stocked in a net zero world. Australian Trucking Association.

[22] Wayan Sukerayasa, Ida Ayu Dwi Giriantari, 2019. Analisis Keluaran Pembangkit Listrik Tenaga Bayu Pada Pilot Project Smart Grid Program Studi Teknik Elektro Universitas Udayana.

[23] Giuseppe Musolino, Corrado Rindone, Antonino Vitetta. 2019. Passengers and freight mobility with electric vehicles: A methodology to plan green transport and logistic services near port area. Transportation Research Procedia 37 (2019) 393–400.

[24] A. Montwiłł, “Inland Ports in the Urban Logistics System. Case Studies,” *Transportation Research Procedia*, vol. 39, no. 2018, pp. 333–340, 2019, doi: 10.1016/j.trpro.2019.06.035.

[25] K. Du, J. Monios, and Y. Wang, “Green Port Strategies in China,” *Green Ports: Inland and Seaside Sustainable Transportation Strategies*, pp. 211–229, 2019, doi: 10.1016/B978-0-12-814054-3.00011-6.

[26] C. Hua *et al.*, “Evaluation and Governance of Green Development Practice of Port: A Sea Port Case of China,” *Journal of Cleaner Production*, vol. 249, p. 119434, Mar. 2020, doi: 10.1016/J.JCLEPRO.2019.119434.

[27] A. Buonomano, G. Del Papa, G. F. Giuzio, A. Palombo, and G. Russo, “Future Pathways for Decarbonization and Energy Efficiency of Ports: Modelling and Optimization as Sustainable Energy Hubs,” *Journal of Cleaner Production*, vol. 420, no. May, p. 138389, 2023, doi: 10.1016/j.jclepro.2023.138389.

[28] D. Pivetta *et al.*, “Optimal Decarbonization Strategies for an Industrial Port Area by Using Hydrogen as Energy Carrier,” *International Journal of Hydrogen Energy*, vol. 52, pp. 1084–1103, 2024, doi: 10.1016/j.ijhydene.2023.07.008.

[29] S. Dm, “Jurnal Manajemen Industri dan Logistik The Influence Of Logistic Management, Governance, And Social Responsibility On Competitiveness And Operational Performance Of Manufacturing Companies At Makassar Industrial Estate ARTICLE INFORMATION ABSTRACT,” *Jurnal Manajemen Industri dan Logistik (JMIL)*, vol. 7, no. 1, pp. 165–176, 2023, doi: 10.30988/jmil.v7i1.1180.

[30] C. Furqon, M. Adib Sultan, H.- Yuin, H. Hendrayati, and A. Paris, “Jurnal Manajemen Industri dan Logistik Green Supply Chain Management Performance Measurement Using the Balanced Scorecard-Analytic Network Process in the Fresh Dairy Industry,” *Jurnal Manajemen Industri dan Logistik (JMIL)*, vol. 6, no. 2, pp. 297–308, 2022, doi: 10.30988/jmil.v6i2.1308.

BIOGRAPHIES OF AUTHORS

Author 1

Arif Devi Dwipayana The author's interest in human resources transportation, green energy conversion and automotive technology began when he completed his undergraduate and graduate studies. The author was born in Denpasar, November 2 1985, the second of three siblings.

The author has completed his formal undergraduate education at the Mechanical Engineering Study Program, Faculty of Engineering, Udayana University, after that he continued his Masters in Management at Udayana University and is currently continuing his studies at the Masters in Mechanical Engineering at Udayana University. After graduating the author worked at PT. Aerofood Indonesia (Garuda Indonesia Group) Denpasar Unit as Assistant Human Capital Manager. Now the author is a lecturer at the Ministry of Transportation, Transportation Human Resources Development Agency, Bali Land Transportation Polytechnic, Automotive Technology Study Program.

If you want to correspond with the author, you can communicate via email. Author's email: arifdevidwipayana@gmail.com or arif.devi@poltradabali.ac.id

Author 2

Ni Luh Darmayanti The author's interest in transportation and logistics management began when the author started working at the Ministry of Transportation, Bali Land Transportation Polytechnic in 2019. The writer was born in Denpasar, on May 13, 1987, and is the first of three children. The author has completed formal Professional Nursing Education at the Nursing Study Program, Institute of Technology and Health Bali. After that, the author worked as an Assistant Lecturer at the Institute of Technology and Health Bali for three years, then as a Training Staff at Kasih Ibu Hospital Group for two years while continuing his education to the Master's Degree of Management at Undiknas Graduate School. After completing a Master's Degree, the author decides to return to work at an educational institution, namely as a lecturer at Bali International University for two years. Currently, the author still working as a lecturer at the Ministry of Transportation, Transportation Human Resources Development Agency, Bali Land Transportation Polytechnic, Diploma Three Logistics Management Study Program.

If you want to correspond with the author, you can communicate via email.
Author Email: niluhdarmayanti.87@gmail.com