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POTENTIAL OF SEA FLOW ENERGY AS A RENEWABLE ENERGY SOURCE *(RENEWABLE ENERGY)* ON THE CAPALULU HOLIDAY, NORTH MALUKU

Joni Widjayanto [1], Adi Bandono [2], I Made Jiwa Astika [3], Agung Tresnadi [4]

Indonesia Defense University, Unhan Jakarta
Indonesian Naval Technology College, STTAL Surabaya

ABSTRACT

One of the biggest obstacles to development progress in Eastern Indonesia is the unavailability of electricity, especially on small island islands. The potential of ocean currents is one of the most renewable sources of energy considering that the majority of Eastern Indonesia is the ocean and has not been utilized optimally. The purpose of writing this paper is to reference the calculation of ocean currents for Indonesian coastal islands that have minimal electricity. This research method uses literature studies on the morphology of the flow velocity and wind that occurs in the Capalulu Strait and the calculation of the potential of electrical energy in the Capalulu Strait so that the results of this calculation are used as one of the renewable energy methods that are able to meet the electricity needs of island islands. which has not been electrified in Indonesia, especially in the Sula Islands, North Maluku.

Keywords: *Electric Energy, Ocean Flow Turbine, Renewable Energy, Strait of Capalulu*

1. INTRODUCTION

As an archipelagic country, Indonesia is known as a country that has abundant natural potential. Not only from the potential of land, Indonesian waters also become a potential that can become an alternative energy source. The Indonesian Ocean can be used as an alternative energy substitute for electricity. Indonesian territorial waters have strong ocean currents that store the potential that can be fully utilized to generate electricity. The occurrence of currents in the ocean is caused by two main factors, namely internal factors and external factors. Internal factors such as differences in sea water density, horizontal pressure gradient and water layer friction. While external factors such as the attraction of the sun and the moon.

Which is influenced by sea floor resistance and coriolis force, differences in air pressure, gravitational force, tectonic force and wind (Gross, 1990). Tides are one part of the external factor in the occurrence of currents. Tidal currents are usually found in narrow straits that are mostly found in the strait of islands in Eastern Indonesia. And the capalulu strait is one of the straits with the strongest tidal currents in Indonesia.

The Capalulu Strait is located in the Sula Archipelago District, North Maluku Province. The strait is flanked by the islands of Mangole and Taliabu. As in the capalulu strait which is on two land surfaces, namely the mainland islands Mangole and Taliabu. While for the two big waters, the Pacific Ocean and Indian Ocean. This narrow strait turns out to be one of the straits with the strongest ocean currents in Indonesia. According to the Center for Research and Development of Marine Geology, Ministry of Energy and Mineral Resources, this point does have strong ocean currents. The site also states that the current strength of the capalulu strait reaches 5 m / s (18 Km / J or 9.72 Knots / Hour), in contrast to the strait on the islands of southeast Nusa Tenggara which reaches 2.5 to 3 meters per second (9Km / Hour - 4.85 Knots to 10.8Km / J - 5.83 Knots / Hour).

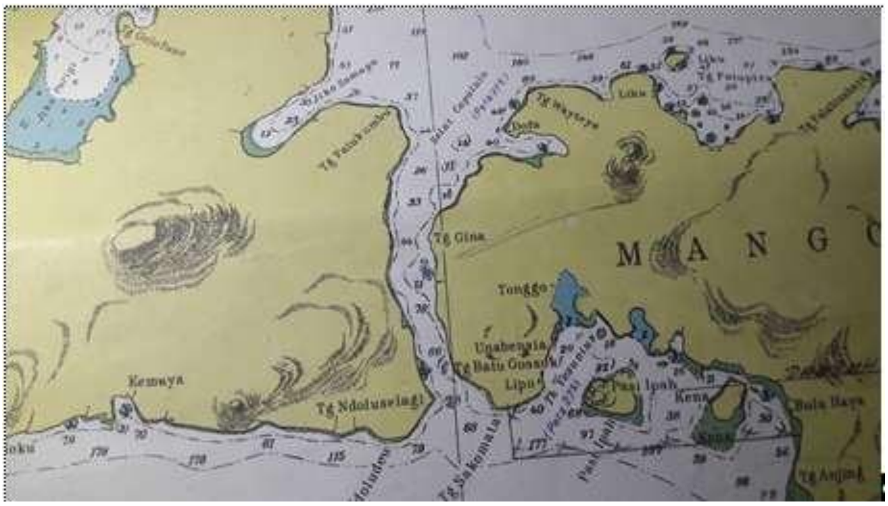


Fig.1 Capalulu Strait

Unlike the ocean wave energy that only occurs in the surface column, ocean currents occur in deeper layers. Ocean currents are interesting to develop because of their relatively stable and predictable characteristics. This is because ocean current energy is kinetic energy generated by the movement of sea water due to tidal processes. Besides being environmentally friendly, the energy generated from ocean currents requires a conversion tool that is relatively not too complex and not noisy. Ocean currents have a high density compared to wind. The power produced by the ocean current turbine is far greater than the power produced by the wind turbine because the density of 800x sea water is greater than the wind.

Fig.2 Turbine System Type

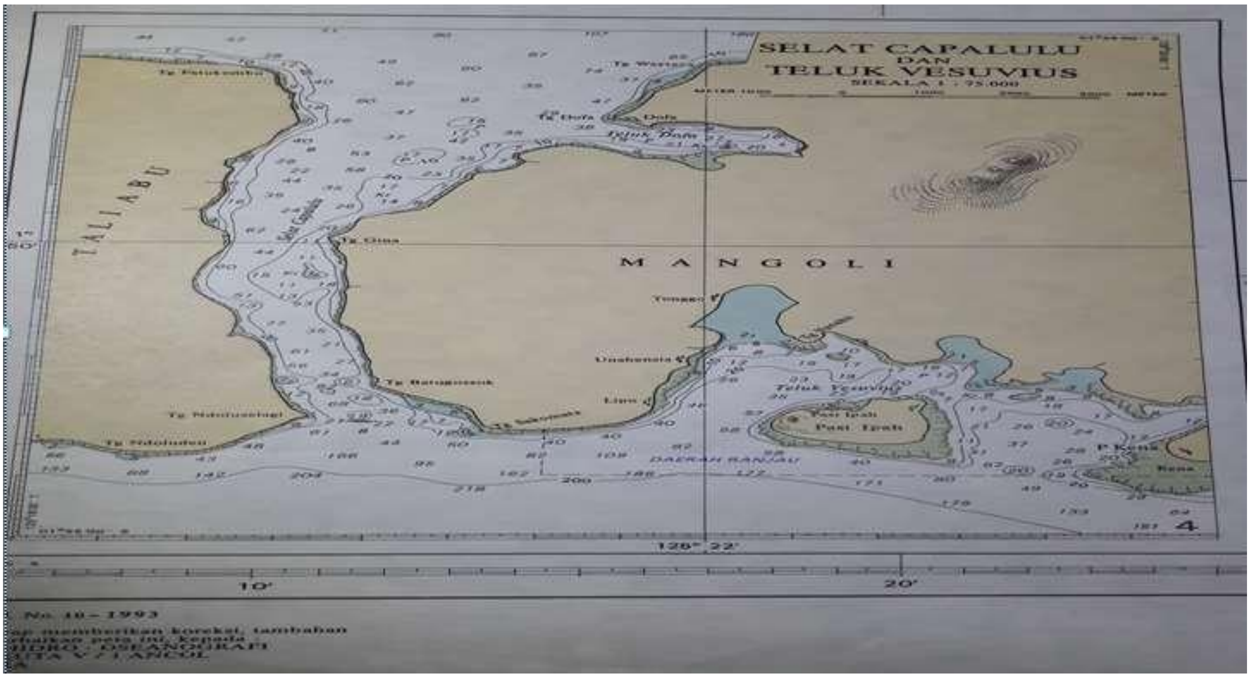
Considering the large amount of energy contained in the Capalulu Strait, more in-depth research is needed to obtain cheap and environmentally friendly energy. At present, not all regions in the Sula islands, both on Taliabu, Sanana, and mangoli islands, are electrified. Even the frequency of electricity is not 24 hours. Electricity is supported by PLTD or Diesel Power plants that have not been able to overcome all electricity needs. The advantage of utilizing ocean current energy is the continuous ocean current energy, because ocean currents are not affected by weather conditions, but are only influenced by tides. The potential of energy contained in the Strait of Capalulu in the Sula Islands, can be seen by calculating the velocity of the current in the Capalulu Strait with data on the tidal stream tables in the Capalulu Strait issued by the Navy's Hydrographic and Oceanographic Service during 2015.

2. MATERIALS AND METHOD

2.1. MATERIAL

2.1.1 Current Potential in the Capalulu Strait

The Capalulu Strait on the edge has a sea depth of 20-30 meters as shown in figure 3, it is very potential to be developed as a sea current turbine. For the central part which has a depth of 60-70 as the flow of shipping traffic. The narrow strait width and connecting 2 oceans namely the Pacific Ocean in the north and the Indian Ocean in the south make the currents in the Capalulu Strait very high and evenly distributed throughout the year. The width of the Capalulu Strait allows for the placement of ocean currents without disturbing shipping traffic as shown in Figure 3.



Fig,3 Potential Flow of the Capalulu Strait

2.1.2 Determination of the amount of electricity

Current velocity can be known from literature studies. List of tidal stream tables tides released by the 2015 Navy's Hydrographic and Oceanographic Service. To determine the magnitude of potential energy generated from ocean currents can use the equation below.

$$P = 0.593\times0.5.\ \rho.A.V^3 \quad \text{(Watt)................(1)}$$

Where:

- P = Electric power (watts)
- 0.593 = The amount of efficiency based on the provisions of Betz
- ρ = Sea water density (1025 kG/m^3)
- A = Cross-sectional area (m^2)
- V = Current speed (m/s)

2.1.3 Ocean Flow Turbine

Calculations will be carried out using Tidal turbines. This is because it was adjusted to the measurements made by the Navy's Hydrographic and Oceanographic Service during 2015 using Tidal streams. Tidal turbines that resemble wind turbines have several advantages. This tool is safer for the environment, does not prevent small vessels from moving on it. Tidal turbines can work well in a place that has a current> 2 m / s (slower currents are not economical. The current will provide four times greater energy density. rather than air, which means a 15 m diameter water turbine will produce the same energy as a wind turbine with a diameter of 60 m.In addition, ocean currents are predictable and reliable, so that they can be said to be better than wind or solar energy.

There are many places throughout the world that allow tidal turbines to be installed. The ideal place is a place close to the waterfront (1 km) and in water with a depth of 20-30m. According to Peter Fraenkel, director of UK-based Marine Current Turbines, the ideal place will produce 10 MW / km2. The European Union has identified 106 suitable places to install this turbine. Fraenkel also believes that Indonesia can also develop this technology to generate energy.

Fig.4 Installation of turbines on the seabed

2.2 METHODOLOGY

Based on the basic explanation of the theory above, and the calculation of the data obtained the results of energy potential in the Strait of Capalulu. So that it is expected that more in-depth research is done so that the energy potential of this ocean current can be utilized throughout the Sula archipelago

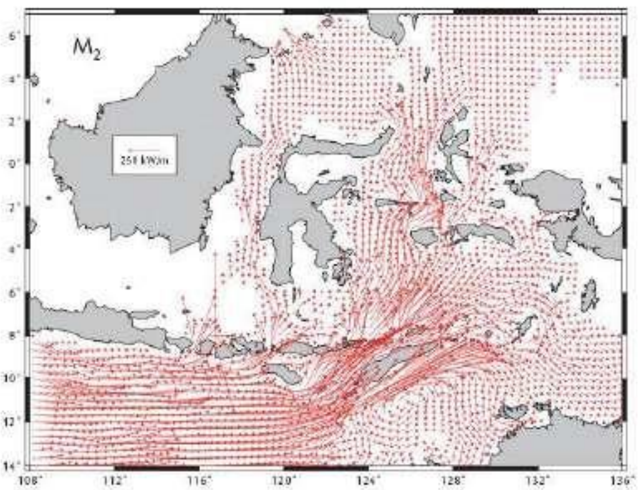


Fig.5 Potential flows in Indonesia

Conduct a literacy study to obtain current velocity data in the Capalulu Strait, and study of turbine design to be used considering that it does not interfere with the shipping flow, is able to withstand strong currents, is able to follow the current direction so that it works at maximum efficiency and is environmentally friendly. This literature study is important because it is the first step in the study and calculation of existing energy potential.

The use of turbines is selected with tidal turbines with 3 blades assuming the blades' finger is 1 m and the surface area of the entire blades is 1m2

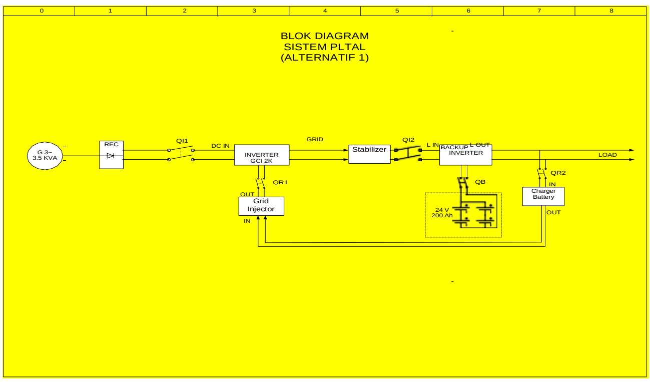


Fig.6 Block diagram of the electricity system

3. RESULTS AND DISCUSSION

From the tidal data obtained from the literature, we get the value of the electric current potential contained in the Capalulu strait in 2015 each month as follows:

Table 2. potential data of January 2015 ocean currents

Date	Average(mil)	Watt
1	2,5916667	9818,9255
2	2,7083333	11205,542
3	2,925	14115,756
4	3,2791667	19889,186
5	3,5958333	26225,586
6	3,8458333	32084,695
7	4,0583333	37702,459
8	4,1625	40680,78
9	3,2875	20041,204
10	3,775	30344,32
11	3,5	24184,141
12	3,225	18919,763
13	2,9291667	14176,166
14	2,8291667	12773,271
15	2,6166667	10105,824
16	2,55	9352,9169
17	2,7	11102,424
18	2,9583333	14603,867
19	3,275	19813,466
20	3,6416667	27241,255
21	3,95	34763,046
22	4,1541667	40436,94
23	4,175	41048,375
24	3,975	35427,29
25	3,7541667	29844,698
26	3,4791667	23754,847
27	3,1708333	17982,364
28	2,9166667	13995,452
29	2,7583333	11837,685
30	2,5	8813,4625
31	2,5041667	8857,6033
Average	3,2836022	39940,006

Table 3. Potential data of February 2015 Sea Currents

Date	Average(mil)	Watt
1	2,5833333	19449,027
2	2,9875	30080,169
3	3,3458333	42254,157
4	3,7083333	57529,795
5	4,0458333	74710,303
6	4,2291667	85333,77
7	4,2	83580,392
8	3,9458333	69306,305
9	3,5666667	51185,164
10	3,4	44339,754
11	3,0375	31615,888
12	2,825	25433,837
13	2,625	20405,369
14	2,3958333	15514,091
15	2,4125	15840,121
16	2,6041667	19923,373
17	3,0666667	32535,407
18	3,4791667	47509,694
19	3,8833333	66064,864
20	4,2041667	83829,39
21	4,2708333	87880,881
22	4,2166667	84579,35
23	3,9541667	69746,343
24	3,7125	57723,933
25	3,3291667	41625,853
26	2,9791667	29829,154
27	2,7041667	22307,808
28	2,4208333	16004,835
Average	3,3619048	47362,108

Table 4. Potential Data of March 2015 Sea Current

Date	Average(mil)	Watt
1	2,2583333	6496,6679
2	2,3791667	7596,283
3	2,7916667	12272,053
4	3,05	16003,908
5	3,6583333	27616,991
6	4	36099,942
7	4,35	46429,532
8	4,2875	44456,875
9	4,1875	41418,178
10	3,925	34107,157
11	3,5875	26043,675
12	3,15	17630,239
13	2,8041667	12437,641
14	2,5083333	8901,8912
15	2,2583333	6496,6679
16	2,2125	6109,0879
17	2,4541667	8337,5547
18	2,8958333	13697,687
19	3,3916667	22007,263
20	3,9791667	35538,814
21	4,1666667	40803,067
22	4,4041667	48185,656
23	4,2916667	44586,613
24	4,1125	39232,345
25	3,7708333	30243,953
26	3,4416667	22994,976
27	2,8041667	12437,641
28	2,5791667	9677,5351
29	2,3666667	7477,1797
30	2,1833333	5870,6565
31	2,2291667	6248,189
Average	3,2412634	19207,442

Table 5. Potential Data of April 2015 Sea Current

Date	Average(mil)	Watt
1	2,6208333	20308,355
2	3,0708333	32668,205
3	3,6041667	52816,684
4	3,9833333	71301,141
5	4,3291667	91531,262
6	4,3416667	92326,413
7	4,2583333	87111,5
8	3,9958333	71974,495
9	3,6083333	53000,075
10	3,2291667	37986,38
11	2,7958333	24654,169
12	2,4541667	16675,109
13	2,2458333	12778,771
14	2,1625	11408,404
15	2,3875	15352,767
16	2,8583333	26344,815
17	3,3083333	40849,271
18	3,7958333	61698,973
19	4,1125	78464,69
20	4,3166667	90740,689
21	4,2791667	88396,31
22	4,1208333	78942,646
23	3,8208333	62926,099
24	3,45	46324,828
25	3,0458333	31876,816
26	2,6458333	20895,077
27	2,3458333	14562,904
28	2,25	12850,028
29	2,2958333	13651,413
30	2,6083333	20019,158
Average	3,2780556	39,73795

Table 6. Potential data of May 2015 Sea Current

Date	Average(mil)	Watt
1	3,0416667	31746,174
2	3,4958333	48195,744
3	3,925	68214,314
4	4,1625	81361,561
5	4,3375	92060,853
6	4,1125	78464,69
7	3,5541667	50648,886
8	3,6791667	56182,999
9	3,2916667	40235,007
10	2,8875	27159,546
11	2,525	18161,038
12	2,3416667	14485,442
13	2,2375	12637,049
14	2,5125	17892,653
15	2,8333333	25659,58
16	3,2166667	37546,954
17	3,6541667	55045,47
18	4,0541667	75172,904
19	4,1958333	83331,887
20	4,175	82096,751
21	4,2375	85839,201
22	3,8625	65007,282
23	3,5333333	49763,436
24	3,1833333	36391,745
25	2,8166667	25209,422
26	2,5291667	18251,093
27	2,375	15112,885
28	2,4666667	16931,207
29	2,6708333	21492,993
30	2,9833333	29954,486
31	3,3708333	43208,418
Average	3,2987903	40,496796

Table 7. Potential data of June 2015 Sea Current

Date	Average(mil)	Watt
1	3,7375	58897,944
2	4,0458333	74710,303
3	4,1625	81361,561
4	4,1041667	77988,667
5	3,8875	66277,747
6	3,7541667	59689,395
7	3,4208333	45159,828
8	3,0708333	32668,205
9	2,9333333	28473,495
10	2,5458333	18614,288
11	2,45	16590,321
12	2,5833333	19449,027
13	2,7875	24434,371
14	3,1166667	34152,901
15	3,475	47339,205
16	3,6	52633,716
17	4,0708333	76103,827
18	4,0916667	77278,248
19	4,1166667	78703,426
20	3,8291667	63338,728
21	3,7041667	57336,092
22	3,4166667	44995,011
23	3,0625	32402,97
24	2,7625	23782,822
25	2,6041667	19923,373
26	2,5708333	19168,066
27	2,8041667	24875,281
28	2,8958333	27395,373
29	3,1958333	36822,129
30	3,4916667	48023,616
Average	3,3430556	42149,004

Table 8. Potential data of July 2015 Sea Current

Date	Average(mil)	Watt
1	3,7916667	61496,016
2	3,8375	63753,157
3	4,0541667	75172,904
4	4,025	73562,111

Date	Average(mil)	Watt
5	3,8458333	64169,39
6	3,6583333	55233,982
7	3,4	44339,754
8	3,0833333	33068,764
9	2,7791667	24215,883
10	2,5833333	19449,027
11	2,5625	18982,27
12	2,7958333	24654,169
13	2,9333333	28473,495
14	3,2291667	37986,38
15	3,5083333	48714,593
16	3,7625	60087,766
17	3,9708333	70632,001
18	4,0083333	72652,075
19	4,0416667	74479,715
20	3,8833333	66064,864
21	3,6625	55422,924
22	3,3583333	42729,512
23	3,0166667	30969,807
24	2,7666667	23890,599
25	2,4833333	17276,732
26	2,5458333	18614,288
27	2,7166667	22618,593
28	2,9458333	28839,056
29	3,2	36966,341
30	3,475	47339,205
31	3,55	50470,963
Average	3,3379032	41,954423

Table 9. Potential data of August 2015 Sea Current

Date	Average(mil)	Watt
1	2,5916667	9818,9255
2	2,7083333	11205,542
3	2,925	14115,756
4	3,2791667	19889,186
5	3,5958333	26225,586
6	3,8458333	32084,695
7	4,0583333	37702,459
8	4,1625	40680,78
9	3,2875	20041,204
10	3,775	30344,32
11	3,5	24184,141
12	3,225	18919,763
13	2,9291667	14176,166
14	2,8291667	12773,271
15	2,6166667	10105,824
16	2,55	9352,9169
17	2,7	11102,424
18	2,9583333	14603,867
19	3,275	19813,466
20	3,6416667	27241,255
21	3,95	34763,046
22	4,1541667	40436,94
23	4,175	41048,375
24	3,975	35427,29

Date	Average(mil)	Watt
25	3,7541667	29844,698
26	3,4791667	23754,847
27	3,1708333	17982,364
28	2,9166667	13995,452
29	2,7583333	11837,685
30	2,5	8813,4625
31	2,5041667	8857,6033
Average	3,2836022	39940,006

Table 10 Potential data of Sept 2015 Sea Current

Date	Average(mil)	Watt
1	4,3291667	91531,262
2	4,1625	81361,561
3	3,9333333	68649,723
4	3,6	52633,716
5	3,1875	36534,832
6	2,8125	25097,712
7	2,4958333	17538,937
8	2,4333333	16254,041
9	2,4708333	17017,152
10	2,5916667	19637,851
11	2,9	27513,797
12	3,3333333	41782,341
13	3,4791667	47509,694
14	3,9791667	71077,627
15	4,2416667	86092,663
16	4,25	86601,083
17	4,1291667	79422,539
18	3,875	65640,465
19	3,5083333	48714,593
20	3,0625	32402,97
21	2,6666667	21392,558
22	2,3791667	15192,566
23	2,3291667	14254,705
24	2,4208333	16004,835
25	3,3708333	43208,418
26	2,9666667	29455,255
27	3,4041667	44502,968
28	3,7666667	60287,614
29	4,1875	82836,357
30	4,3	89693,691
Average	3,3522222	42496,673

Table 11. Potential data of October 2015 Sea Current

Date	Average(mil)	Watt
1	4,2833333	88654,779
2	4,0458333	74710,303
3	3,7541667	59689,395
4	3,2125	37401,235
5	2,8583333	26344,815
6	2,5083333	17803,782
7	2,2583333	12993,336
8	2,3416667	14485,442
9	2,4375	16337,681
10	2,7583333	23675,37

Date	Average(mil)	Watt
11	3,1375	34842,374
12	3,5708333	51364,761
13	3,925	68214,314
14	4,1333333	79663,214
15	4,3125	90478,18
16	4,2708333	87880,881
17	4,0208333	73333,894
18	3,55	50470,963
19	3,0375	31615,888
20	2,8125	25097,712
21	2,4291667	16170,687
22	2,3625	14875,514
23	2,3833333	15272,527
24	2,5	17626,925
25	2,8916667	27277,29
26	3,2666667	39325,205
27	3,6708333	55802,098
28	4,0458333	74710,303
29	4,1833333	82589,33
30	4,2708333	87880,881
31	4,1833333	82589,33
Average	3,3360215	41883,509

Table 12. Potential data of November 2015 Sea Current

Date	Average(mil)	Watt
1	3,8416667	63961,048
2	3,4708333	47169,124
3	3,0666667	32535,407
4	2,7291667	22932,252
5	2,4583333	16760,186
6	2,4208333	16004,835
7	2,425	16087,619
8	2,6916667	21999,882
9	3,0416667	31746,174
10	3,3875	43852,509
11	3,7791667	60889,817
12	4,0416667	74479,715
13	4,15	80630,773
14	4,2333333	85586,236
15	4,0583333	75404,919
16	3,7583333	59888,36
17	3,325	41469,756
18	2,95	28961,602
19	2,6416667	20796,516
20	2,55	18705,834
21	2,4375	16337,681
22	2,5166667	17981,819
23	2,6125	20115,25
24	3,075	32801,363
25	3,4458333	46157,187
26	3,775	60688,639
27	3,9958333	71974,495
28	4,1333333	79663,214
29	4,1791667	82342,795
30	3,7708333	60487,905
Average	3,29875	40495,311

Table 13. Potential data of December 2015 Sea Current

Date	Average(mil)	Watt
1	3,6458333	54669,734
2	3,2666667	39325,205
3	2,9583333	29207,733
4	2,7041667	22307,808
5	2,6541667	21093,134
6	2,5416667	18523,042
7	2,4875	17363,841
8	3,2	36966,341
9	3,1291667	34565,482
10	3,4833333	47680,592
11	3,7916667	61496,016
12	4,0041667	72425,745
13	4,1041667	77988,667
14	4,125	79182,35
15	3,875	65640,465
16	3,6083333	53000,075
17	3,2708333	39475,876
18	2,9583333	29207,733
19	2,7833333	24324,963
20	2,7	22204,849
21	2,6041667	19923,373
22	2,675	21593,741
23	2,9	27513,797
24	3,2	36966,341
25	3,4958333	48195,744
26	3,7791667	60889,817
27	4,0291667	73790,802
28	4,1833333	82589,33
29	4,075	76337,753
30	3,825	63132,189
31	3,5083333	48714,593
Average	3,3408602	42066,022

Based on the literature study that has been obtained, several potential ocean currents in the Capalulu Strait can be displayed in the form of an average flow velocity table for each month and electricity potential in 2015, between January and December.

Table 14. Potential data of sea curret in 2015

Month	Average(mil)	Watt
January	3,2836022	39940,006
February	3,3619048	47362,108
March	3,2412634	19207,442
April	3,2780556	39,73795
May	3,2987903	40,496796
June	3,3430556	42149,004

Month	Average(mil)	Watt
July	3,3379032	41,954423
August	3,2836022	39940,006
September	3,3522222	42496,673
October	3,3360215	41883,509
November	3,29875	40495,311
December	3,3408602	42066,022
Average	3,3130026	29638,522

Based on the table and figure above, it is known that the average velocity of the ocean currents in the Strait of Capalulu is 3.3 miles / hour or 6.1 m / s with a potential average of 29,638 Watts / Hour. The maximum current occurs in February with an average current speed of 3.36 miles / hour and an electric potential of 47,362 watts, while the weakest current is in March with an average speed of 3.24 miles / hour and an electricity potential of 19,207 watts. Data and calculations also get evenly distributed current potential throughout the year so that it is very potential to be developed.

4. CONCLUSION

Looking at the results of the analysis above, it can be gathered that, using 1 tidal turbine with 3 blades assuming the blades' fingers are 1 m and the surface area of all the blades is 1 m2, the average electric current will be 29,638 Watts / Hour. The maximum electric current is obtained in February the potential of electricity is 47,362 watts, while the weakest electricity potential is in March with an electricity potential of 19,207 watts.

Data and calculations also get evenly distributed current potential throughout the year so that it is very potential to be developed.

With the writing of this paper, it is expected to become one of the inputs to develop renewable energy in Indonesia, especially Eastern Indonesia, especially the Sula Islands (Taliabu Island and Mangoli Island, Sanana Island), which have not all been electrified. And the occurrence of electricity needs through ocean current energy is expected to be able to raise the standard of living of people in the Sula Islands region.

5. REFERENCES

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