

HYBRID POWER PLANT FEASIBILITY STUDY IN MANDANGIN ISLAND USING HOMER SOFTWARE

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ABSTRACT

In this research, a feasibility study of Diesel Power Plant (diesel) existing on the island Mandangin with hibrid using Renewable Energy (ET) in the form of photovoltaic (PV). HOMER is an optimization analysis software for power generation system design, seen from the value of the Net Present Cost (NPC) the lowest. HOMER itself is an abbreviation of Hybrid Optimization Model for Electric Renewable developed by the National Renewable Energy Laboratory (NREL) USA. The system design is based on data obtained from diesel Mandangin island. of the total power of 1500 kW able to be raised, but only used up to 400 kW. For design optimization was performed by adding a PV system as a source of renewable energy amounting to 300 kW. Analysis of the resulting HOMER, designs are made to meet the needs of 100% load with energy excess of 0.01%. Hybrid system configuration are made which have high initial costs, but the total NPC generated was reduced by $ 4,948,556. For the amount of fuel used, Hybrid system uses less fuel amount to a reduction of 184 565 L / year or a total of $ 180.931 per year compared with the existing diesel system. The amount of emissions released Hybrid system was also decreased with the decrease of 486.123 kg / yr of CO2 and 1,200 kg / yr of CO. In conclusion, HOMER is a software that can optimize power generation.

Keywords: Hybrid system, diesel, Photovoltaic, , HOMER

BACKGROUND

Mandangin Island is one of the villages located in the district of Sampang and is located 15 Km sourth Sampang city. The island Mandangin about 1.65 km2 ellipse-shaped cross-section with a diameter, a length of approximately 1,800 m and a width of 800m. , Mandangin island consists of three hamlets namely West Dusun, Dusun Kramat (Central Gili) and Hamlet Candin (Gili East). For availability of electricity, the island has a diesel Mandangin managed by PLN with the total power of 1500 kW can be generated, but used only 400 kW. One of the factors that lead to high cost of operation and maintenance of Diesel Power of grid Power Plant are currently widely applied in remote areas due to the diesel power plant can not operate optimally, so is contained in Mandangin island.

One reason is the magnitude of the difference between the base load that usually occurs in the morning - and afternoon peak load that occurs at night. In remote areas are generally the existing load is a load of housing / residential so the loading pattern is usually a 12 hour loading pattern. In conventional systems which the energy supply is only using the diesel, so if the diesel is operated at the load base so that operation of diesel would be inefficient because diesel has been working to the maximum at the time of loading capacity of only 80% - 90% of nominal capacity (rated capacity). The impact of this efficient operation causes the costs for operation and maintenance of diesel will be increased, especially the cost of fuel oil it. Therefore, to reduce the use of diesel fuel so that the performance diesel can be increased is by changing patterns of diesel operations of single diesel into Hybrid Power Plant Diesel (hybrid diesel – solar).

Modeling using the software on a computer is an option that can simplify the analysis of the desired system. This study uses the HOMER software as software for designing and optimizing its systems Hybrid Power Plant considered economic terms, such as start-up costs, operating and maintenance costs (O & M) and the net present cost (NPC).

While the environmental aspects that are optimized gas emissions issued by the system, whether in the form of CO2, CO and others. The use HOMER makes the process of feasibility studies to be more effective and efficient by incorporating all the factors into the design of the system.

HOMER

HOMER is a micropower models to facilitate in evaluating the design of a single network (grid-off) as well as networks that are connected to the system (grid-connected). In designing power systems must be observed regarding the configuration of the system, including: components of that can not be included in the system configuration, how many and what size of each component to be used, the number of technology options in the calculation of the cost and availability of energy resources exist such as shown in figure 1 below

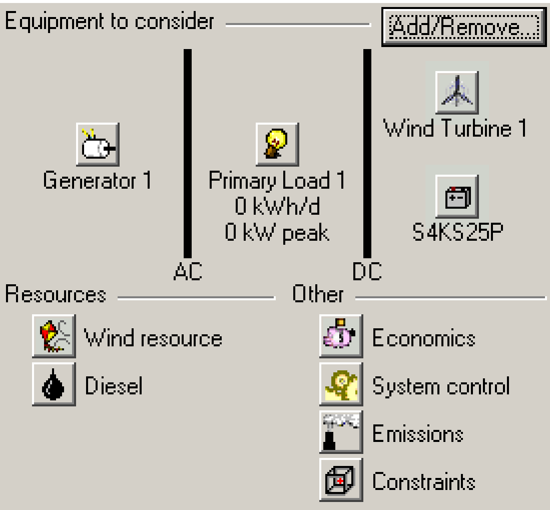

Figure 1. Homer Configuration

This model can analyze a stand-alone system using some components of wind energy, PV and fuel cell, the DC power produced by PV and fuel cell is converted into AC and transmitted to bus air conditioning, power produced by wind turbines is directly supplied to the AC buses, the excess power will be stored in the battery and electrolizer. Software Homer determine and calculate the net present value (Net Present Cost, NPC), power generation cost (Cost Of Electricity, COE) and optimize based on the value of the lowest NPC.

Figure 2. Shows one of the results of calculations HOMER software, where we can find out the excess energy generated by the plant system configuration that we created, which in turn required configuration improvements to reduce the excess energy produced. Results NPC also seen in the picture, which is the total cost incurred to optimize plant configuration is made.

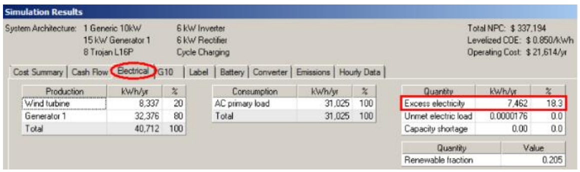

Figure 2. Result of HOMER Simulation

RESULTS AND DISCUSSION

Electrical System and Load Conditions

1. The main activity is the implementation of time-consuming data collection or survey the location. Diesel Power (diesel) which has been operating in the islands Mandangin, as organizations are under the management of PT. PLN (Persero) APJ Sampang.
2. Thus the necessary secondary data in this study, mostly obtained from documents at PT. PLN (Persero) APJ Sampang. While other secondary data obtained directly from the Technical Implementation Unit Power diesel power plant on the islands Mandangin. Primary data was collected by means of measurements as well as direct observation in the study site.Data Aset

Jumlah pelanggan pra-bayar	2,360 pelanggan
Jumlah pelanggan pasca-bayar	6 pelanggan
Jumlah	19,507 jiwa
Jumlah kepala keluarga	6,736 KK
Mesin operasi	1. DEUTZ F10L 413F 125 kVA no. Seri

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	75710 2. DEUTZ F10L 413F 125 kVA no. Seri 6711971 3. MERCY BENZ OM 407 125 kVA no.seri 017840 4. DEUTZ TBD 616 V12 500 kW no.seri 2204139
Beban puncak	525 kW
Jaringan tegangan rendah	6,706 kms
LV panel	5 buah
Tiang beton	56 buah
Tiang besi	82 buah
Jumlah feeder	1 jurusan JTM, 3 jurusan JTR
Luas wilayah	2.88 km2
SFC tahun 2012	0.316
Jam operasi tahun 2012	6,948 jam
Jam *stand by*	1,812 jam

3. Load profile

Figure 3 shows the load pattern found on the island Mandangin, this data is based on secondary data obtained from Mandangin diesel with 537 kW peak load and the lowest load up to 220 kW.

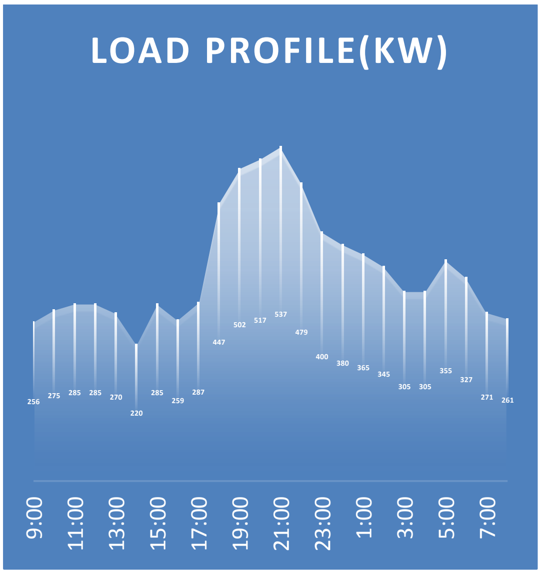


Figure 3. Load Profile Mandangin Island

4. Renewable Energy Potential

Offshore regions or islands have a lot of very diverse natural resources, one of them in terms of solar radiation. Solar radiation to this area tend to be larger than in other regions that are likely able to raise the potential of solar energy in the form of panels.

In this study, conducted primary data collection for solar radiation. The data have been obtained were compared with data taken from the website eosweb.larc.nasa.gov by entering the coordinates of the desired region. Mandangin island located at coordinates 7 ° 18 '37.63 "latitude and 113 ° 12' 44.93" E. For data retrieval is done manually, using solar radiation measuring devices, solar meter.

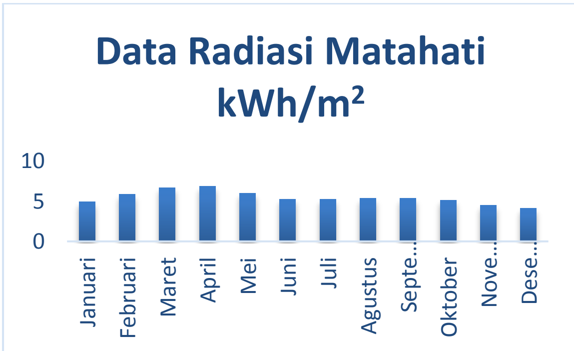


Figure 4. Solar Radiation Data Mandangin Island

Operating Systems Design and Pattern

This study used a parallel hybrid configuration of the system as shown below.

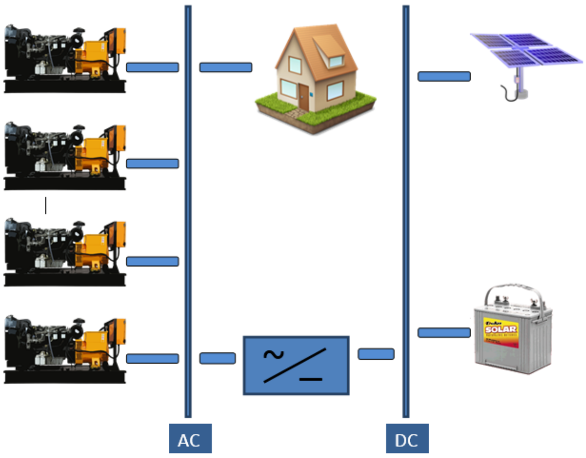


Figure 5. System Configuration

With the configuration as shown in Figure 5. Above, then the simulation by entering the respective components are required, it will look like in Figure 6 below.

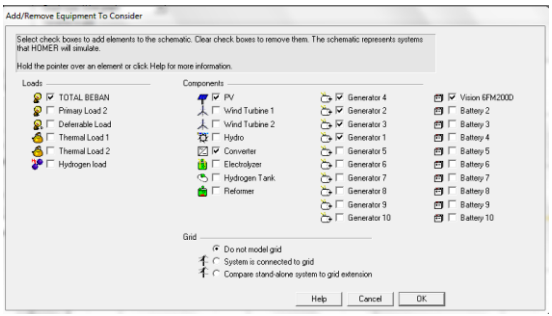
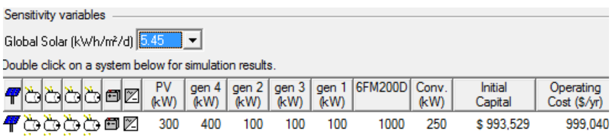


Figure 6. On the Component Selection HOMER

Pattern Design and Operating Results

Based on data from simulated daily load on the system configuration and with mengambiil example of pattern generation in one month (January), then produce a pattern of daily operations of each unit.



Sensitivity variables

Global Solar (kWh/m²/d) 5.45

Double click on a system below for simulation results.

PV (kW)	gen 4 (kW)	gen 2 (kW)	gen 3 (kW)	gen 1 (kW)	6FM200D	Conv. (kW)	Initial Capital	Operating Cost ($/yr)
300	400	100	100	100	1000	250	$ 993,529	999,040

Figure 7. Results of Simulation Optimization HOMER

1. Operation Pattern 1

Operation pattern 1 is a pattern of operation of the system that runs from 06.00 until 18.00. The figures (kW) accompanying the images 5., said power generation / load at 12:00 hours.

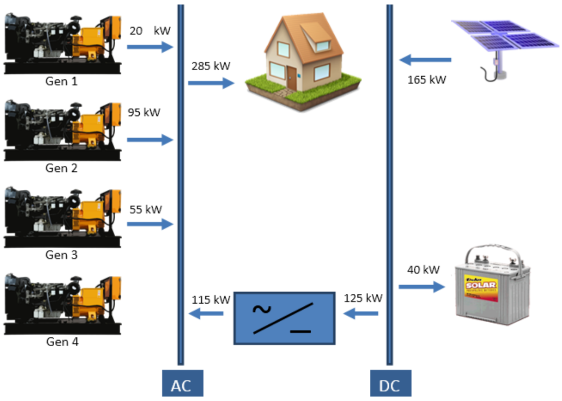


Figure 8. First Operation Pattern

Seen first operation pattern, ie when the load is supplied by renewable energy (ET) in the form of PV and was helped by three generators, generator 1, a generator 2, the generator 3, and the battery at that time in the charging position.

2. Operation Pattern 2

Operation pattern 2 is a pattern of continued operation of the first operation pattern, which is located at 18.00 - 23:00 or in other words the pattern of these operations refer to the peak load of the load curve. The figures shown in the picture 9. Shows the power generation at 21.00.

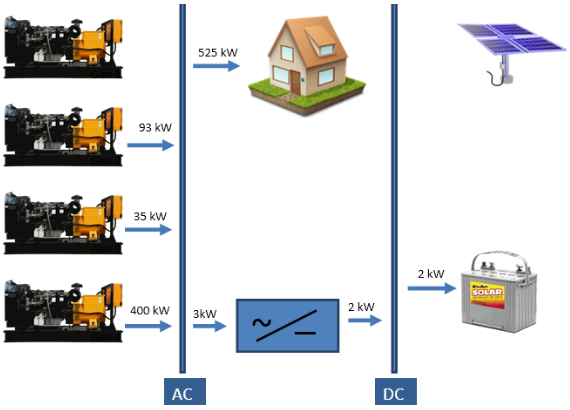


Figure 9. Pattern Second Operation

Show different patterns of operation, for this second operation pattern in which the sun had set, then PV is clearly no longer in operation. Thus it is seen that the generator 4 which has a capacity of 400 kW started work, assisted by a second generator, and the generator 3 was deemed enough to carry peak loads. In this operation pattern beoperasi battery still in a state of charging even if the input power to the battery is relatively less compared with the first operation pattern.

Operation Pattern 3

Pattern 3 operating is the last operating pole can be inferred from existing generation curve. This pattern tends to lie in the middle of the night until sunrise, which is located at 23.00 to 06:00. Figure 5. Shows the operating pattern located at 03.00, and the figures in the picture 5. Shows power generation at that hour.

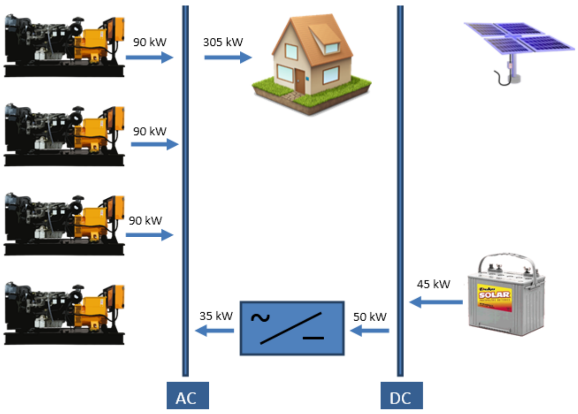
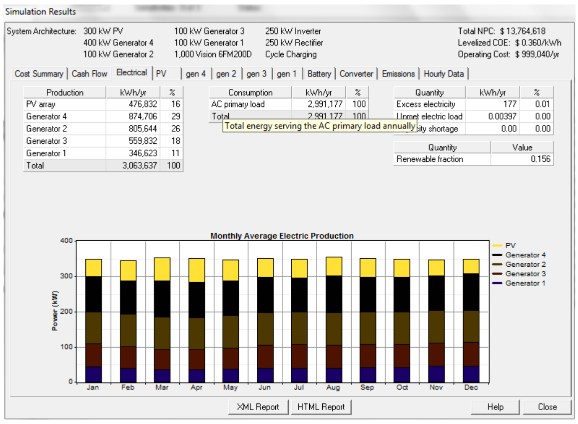


Figure 10. Pattern Operation 4

Visible operation pattern involving batteries as a source of power generation. Assisted by generator 2, the generator 3 and the generator 4 as an energy source. For generator 4, does not operate due to the other generator and battery is sufficient to supply the load. PV is not operating because the sun does not exist for the moment.

Electrical analysis

In this analysis views the role of usage for each component installed on the configuration diinput¬kan into the HOMER software in terms of the contribution of energy supply. Figure 11 below shows the role of each component installed.

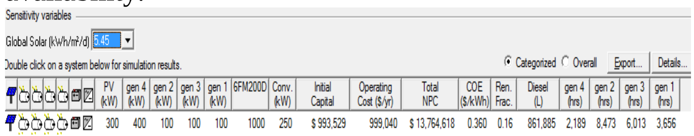


Gambar 11. Kinerja Sumber Energi

From these data we see that the role of ET here is able to meet the needs of the load by 16% per year, due to the obvious role of PV herein are only available during the daytime when exposed to solar radiation alone. And if you look at the column of excess electricity or excess energy is seen only by 0.01% or 177 kWh / yr in which the configuration of the system is very effective.

Economic analysis

Economic analysis refers to how the cost of installation, NPC (Net Present Cost) and how much it costs to supply diesel fuel for the purpose of this study itself refers to the policy PLN to save fuel from year to year more and more expensive while the dwindling availability.



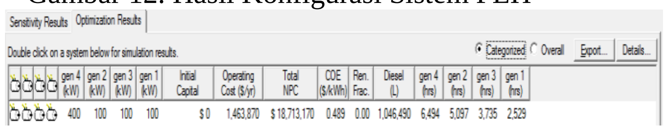
Sensitivity variables

Global Solar (kWh/m²/d) 5.45

Double click on a system below for simulation results.

PV (kW)	gen 4 (kW)	gen 2 (kW)	gen 3 (kW)	gen 1 (kW)	6FM200D	Conv. (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Diesel (L)	gen 4 (hrs)	gen 2 (hrs)	gen 3 (hrs)	gen 1 (hrs)
300	400	100	100	100	1000	250	$ 993,529	999,040	$ 13,764,618	0.360	0.16	861,885	2,189	8,473	6,013	3,656

Gambar 12. Hasil Konfigurasi Sistem PLH



Sensitivity Results | Optimization Results

Double click on a system below for simulation results.

gen 4 (kW)	gen 2 (kW)	gen 3 (kW)	gen 1 (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Diesel (L)	gen 4 (hrs)	gen 2 (hrs)	gen 3 (hrs)	gen 1 (hrs)
400	100	100	100	$ 0	1,463,870	$ 18,713,170	0.489	0.00	1,046,490	6,494	5,097	3,735	2,529

Figure 13. Results of Configuration diesel system

From Figure 12 and Figure 13 shows that the EE system can save fuel consumption Bbahan around $ 180.931 per year and the use of fuel by 184 565 L / year.

From the comparison of the two pictures above, also shows differences in total NPC obtained. NPC is calculated based on the total cost incurred during the calculation of 25 years. For EE configuration, obtained a total of $ 13,764,624 NPC, while for diesel configuration NPC obtained a total of $ 18,713,180. Although the system configuration for PLH-consuming initial cost of $ 77.721. For PV installation at a cost of $ 44.589, with a cost of $ 1.841 converter and battery at a cost of $ 31.291 per year with a total of $ 993.529 for 25 years.

Emissions and Environmental Analysis

In these discussions, compared to two system configurations to determine the differences and changes that occur when ET is used on the system configuration Hybrid system.

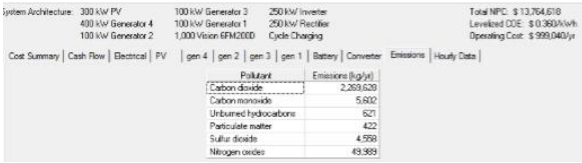


Figure 14. Emission System Simulation Results Hybrid system

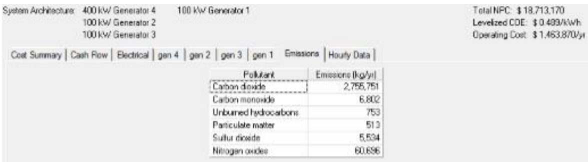


Figure 15. Emission Simulation Results of diesel system

RE visible role in the system configuration hybrid system able to break down carbon dioxide (CO2) which dikerluarkan amounted to 486.123 kg / yr, and this is a very large number if calculated from diesel emissions that have previously been operated for many years. And the role of ET was able to reduce the amount of carbon monoxide (CO) emitted from diesel configuration of 1,200 kg / yr.

Due to the standard atmospheric state the amount of carbon monoxide (CO) in the air is only about 0.1 ppm, in relation to the emissions released by diesel it will be very dangerous if not maintained. And to carbon dioxide itself, if not actually on tap expenditure, the amount in the atmosphere will be more and more and will further damage the ozone, in other words, will cause the greenhouse effect, ozone. In addition to damage to human health, such as skin cancer, it is also very dangerous for the environment. The greenhouse effect is due to the increasing amount of carbon dioxide (CO2) can raise the temperature of the earth and the most severe polar ice will melt in the long term. Therefore, the use of ET is mainly in the form of PV will be very useful to reduce environmental damage produced by diesel emissions.

CONCLUSION

From the simulation results based on system configuration PLH desired, it was concluded regarding electricity, economy, and environment as follows below.

1. Mandangin Island has diesel power systems that tend to be inefficient (in operation 1984).
2. Island Mandangin have renewable energy sources, especially solar, which can be used as a source of electrical energy to areas that do not receive the electrification of PLN.
3. The hybrid system includes four defined PLN diesel generator, photovoltaic, battery and converter.
4. The hybrid system defined able to meet the needs of 100% load with excess electricity (excess energy) by 0.01%.
5. From the hybrid system is specified, the contribution of renewable energy that is channeled through photovoltaic able to meet the load requirements of 16% of the total load required.
6. Optimization hybrid system compared to existing diesel power plant optimization resulted in a decline in total NPC of $ 4,948,556 and a decrease in the use of fuel by 184 565 L / year or a decrease of $ 180.931 per year.
7. In terms of emissions, hybrid systems tend to be more in the form of emissions of carbon dioxide (CO2) and carbon monoxide (CO) is less than the existing diesel power system configuration with a decrease of 486.123 kg / yr of CO2 and 1,200 kg / yr of CO.

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