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Analysis Of The Application Of Renewable Energy At The Muara Angke Passenger Port As A Means Of Supporting Thousand Island Tourism

Fuad Maulana, Arif Fadillah*
Department of Naval Architecture, Faculty of Marine Technology, Darma Persada University, Indonesia
*Correspondence: arif_fadillah@yahoo.com

Abstract

Kepulauan seribu are also a frequently visited destination for domestic and foreign tourists and are among the priority destinations in Indonesia. The development of the passenger port in Muara Angke is an important step in supporting the tourism sector in Kepulauan Seribu. However, this development must also consider environmental impacts, including carbon emissions and the use of natural resources. Indonesia has taken steps towards developing renewable energy and policies that support it by implementing renewable energy at the Muara Angke Passenger Port will be in line with government initiatives to achieve energy targets national renewable. The method used is primary data, secondary data, by calculating the need for solar panels and wind turbines and collecting supporting data sourced from related websites. The results are 324 solar panels placed on the roof of the main building of the port where the wind turbine is placed on the west side. with a total of 6 units, on the east side of the port there are 6 units and on the south side of the port there are 4 wind turbine units

Keyword : Muara Angke Passenger Port, renewable energy, solar panels, wind turbines

1. INTRODUCTION

Kepulauan Seribu is a popular tourism destination around Jakarta, known for its beautiful beaches, exotic islands, and rich underwater life. The Thousand Islands is also a widely visited destination for domestic and foreign tourists and is included in the priority destinations in Indonesia.[1] Tourism is one of the main sources of income for this area, and therefore it is important to maintain a sustainable environment and natural resources.

The development of a passenger port in Muara Angke is an important step in supporting the tourism sector in the Thousand Islands. However, this development must also consider environmental impacts, including carbon emissions and natural resource use.

Renewable energy, such as solar panels, wind, or hydropower systems, is a sustainable solution to meet the energy needs of the passenger port. The implementation of renewable energy can help reduce carbon emissions, save long-term operational costs, and create an environmentally friendly port image.

Indonesia has taken steps towards the development of renewable energy and policies that support it. One of the policies that support the use of renewable energy as an alternative energy source is the Minister of Energy and Mineral Resources Regulation Number 50 of 2017 concerning Utilization of Renewable Energy Sources for Electricity Supply [2].Therefore, implementing renewable energy at Muara Angke Passenger Port will be in line with government initiatives to achieve national renewable energy goals.

Analysis of the application of renewable energy can also consider economic aspects, including return on investment, long-term benefits, and the potential for greater tourism development as a result of sustainable efforts.

So based on the description above, the analysis of the application of renewable energy at Muara Angke Passenger Port will help create sustainable tourism infrastructure and support economic growth in the Thousand Islands, so as to preserve the natural environment.

2. METHODS

The location used as a research site is Muara Angke Passenger Port. This port was chosen because Muara Angke Passenger Port became a port built by the government as a means of transportation to the thousand islands. The type of renewable energy used in the analysis of the application of renewable energy is to take into account the use of solar energy (solar panels) and the use of wind energy (wind turbine) as an alternative energy source that can be used for port activities. in the analysis of the application of renewable energy at Muara angke passenger port also considers data sourced from related websites. Websites that can support the provision of data

2.1 Solar Panel Planning Method

The calculation method used to calculate the need to use solar panel equipment [3] which will be used as an alternative energy source at the port is as follows:

$$PV\ Area\ = \frac{El}{Gav\ x\ nPV\ x\ Tcf\ x\ nOut} \quad (1)$$

Description:

PV Area = Solar Panel Area installation area (m2)

EL = Electric Energy Usage per Day (kWh / Day)

GAV = Average Daily Solar Insulation (kWh/m2 / Day)

ɲPV = Efficiency on Solar Panels

TCF = Temperature on solar panels

nOut = Efficiency of the Inverter

$$\eta PV = \frac{pmpp}{1000\ x\ A}\ x\ 100\% \quad (2)$$

Description:

ɲPV = Efficiency of Solar Panel

Pmpp = Maximum Output Power of Solar Panel

A = Solar Panel area (m2)

$$\text{Total}\ panel = \frac{P}{pmpp} \quad (3)$$

Description:

P = Power required (Watt / Day)

Pmpp = Maximum Output Power of Solar Panel (Watt)

2.2 Wind Turbine Planning Method

The calculation method used to calculate the need to use wind turbine equipment [4] which will be used as an alternative energy source at the port is as follows:

$$JT = \frac{W\ Load}{Pw} \quad (4)$$

Description:

JT = Number of Turbines (unit)

W load = Electricity demand (watt)

Pw = Electric power 1 turbine (Watt)

$$A = \pi.r^2 \quad (5)$$

Description:
A = Blade Area (m2)
r = radius of the wind turbine rotor

$$Pw = \frac{1}{2} \times pAv^3 \quad (6)$$

Description:
Pw = Wind Power (Watt)
p = Air Density (kg / m3)
A = Turbine Cross-Sectional Area (m2)
v = Wind Speed (m/s)

2.3 Peralatan *Solar Panel*

Solar panels that will be used in the research are taken based on 3 types of solar panel sizes, namely 150 Wp, 175 Wp, and 360 Wp. The equipment specification data used as research material is based on the Victron Energy catalogue [5] with the following specifications:

Table.1 Spesifikasi Solar Panel

Solar Panel 115 Wp		
No	Specifications	
1	*Merk*	*Victron energy*
2	*Type*	*Monocrytline*
3	*Power (pmpp)*	115 W
4	*Voltage*	24 V
5	*Curret*	6,04 A
6	*Isc*	6,61 A
7	*Temperature*	40 °C – 85 °C
8	*Efficiency*	95 %
9	*Surface Max Load*	200 Kg/m^2
10	*Dimension*	1015 x 668 x 30 mm
11	*Net Weight*	8 Kg

Solar Panel 175 Wp		
No	Specifications	
1	*Merk*	*Victron energy*
2	*Type*	*Monocrytline*
3	*Power (pmpp)*	175 W
4	*Voltage*	24 V
5	*Curret*	9,30 A
6	*Isc*	9,89 A
7	*Temperature*	-40 °C – 85 °C
8	*Efficiency*	95 %
9	*Surface Max Load*	200 Kg/m^2
10	*Dimension*	1485 x 668 x 30 mm
11	*Net Weight*	11 Kg

Solar Panel 360 Wp		
No	Specifications	
1	*Merk*	*Victron energy*
2	*Type*	*Monocrytline*
3	*Power (pmpp)*	360 W
4	*Voltage*	24 V
5	*Curret*	9,38 A
6	*Isc*	10,27 A
7	*Temperature*	-40 °C – 85 °C
8	*Efficiency*	95 %
9	*Surface Max Load*	200 Kg/m^2
10	*Dimension*	1658 x 1002 x 35 mm
11	*Net Weight*	19 Kg

2.4 Wind Turbine Equipment

The size of the wind turbine to be used in the research is taken based on 3 types of wind turbine sizes, namely 3 kW, 5 kW, and 30 kW. The equipment specification data used as research material is based on the catalogue vision air [6] and GHREPower [7] with the following specifications:

Table.2 Spesifikasi *wind turbine*

Wind Turbine 3 kW		
No	Specifications	
1	*Merk*	*Vision Air*
2	*Type*	*vision -3*
3	*Height*	3,2 m
4	*Width*	1,8 m
5	*Blade Area*	5,76 m^2
6	*Max Wind Speed*	12 m/s
7	*Cut in Wind Speed*	3 m/s
8	*Cut Out Wind Speed*	20 m/s
9	*Survival Wind Speed*	50 m/s
10	*Rated RPM*	200 rpm
11	*Blade Material*	Fibreglass
12	*Nett weight*	274 Kg
13	*Operating Temperature*	-15°C – 55 °C
14	*Max Power*	3 kW

Wind Turbine 5 kW		
No	Specifications	
1	*Merk*	*Vision Air*
2	*Type*	*vision -5*
3	*Height*	5,2 m
4	*Width*	3,8 m
5	*Blade Area*	16,6 m^2
6	*Max Wind Speed*	12 m/s
7	*Cut in Wind Speed*	3,2
8	*Cut Out Wind Speed*	20 m/s
9	*Survival Wind Speed*	50 m/s
10	*Rated RPM*	130 rpm
11	*Blade Material*	Fibreglass
12	*Nett weight*	754 Kg
13	*Operating Temperature*	-15°C – 55 °C
14	*Max Power*	5 kW

Wind Turbine 30 kW		
No	Specifications	
1	*Merk*	*GHRE Power*
2	*Type*	*Fd16-30*
3	*Height*	32 m
4	*Width*	6 m
5	*Blade Diameter*	15 m
6	*Max Wind Speed*	12 m/s
7	*Cut in Wind Speed*	3 m/s
8	*Cut Out Wind Speed*	25 m/s
9	*Max Wind Speed*	10 m/s
10	*Rated RPM*	150 rpm
12	*Nett weight*	4000 Kg
13	*Operating Temperature*	-20°C – 55 °C
14	*Max Power*	30 kW

3. Results and Discussion

3.1 Site Selection

Based on the results of field surveys conducted at Muara Angke Passenger Port. The location that can be used as a place for the placement of renewable energy equipment (solar panels & wind turbines) is the roof of the main building and the vehicle parking lot with an area in existing conditions is :

Table. 3 Site Selection

No	Location	Length	Width	Area
1	Main Building Roof 1	95 m	15 m	1425 m^2
2	Main Building Roof 2	60 m	15 m	900 m^2
3	Main Building Roof 3	95 m	30 m	2850 m^2
4	Parking Area	130 m	100 m	13000 m^2

Fig.1 Top View of Port Plan

3.2 Electrical Power Requirements

Electrical power requirements can be calculated by collecting data on the needs of equipment supporting port activities and can be added with 10% reserve power with the results of data collection of electricity requirements for the Muara angke passenger port as follows:

Table. 4 Estimated Port Electrical Power requirements

No	Location	Electricity Power Requirement (kW)
1	Passenger Port Main Building	275
2	Port Parking Lot	5
3	Dock	6,2
4	Vessel Requirements (15 vessels)	67,5
5	Clean Water Pump	5
6	Backup power requirement	30
	TOTAL	388,7

Based on the electrical power demand data in Table 4, the next step is to determine the amount of electrical power supply that must be generated by renewable energy equipment. It can be assumed that the use of electrical power sourced from renewable energy at least supplies electrical energy by 50% of the total power demand at the port and includes supplying electricity that is leaning.

3.3 Analysis of Renewable Energy Equipment needs

1. Solar Panel

Based on the output prediction power data obtained from the globalsolaratlas website [8], the average output power generated in the area around the Muara angke passenger port is 1430.6 kW / year. So based on this data, the estimated number of solar panels needed can be calculated with the calculation results as shown in table 5.

Table .5 Solar Panel Requirement Analysis Results

No	Solar Panel size (Wp)	Efficiency (%)	Pvarea (m^2)	Quantity (Unit)
1	150	14%	0,640	777
2	175	18%	0,518	667
3	360	23%	0,425	324

Based on table.5 regarding the results of the analysis of solar panel requirements above and after considering the availability of the roof area of the main building of Muara Angke Passenger Port and other places that can be utilized as a place to install solar panels, it is determined that the size of the solar panel to be used is 360 W with monocrytline type.

This is also based on the results of the calculation it can be seen that the size of 360 Wp requires a smaller number of solar panel units compared to other sizes even though it requires a slightly larger area compared to the size of 150 Wp or the size of 175 Wp. so that by using solar panels with a size of 360 Wp can save space on the roof of the main building which can still be used for other purposes.

2. Wind Turbine

Based on wind speed data on the windy website [9] and the windprospecting website [10], the average wind speed in the Muara angke passenger port environment is 4.2 m/s and the lowest average wind speed is 1.3 m/s.

Table 6. Wind Turbine Requirement Analysis Results

No	*Wind Turbine Size* (kW)	Quantity (Unit)	*Ouput Turbine (Watt)*	
			High	Low
1	3	26	277,4	8,22
2	5	16	799,4	23,7
3	30	3	1136,5	33,7

Based on table.6 regarding the results of the analysis of wind turbine requirements, the wind turbine selected is 5 kW with savonius type. This type was chosen savonius with a size of 5 kW this type was chosen because the wind turbine with a size of 30 kW is too large when placed in the port environment and will require a large space if there is a problem with the turbine and requires maintenance.

Wind turbines with the savonius type were chosen because these turbines can still rotate at low wind speeds considering that the wind speed in the area around the port is fairly low speed and this turbine has a unique shape so that it can add aesthetic value to the environment around Muara Angke Passenger Port.

3.4 Port Overview Results

The layout in Figure 2 is an overview of the Muara Angke Passenger Port that has been re-designed and by adding the placement of several points of renewable energy equipment. (solar panel & wind turbine)

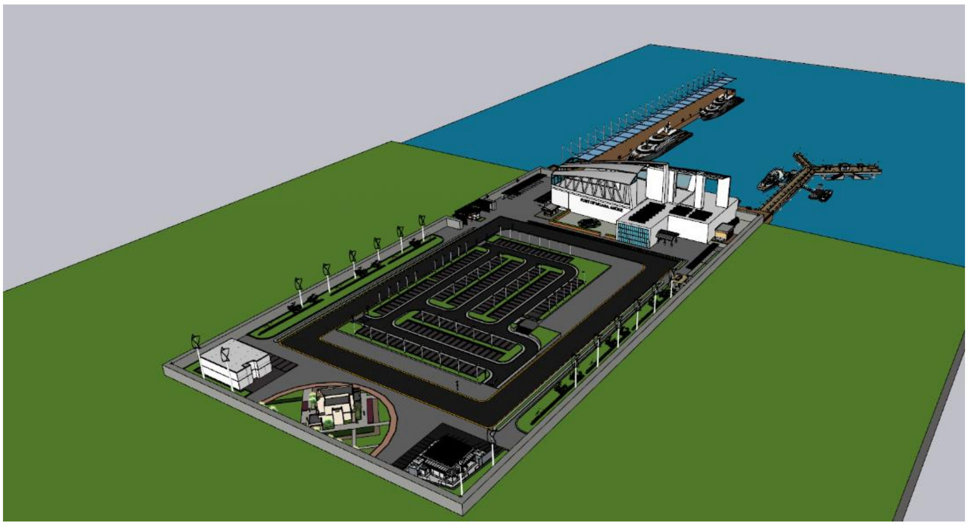

Fig.2 Results of Muara Angke Passenger Port Re-Design.

Fig.3 Detailed Overview Of Wind Turbine Placement

Fig.4 Detailed View Of Solar Panel Placement

CONCLUSION

From the results of the analysis that has been described, in the application of solar panels, the solar panel chosen is the size of 360 Wp with a total of 324 solar panels placed on the roof of the main port building and placed on the vehicle parking lot located on the west side of the port. In the application of wind turbines, the results of the port overview show the placement of wind turbines on the west side with a total of 6 units, on the east side of the port with 6 units and on the south side of the port with 4 wind turbine units. So that in the future the port is expected to have further analysis of the economic impact of the application of renewable energy at the Muara angke passenger port as a means of supporting tourism in the Kepulauan Seribu.

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