

Strategic Management of the Wind Turbine's Simulation

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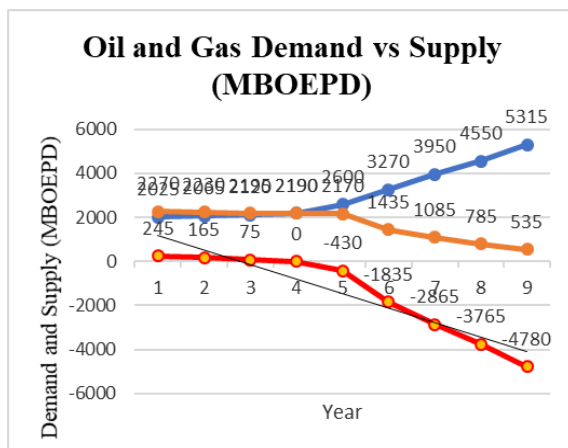
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Abstract—The research objective is to analyze and to compare the effect of the variation of the NACA type to the electric power generated by wind turbine using NACA 3412, 4412, and 6412. The number turbine blades used 4 units and the variation of the wind speed is 3.0 till 6.0 meter per second. The research variables are variation of the NACA type as independent variables, and the electric power as dependent variable. This research applies quantitative method is experimental design using one-way classification and data simulation. The finding of this research reveals is the null hypothesis is rejected, it means that is a difference effect between variation of NACA type to the electric power generated by wind turbine and the first strategy development for choosing the power is the maximum power generated by wind turbine using NACA 6412 type, the wind speed is 5.5 till 6.0 [meter/second], number of blades is 4 units, and the average power generated by wind turbine is 26.25 [watt].

Keywords: wind turbine, wind energy, NACA, strategic

I. INTRODUCTION

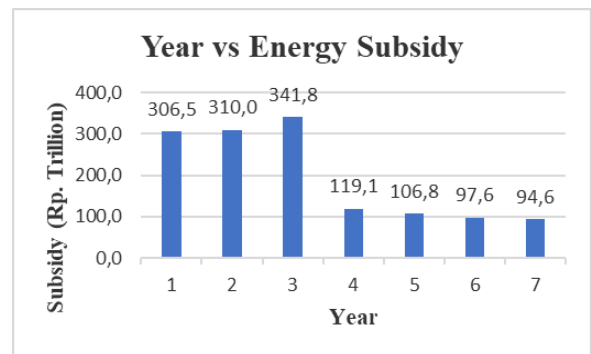
The National (Indonesia) oil production trend decreased slowly, on the side, the oil consumption trend increased faster, so the energy's gap between demand and supply is widened. Figure 1 shows the oil demand and supply, and the gap in the year 2005 to 2015. The gap is increased in every year.



Notes: Year 1 = 2012; MBOEPD = Thousand Barrels of Oil Equivalents Per Day; Source: [1].

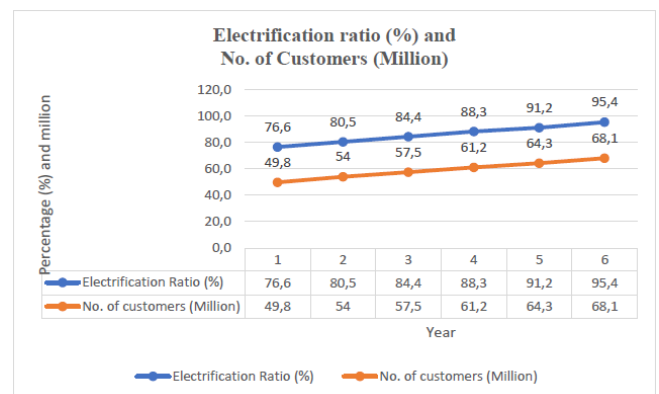
Fig. 1. Oil demand and supply, and gap.

Secondly, the government budget allocation for energy's subsidy increased in the year 2012 till 2014. Actually this subsidy is not correct strategy, because the government subsidized for the rich people (for example subsidized the people which have private cars). The present government change the energy strategy. The energy subsidy decreased and shift to build the infrastructure and the health care (Figure 2).



Notes: Year 1 = year 2012; Year 7 = year 2018. Source: [1].

Fig. 2. Government energy subsidy.



Notes: Year 1 = 2012; Year 6 = year 2017. Source: [2].

Fig. 3. Electrification ratio and no. of customers.

Third, the government of Indonesia tried to increase the electrification ratio and tried to shift also to look for an alternative energy to prevent future scarcity of energy resources. One alternative used is to utilize wind energy and the wind energy is green energy, no pollution, cheaper, and

easier to find it. Wind energy potential in Indonesia is more than 90 GB and the production electric energy using wind energy has not been explored optimally yet.

II. RESEARCH OBJECTIVE

A. The Research Objective

The research objective is to analyze, and to compare the effect of the variation of the NACA type to the electric power generated by wind turbine using NACA 3412, 4412, and 6412 also to determine the strategy management to implement the type of turbine blades and the electric power.

B. The Limitation

The number turbine blades used 4 units, the variation of the wind speed is 3.0 till 6.0 meter per second, and wind turbine using NACA 3412, 4412, and 6412.

C. Hypothesis

The null hypothesis is rejected; it means that is a difference effect between variation of NACA type to the electric power generated by wind turbine. using NACA 3412, 4412, and 6412.

III. LITERATURE STUDY

In this chapter will discussed about the simulation, strategic, mathematical model.

A. Simulation

Simulation is an activity that depends on exercising a model. Simulation is a model of a set of problems or events that can be used to teach someone how to do something, or the process of making such a model. Model is something that represents another thing, either as a physical object that is usually smaller than the real object, or as a simple description that can be used in calculations. The simulation objectives are: 1) To train the specific skills as a professionally about lifestyle or human being. 2). To get the concept ability. 3). To train for solving the problems. 4). To increase the activities and to motivate to learn. 5). To train the team work. 6). To grow the creativity and innovation [2-4].

B. Strategic

Strategic is defined as a method or plan chosen to bring about a desired future, such as achievement of a goal or solution to a problem or the art and science of planning and marshalling resources for their most efficient and effective use or leading an army [5-7]. Strategy is the way to carry out the actions and activities (Figure 4) [2].

C. Mathematical Model

1) Power formula (P) is [8]:

$$P = V.I \text{ [watt]} \tag{1}$$

Where,

V = voltage [volt]

I = Current [ampere]



Fig. 4. Strategic Planning Hierarchy [6].

2) Formula one way classification

$$y_{ij} = \mu + NT_i + \epsilon_{ij} \tag{2}$$

Where,

i = 1, 2, ..., a

j = 1, 2, ..., b

NT = NACA type

μ = Means effect

ϵ_{ij} = Error

y_{ij} = electric power

D. Results and Discussion

1) The design of wind turbine: Wind turbine include the runner (Figure 5), [9,10].

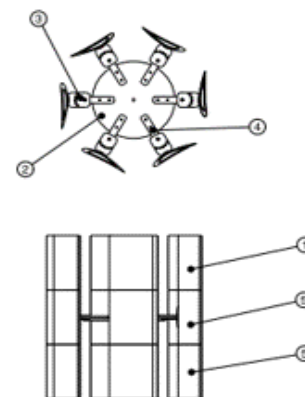


Fig. 5. Design of the runner of wind turbine (1. & 5. Turbine Blades; 2. Disk; 3. Bracket; 4. Arm).

2) Wind turbine simulation: Figure 6 shows the preparation of the wind turbine simulation.



Fig. 6. Wind turbine apparatus [3,9,10].

E. Data Simulation

Figure 7 shows the experiment data simulation.

Replication	Electric Power [watt]				
	N1V3.5B4	N1V3.6B4	N2V3.5B4	N3V6.0B4	
1	4,96	7,91	23,07	29,11	
2	4,97	7,92	23,11	29,16	
3	5,10	8,05	24,49	29,43	
4	5,11	8,06	24,54	30,18	
5	5,16	8,11	25,04	28,82	
6	5,16	8,11	25,04	24,29	
7	5,21	8,16	25,54	21,01	
8	5,35	8,30	27,00	22,14	
9	5,88	8,83	32,30	24,01	
10	6,01	8,96	32,35	21,57	
Sub total	52,92	82,42	262,48	259,70	657,52
n	10	10	10	10	40
Means	5,29	8,24	26,25	25,97	16,44

Fig. 7. Data NACA type, replication, and electric power.

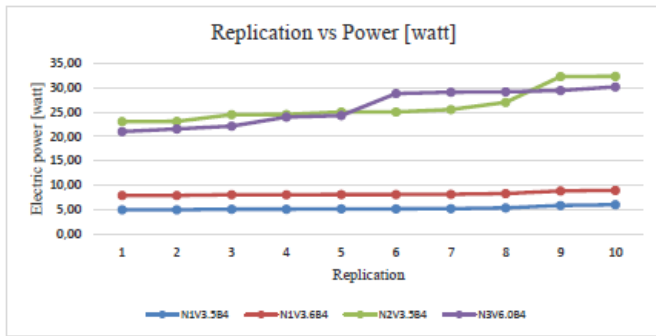


Fig. 8. Replication vs electric power.

Source of variation	df	SS	MS	Fratio	Ftable
SSTr	3	3785,22	1261,74	198,04	2,72
SSE	36	229,36	6,37		
SSTr	39	4014,58			

Notes:

- N1V3.5B4 = NACA 3412, Wind speed 3,5 [m/s], No. Blades 4 unit
- N1V3.6B4 = NACA 3412, Wind speed 3,6 [m/s], No. Blades 4 unit
- N2V3.5B4 = NACA 4412, Wind speed 3,5 [m/s], No. Blades 4 unit
- N3V6.0B4 = NACA 6412, Wind speed 5,5-6,0 [m/s], No. Blades 4 unit

Fig. 9. Analysis of variance.

Figure 7,8 and 9 shows that the null hypothesis is rejected, it means that is a difference effect between variation of NACA type to the electric power generated by wind turbine [11].

Strategic development is: The first strategy development is the largest power generated by wind turbine using NACA 4412 type, the wind speed is 3.5 [meter/second], number of blades is 4 units, and the average power generated by wind turbine is 26.25 [watt] [2,7]. The second strategy development is the second largest power generated by wind turbine using NACA 6412 type, the wind speed is 5.5 till 6 [meter/second], number of blades is 4 units, and the average power generated by wind turbine is 25.97 [watt]. The third strategy development is the third largest power generated by wind turbine using NACA 3412 type, the wind speed is 3.6 [meter/second], number of blades is 4 units, and the average power generated by wind turbine is 8.24 [watt]. And the last, the fourth strategy

development is the smallest power generated by wind turbine using NACA 3412 type, the wind speed is 3.5 [meter/second], number of blades is 4 units, and the average power generated by wind turbine is 5.29 [watt].

IV. CONCLUSION

The F ratio exceeds F table, it means the null hypothesis is rejected or there is a different between NACA type and the electric power significantly at 5%. The first strategy development for choosing the power is the maximum power generated by wind turbine using NACA 6412 type, the wind speed is 5.5 till 6.0 [meter/second], number of blades is 4 units, and the average power generated by wind turbine is 26.25 [watt], and the last strategy development is the minimum power generated by wind turbine using NACA 4412 type, the wind speed is 3.5 [meter/second], number of blades is 4 units, and the average power generated by wind turbine is 5.29 [watt].

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