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Decision Making of Diesel Power Plant Hybridization Method of Selat Nasik Diesel Power Plant in Belitung Island Using AHP-Vikor

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ABSTRACT

The selection of best hybridization methods scenario of Diesel Power Plant or HRES (Hybridization Renewable Energy System) requires not only a good analysis of techno-economic criteria but also many other criteria such as land availability, energy sources availability, and so on. Considering the complexity of criteria involved in the selection of hybridization methods, Multi-Criteria Decision Making (MCDM) is commonly used to evaluate problems with multiple criteria that often have conflicting interests. The HOMER software was used as the basis for conducting techno-economic analysis of various hybridization scenarios that would be applied to the Selat Nasik Diesel Power Plant. Then, an FGD expert was conducted to validate and determine the important criteria for selecting hybridization method scenarios. A pairwise questionnaire were filled out by 5 (five) experts, and then the criteria were weighted using the Analytic Hierarchy Process (AHP). The obtained criteria weights then used by experts to assess several hybridization scenario options, and their rankings were determined using VIKOR. In this research, 17 sub-criteria were identified and categorized into 3 criteria: Technical and Design-Oriented Criteria (Lifespan of HRES, Energy Resources Sustainability, and Potential Power Generation), Financial-Oriented Criteria (CAPEX, O&M Cost, NPV, LCOE, and Diesel Fuel Consumption), and Socio-economic and Environment-Oriented Criteria (GHG Emission, Land Acquisition, Effect on Ecosystem (Animal and Nature Protection), Force Majeure, Noise Pollution, Prospective Jobs and Economic Growth, Political and Regulatory Aspect, Public Awareness Level, and Tradition and Cultural Heritage). Top three sub-criteria with the highest weights were selected: Energy Resources Sustainability (weight 0.408), LCOE (weight 0.096), and CAPEX (weight 0.087). Scenario 1 (S1 (Diesel, PV, Battery)) was chosen as the first-rank scenario (the best scenario) followed by S2 (PV, Battery), S3 (Wind Turbine, PV, Battery), and S4 (Diesel, Wind Turbine, Battery).

KEYWORDS: AHP-VIKOR, HRES (Hybrid Renewables Energy System), MCDM (Multi Criteria Decision Making)

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1. INTRODUCTION

Most Diesel Power Plants had been installed in areas outside Java, especially in areas that are remote and sparsely populated islands or commonly called the Underdeveloped, Frontier and Outermost areas. The problem is that most of the Diesel Power Plants units have exceeded the operating lifetime of more than 20 years and resulted in the declining of efficiency and performance in electricity production thus a strategy is needed, like the termination of the operating period and/or build Diesel Power Plant hybrid system with other types of renewable energy-based power plants. Around 3518-units of Diesel Power Plants are installed in the territory of Indonesia, spread in approximately 2000 locations with the potential to be converted to renewable energy-based plants of ±3 GW and most Diesel Power Plant's locations, in a radius of 5 km to 100 km around there are potential areas of renewable energy such as wind energy, solar energy, micro hydro energy, and biomass energy. The Selat Nasik itself is important to choose in this study because in addition to the obsolete of Selat Nasik Diesel Power Plant, it also only has small electrification needs so it is expected to be lower in investment cost large but shall optimally moves the wheels of the economy in that area better.

In selecting the appropriate method of hybridization or HRES (Hybridization Renewable Energy System) for a diesel power plant, it is not only necessary to have a good analysis of techno-economic criteria, but there are also many other criteria to consider, such as land availability, energy source availability, etc. Considering the complex profile of the Diesel Power Plant hybridization method selection problem, multi-criteria decision making (MCDM) is a commonly used method to evaluate problems that involve multiple criteria, which often have conflicting interests.

HOMER software (Hybrid Optimization Model for Electric Renewables) shall be used as a foundation for conducting techno-economic analysis of various hybridization or HRES scenarios for the Selat Nasik diesel power plant. HOMER simulation result is necessary as the basis for evaluating and ranking the best hybridization methods within the MCDM framework.

Utilizing the integration of AHP (Analytic Hierarchy Process) and VIKOR (Više kriterijumsko Kompromisno Rangiranje) methods is recommended because it can compensate for the limitations of each method when used separately. The AHP method is good for weighting criteria but lacks in ranking the best alternative choices (Purnomo et al., 2013). On the other hand, the VIKOR method has been proven to provide appropriate results in ranking the best alternative choices, but it falls short in criteria weighting (Lengkong et al., 2015). Therefore, the AHP and VIKOR methods are highly suitable to be implemented in this research because they complement each other's strengths and weaknesses. It can be concluded that combining the AHP and VIKOR methods produces better rankings compared to using a single method alone since the criteria weighting process using the AHP and VIKOR methods is used in alternative ranking (Lengkong et al., 2015).

2. LITERATURE REVIEW

Sub-Section

The selection of renewable energy technologies is a complex and multidisciplinary issue that primarily involves the performance of technologies across various criteria such as environmental, social, technical, and economic aspects (Wu et al., 2018). MCDM methods have been successfully applied in the optimal design selection of solar, wind, diesel-based RO desalination integrating flow- battery and pumped-hydro storage using integrated Fuzzy-AHP and Fuzzy-VIKOR systems (Kotb et al., 2021), and in the selection of solar-wind energy systems using the AHP-CODAS method (Ali et al., 2020). Optimal design selection of sustainable energy systems has also shown promising results using AHP, TOPSIS, VIKOR, CODAS, and WASPAS methods (Elkadeem et al., 2021). For a comprehensive review of previous researches, please refer to Table 1 as follows.

TABLE 1. Previous Researches of MCDM Application in The Selection of Renewable Energy System

No	Researchers	Research	Method	Result
1	(Ali et al., 2020)	A hybrid multi-criteria decision-making approach to solve renewable energy technology selection problem for Rohingya refugees in Bangladesh	AHP-CODAS	Choosing 3 feasible alternatives: Solar-wind hybrid energy system, Solar mini-grid, Wind mini-grid based on 13 sub-criteria according to 4 aspects: Technical, Economic, Environmental, Socio-political. The solar-wind hybrid energy system has been selected as the best alternative.
2	(Kotb et al., 2021)	A fuzzy decision-making model for optimal design of solar, wind, diesel-based RO desalination integrating flow-battery and pumped-hydro storage: Case study in Baltim, Egypt	Fuzzy AHP (FAHP) and Fuzzy-VIKOR	Selecting the optimal design from 10 design alternatives: solar, wind, diesel-based RO desalination integrating flow, battery, and pumped-hydro storage based on 10 key performance criteria (KPC) according to the following aspects: Economic, Environmental, Energy. The "optimal system" consists of 5 × 20-kW wind turbines, a 328-kW photovoltaic array, a 100-kW diesel generator, 112 batteries, and a 235-kW converter.
3	(Elkadeem et al., 2021)	Sustainable siting and design optimization of hybrid renewable energy system: A geospatial multi-criteria analysis	AHP, TOPSIS, VIKOR, CODAS, WASPAS	The solar/wind/diesel/battery system was the best-selected system according to 12 sub-criteria based on the following criteria: Energy, Economic, Environmental, and Social.

No	Researchers	Research	Method	Result
4	Yunna et al., 2014	Multi-criteria decision making on selection of solar-wind hybrid power station location: a case of China	AHP	To determine the weight of criteria in the development of a solar-wind hybrid system, considering the following criteria: Grid accessibility, Wind resource (speed, power density, utilization time), Solar resource (sunshine hours, radiation), Economy (payback period, ROI, profit on capital), Social risk (public security, policy support), Environment (energy saving benefit, emission reduction, noise and light pollution, ecological damage, water and soil loss, impact on local residential life), a multi-criteria decision analysis can be conducted.
5	(Toopshekan et al., 2022)	Evaluation of a stand-alone CHP-Hybrid system using a multi-criteria decision making due to the sustainable development goals	TOPSIS	The HOMER optimization algorithm and sensitivity analysis used to analyze the impact of project variables such as component prices, renewable energy potential, power grid breakeven distance, and power consumption profiles on performance. On the other hand, TOPSIS used to determine the weights of sustainable development goals, both of which were taken into consideration in establishing an HRES (Hybrid Renewable Energy System) with PV (Photovoltaic)/WT (Wind Turbine)/BAT (Battery)/Boiler, consisting of an 18 kW wind turbine, 33.2 kW photovoltaic array, 119 kWh battery, and a cost of energy of 0.301 $/kWh.
6	(Troldborg et al., 2014)	Assessing the sustainability of renewable energy technologies using multi-criteria analysis: Suitability of approach for national-scale assessments and associated uncertainties	MCA (Monte Carlo Analysis)	The developed MCA had considered nine sub-criteria, consisting of three technical sub-criteria, three environmental sub-criteria, and three socio-economic criteria.
7	(Wu et al., 2018)	Evaluation of renewable power sources using a fuzzy MCDM based on cumulative prospect	AHP model and experts' feedback	The performance of different Renewable Power System (RPS) options were evaluated against thirteen sub-criteria reflecting economic, environmental, social, and technical issues, and solar power was selected as the highly suitable RPS option for Algeria.

In all the aforementioned cases, MCDM had supported decision-makers in determining the importance of criteria and preferences for alternatives, and in making appropriate choices based on the ranking order of alternatives.

3. METHODS

This research used the integration of AHP-VIKOR. The initial step of this study were to determine and weight the criteria in choosing a hybridization method (HRES) then determined the best hybridization method scenario from several alternative scenarios proposed. In Figure 1, AHP-based calculations, the expected result was to get the weight of each sub-criterion. Initially, using literature and FGD (expert review) the most important relevant criteria were determined and must be present in the evaluation of the hybridization method through validation of sub-criteria proposed by researchers from literature studies and feedback (input) from experts. Next, 5 experts would select the tendency values of importance for each pair of criteria compared in the questionnaire. After summarizing the questionnaire, a paired matrix would be created, and the eigenvalue and eigenvector would be determined. Subsequently, a Consistency Test could be conducted. If the consistency ratio (CR) was greater than 10% or 0.1, the judgment data in the questionnaire would need to be revised. However, if the consistency ratio (CR) was less than or equal to 10% or 0.1, the calculation results could be considered valid. If the CR value would met, the weights for each criterion would be obtained. The researcher would determine the alternative scenarios for the HRES, considering the available renewable energy potential then simulate its techno-economic performance using HOMER Pro software as the basis for expert consideration in filling out the VIKOR questionnaire later on.

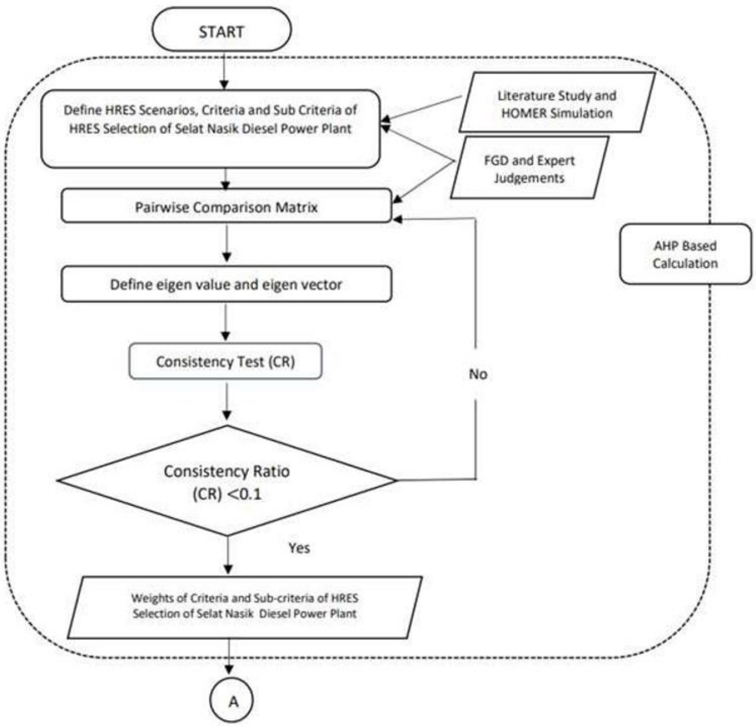


FIGURE 1. AHP Based Calculation Flowchart

In Figure 2, VIKOR-based calculations, using the weights obtained from the AHP process and the expert's assessment in the VIKOR questionnaire, the calculation of S values (Utility Measures) and Regret Measures for each scenario could be performed. Subsequently, the Q value (VIKOR index) could be calculated. The smaller the VIKOR index value (Qi), the better the scenario. Next, a sensitivity analysis was conducted to determine, obtain, and compare the results of the evaluation criteria to assess whether the rank of scenarios would change if the values of w and v were altered.

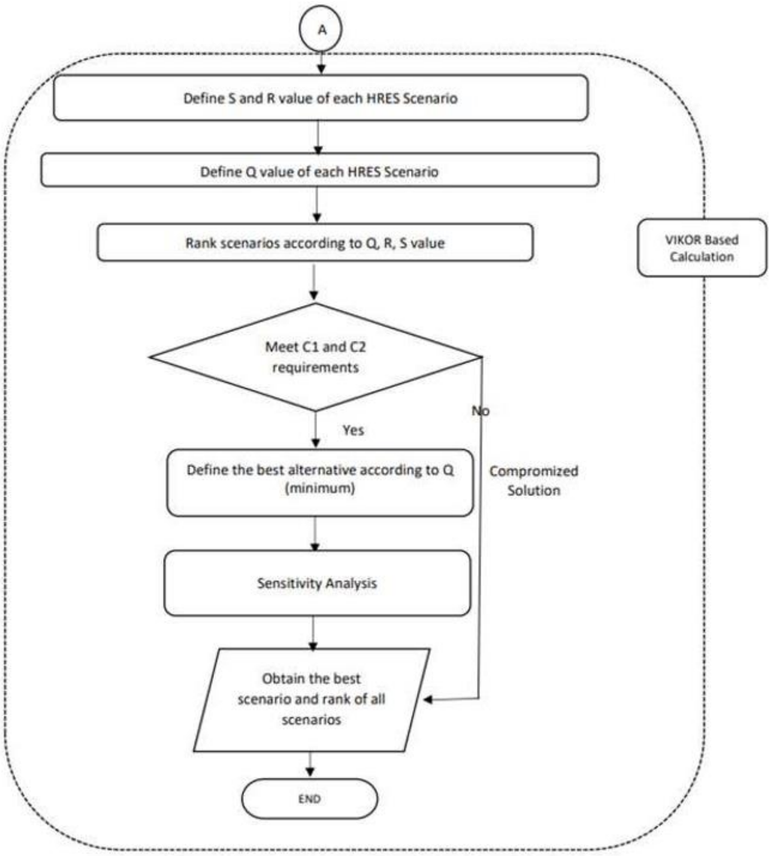


FIGURE 2. VIKOR Based Calculation Flowchart

The following Table 2 is Criteria and Sub Criteria that had been obtained from previous literature study and FGD (Focused Group Discussion):

TABLE 2. Criteria and Sub Criteria of Selat Nasik Diesel HRES Selection

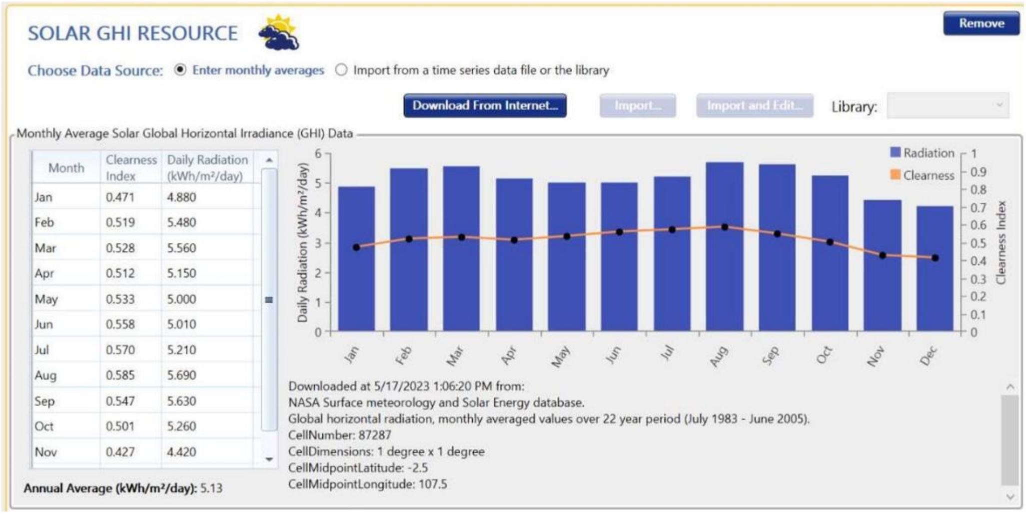
Sub Criteria	Criteria	Definition	References
C1.1	Technical and Design Oriented Criteria (C1)	Lifespan of HRES	(Troldborg et al., 2014)
C1.2		Energy Resources Sustainability	(Troldborg et al., 2014)
C1.3		Potential Total Power Generation	(Troldborg et al., 2014), (Wu et al., 2018)

Sub Criteria	Criteria	Definition	References
C2.1	Financial Oriented Criteria (C2)	CAPEX	(Troldborg et al., 2014)
C2.2		O&M Cost	(Wu et al., 2018)
C2.3		NPC	(Troldborg et al., 2014)
C2.4		LCOE	(Troldborg et al., 2014),(Wu et al., 2018)
C2.5		Diesel Fuel Cost Saving	(Troldborg et al., 2014)
C3.1	Socio-economic and environment oriented Criteria (C3)	GHG Emission	(Troldborg et al., 2014))
C3.2		Land Acquisition	(Troldborg et al., 2014)),(Wu et al., 2018)
C3.3		Effect on Ecosystem	(Taoufik & Fekri, 2021), (Ali et al., 2020)
C3.4		Force Majeur	(Troldborg et al., 2014)
C3.5		Noise Pollution	(Ali et al., 2020))
C3.6		Prospective Jobs and Economic Growth	(Troldborg et al., 2014)),(Wu et al., 2018)
C3.7		Political and regulatory aspect	(Ali et al., 2020)
C3.8		Society Awareness	FGD
C3.9		Tradition and Cultural Heritage	FGD

4. RESULTS

HOMER Simulation Result

The initial step before starting simulation was the selection of hybridization method scenarios. Selat Nasik Diesel Power Plant did not have any other energy sources in its vicinity except for solar radiation and wind energy. With the assistance of HOMER Pro, the available solar radiation potential and wind speeds in the Selat Nasik were as follows:



Source: HOMER

FIGURE 3. Solar GHI Resources Monthly Average

In Figure 3, solar radiation in Selat Nasik was capable of generating an average of 5.13 kWh/m^2/day. To increase power output would require a larger land area to accommodate the additional solar panels. In Figure 4, annual average wind speed (m/s) was 3.75, where at wind speeds smaller than 3 there would be no power output (0) and at wind speed 3.75 it was estimated that an average of 5.3 kW would be produced according to Table 3.

Source: HOMER

FIGURE 4. Wind Resources Monthly Average

Highlighting the limited potential for electricity generation from wind turbines (as shown in Table 3), researcher had attempted to simulate scenarios that minimize the use of a large number of wind turbines. Instead, batteries were employed in all scenarios to store intermittent electrical energy generated from both wind turbines and PV systems, enabling their utilization at any time.

TABLE 3. Windspeed vs Power Output of Wind Turbine

No	Wind Speed (m/s)	Wind Turbine Power Output (kW)
1	3	2
2	4	5.6
3	6	19
4	7	30.1
5	11-16	100

Source: HOMER

In Figure 5 below, System Configuration of Scenario 1 (Diesel, PV, Battery) and Scenario 2 (PV, Battery) simulated by using HOMER. Both Scenario 1 and Scenario 2 didn't use wind turbine in their system.

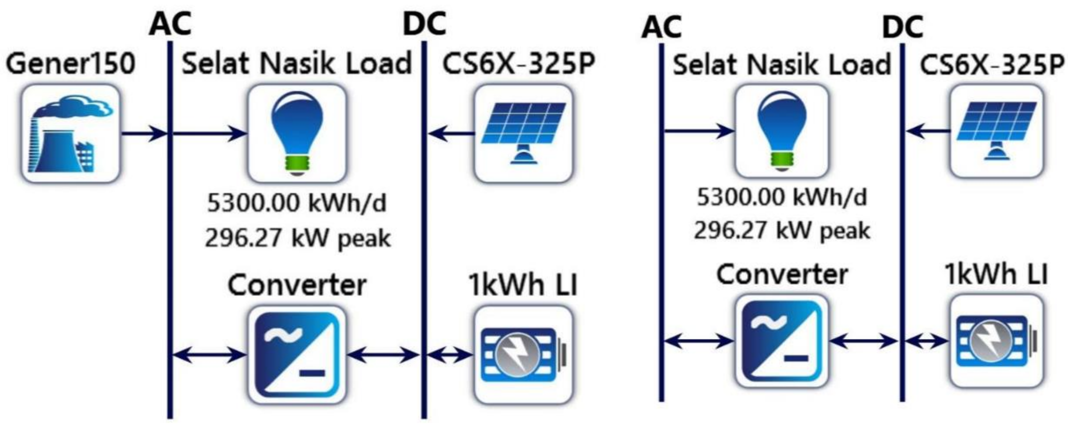


FIGURE 5. System Configuration for Scenario 1(left) and Scenario 2 (right)

Then in Figure 6 below, System Configuration of Scenario 3 (Wind Turbine, PV, Battery) and Scenario 4 (Diesel, Wind Turbine, Battery) simulated by using HOMER. Both Scenario 3 and Scenario 4 used wind turbine in their system.

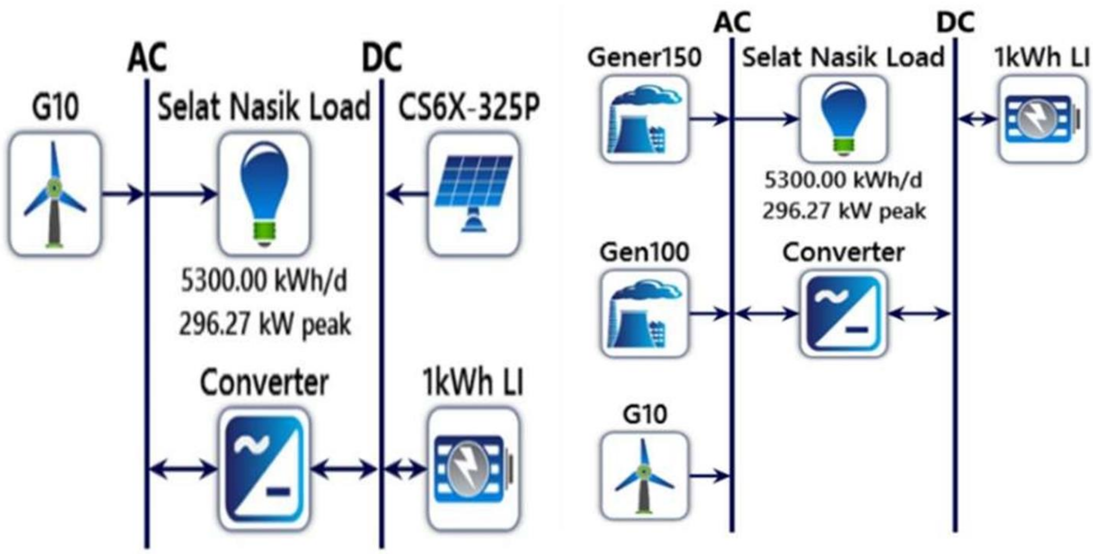


FIGURE 6. System Configuration for Scenario 3 (left) and Scenario 4 (right)

After the S1, S2, S3 and S4 scenarios were simulated with HOMER Pro, the following techno- economic data were obtained in Table 4.

TABLE 4. HOMER Simulation Result to Sub Criteria

<table>
<tr><th rowspan="3">Sub-Criteria</th><th rowspan="3">Definition</th><th colspan="4">Definition</th></tr>
<tr><th>Diesel, PV, Battery</th><th>PV, Battery</th><th>Wind Turbine, PV, Battery</th><th>Diesel, Wind Turbine,</th></tr>
<tr><th>S1</th><th>S2</th><th>S3</th><th>S4</th></tr>
<tr><td>C1.1</td><td>Lifespan of HRES (Yrs)</td><td>25 Yrs, 1x battery replacement, obsolote Diesel Power Plant</td><td>25 Yrs, 1x battery replacement</td><td>25 Yrs, 1x battery replacement</td><td>25 Yrs, 1x battery replacement, obsolote Diesel Power Plant</td></tr>
<tr><td>C1.2</td><td>Energy Resources Sustainability</td><td>Diesel, Sun Radiation</td><td>Sun Radiation</td><td>Sun Radiation, Wind</td><td>Diesel, Wind</td></tr>
<tr><td>C1.3</td><td>Potential Total Power Generation (kWH/Yr)</td><td>4,268,753</td><td>11,170,456</td><td>10,897,604</td><td>1,944,113</td></tr>
<tr><td>C2.1</td><td>CAPEX ($)</td><td>$231,764</td><td>$665,896</td><td>$661,602</td><td>$17,944</td></tr>
<tr><td>C2.2</td><td>O&M Cost ($)</td><td>$ 49,546</td><td>$94,738</td><td>$95,387</td><td>$46,110</td></tr>
<tr><td>C2.3</td><td>NPC ($)</td><td>$ 6,632,738</td><td>$ 11,053,280</td><td>$ 10,999,770</td><td>$6,485,582</td></tr>
<tr><td>C2.4</td><td>LCOE ($/kWH)</td><td>$0.265</td><td>$0.442</td><td>$0.440</td><td>$0.259</td></tr>
<tr><td>C2.5</td><td>Diesel Fuel Consumption (L/year or $/year ($0.8 perliter)</td><td>239,668 L or $ 190,934</td><td>0</td><td>0</td><td>539,338 L or $ 431,470</td></tr>
<tr><td>C3.1</td><td>GHG Emission (kgCO2/yr)</td><td>628,889</td><td>0</td><td>0</td><td>1,413,178</td></tr>
</table>

Scenario 1 emerged as the best scenario, as it did not only fulfill the techno-economic aspect but also reduced dependency on diesel, with PV contributed to 79.4% of electricity production.

AHP Procedure Result

Pairwise comparison questionnaires had been processed using AHP, thus globally obtained weights for each sub-criteria as shown in Table 5. C1 (Design and Technical Oriented Criteria) became the most important Criteria (0.54031). The top 3 (three) sub criteria were Energy Resources Sustainability or C1.2 (0,408), LCOE or C2.4(0,096), CAPEX or C2.1(0,087), thus these three information become the most important to know in choosing the best hybridization method of Selat Nasik Diesel Power Plant.

TABLE 5. Criteria and Sub Criteria Weights Obtained (AHP Calculation)

<table>
<tr><th>Sub Criteria</th><th>Sub Criteria Weights</th><th>Criteria</th><th>Criteria Weights</th></tr>
<tr><td>C1.1</td><td>0,05077</td><td rowspan="3">C1</td><td rowspan="3">0,54031</td></tr>
<tr><td>C1.2</td><td>0,40765</td></tr>
<tr><td>C1.3</td><td>0,0819</td></tr>
</table>

Sub Criteria	Sub Criteria Weights	Criteria	Criteria Weights
C2.1	0,08674	C2	0,29198
C2.2	0,01607		
C2.3	0,06633		
C2.4	0,09556		
C2.5	0,02728		
C3.1	0,02919	C3	0,16771
C3.2	0,00939		
C3.3	0,02704		
C3.4	0,03656		
C3.5	0,00654		
C3.6	0,01287		
C3.7	0,0238		
C3.8	0,01104		
C3.9	0,01128		

VIKOR Procedure Result

Utility measure calculation was the calculation that result S and R value, with the following formula:

$$S_1 = \sum_{j=1}^{n} F_{1j} \tag{1}$$

Then R value was :

$$R_{11=} \max(F_{11}, F_{12}, F_{13,....,} F_{1n} \tag{2}$$

VIKOR index value (Q), was where the VIKOR value chosen to be the most ideal solution regarding to the smallest (Q), with the following formula:

$$Q_1 = \left[\frac{S_i - S^+}{S^- - S^+}\right] V + \left[\frac{R_i - R^+}{R^- - R^+}\right] (1 - V) \tag{3}$$

Using value of V=0.5 the following result obtained (as shown in Table 6).

TABLE 6. Scenario Rank (VIKOR Calculation)

Scenario	S	R	Q	Rank
S1	0.07	0.02	0.00	1
S2	0.17	0.10	0.17	2
S3	0.71	0.31	0.73	3
S4	0.96	0.41	1.00	4

S1 had the smallest Q value became the best scenario of HRES Selat Nasik Diesel Power Plant. Then sensitivity analysis had been conducted with the following results:

TABLE 7. Sensitivity Analysis of Different V

Scenario	Q (V = 0.3)	Rank	Q (V = 0.5)	Rank	Q (V = 0.6)	Rank	Q (V = 0.8)	Rank
S1	0.00	1	0.00	1	0.00	1	0.00	1
S2	0.19	2	0.17	2	0.16	2	0.14	2

S3	0.73	3	0.73	3	0.73	3	0.72	3
S4	1.00	4	1.00	4	1.00	4	1.00	4

Table 7 had shown that V difference didn’t affect the rank of the scenario, then S1 still became the best scenario.

TABLE 8. Sensitivity Analysis of Different W

Scenario	Q (W)	Rank	Q (5W)	Rank	Q (10W)	Rank	Q (25W)	Rank
S1	0.00	1	0.00	1	0.00	1	0.00	1
S2	0.17	2	0.17	2	0.17	2	0.17	2
S3	0.73	3	0.73	3	0.73	3	0.73	3
S4	1.00	4	1.00	4	1.00	4	1.00	4

Table 8 also had shown that W difference didn’t affect the rank of the scenario, then S1 still became the best scenario.

Managerial Implications

The simulation results from HOMER and the AHP-VIKOR calculations have managerial implications for the dedieselization program of the Selat Nasik Diesel Power Plant:

1. The AHP-VIKOR method and the criteria weights and sub-criteria derived from this research could be used to select hybridization scenarios for other Diesel Power Plant (not exclusively to Selat Nasik Diesel Power Plant).
2. Operating Diesel Power Plant in combination with renewable energy sources (Wind Turbine, PV, Minihydro, etc) often becomes a solution to balance investment costs, LCOE, and accommodate NZE (Net Zero Emission) policies. However, the challenge lies in the obsolete of Diesel Power Plant, which requires modification strategies and proper spare part management.
3. Although LCOE and the investment in Diesel Power Plant hybridization might not always appear profitable compared to continuing full operation of the Diesel Power Plant, this policy is often necessary to meet the electricity demand in remote areas or underdeveloped area and support the government's NZE (Net Zero Emission) program.

5. CONCLUSIONS

Regarding to the results in this study, it might be concluded as follows:

1. According to expert opinions and literature review, 17 sub-criteria were classified into 3 criteria, namely: Technical and Design Oriented Criteria had 3 sub-criteria, namely Lifespan of HRES, Energy Resources Sustainability and Potential Power Generation. Financial Oriented Criteria had 5 sub-criteria, namely CAPEX, O&M Cost, NPV, LCOE and Diesel Fuel Consumption. While the Socio-economic and Environment Oriented Criteria had 9 sub- criteria, namely: GHG Emission, Land Acquisition, Effect on ecosystem (Animal and Nature Protection), Force Majeur,

Noise Pollution, Prospective Jobs and Economic Growth and Political and Regulatory, Level of Public Awareness and Traditions and Cultural Heritage.
2. In this research 3 sub-criteria with the largest weight were selected, namely: Energy Resources Sustainability (weight 0.408), LCOE (weight 0.096) and CAPEX (weight 0.087), thus to facilitate the process of selecting the best hybridization method scenario, you can obtain these three information firstly.
3. Scenario 1 was selected as the first rank (best scenario) and the sensitivity test was not sensitive to changes in v values, the ranking order starting from the first rank: S1(Diesel, PV, Battery), S2 (PV, Battery), S3 (Wind Turbine, PV, Battery) and S4 (Diesel, Wind Turbine, Battery)..

REFERENCES

Ali, T., Nahian, A. J., & Ma, H. (2020). A hybrid multi-criteria decision-making approach to solve renewable energy technology selection problem for Rohingya refugees in Bangladesh. Journal of Cleaner Production, 273, 1–12. https://doi.org/10.1016/j.jclepro.2020.122967

Ciptomulyono, U. (2005). Analisa Sistem Keputusan Decission Making (MCDM). Materi Ajar: Analisa Sistem Keputusan, ITS, Surabaya.

Ciptomulyono, U. (2017). Multi Criteria Decission Making (MCDM) dan Perspektif Teknik Industri.Materi Kuliah Tamu: Teknik Indutri, Universitas Al Ahzar, Jakarta.

Elkadeem, M. R., Kotb, K. M., Ullah, Z., Atiya, E. G., Dan, ´ A., & Wang, S. (2021a). A twostage multi-attribute analysis method for city-integrated hybrid mini-grid design. Sustainable Cities and Society, 65, Article 102603.

Elkadeem, M. R., Younes, A., Sharshir, S. W., Campana, P. E., & Wang, S. (2021). Sustainable siting and design optimization of hybrid renewable energy system: A geospatial multi-criteria analysis. Applied Energy, 295, 1–35. https://doi.org/10.1016/j.apenergy.2021.117071

Kotb, K. M., Elkadeem, M. R., Khalil, A., Imam, S. M., Hamada, M. A., Sharshir, S. W., & Dán, A. (2021). A fuzzy decision-making model for optimal design of solar, wind, diesel-based RO desalination integrating flow-battery and pumped-hydro storage: Case study in Baltim, Egypt. Energy Conversion and Management, 235, 1–32. https://doi.org/10.1016/j.enconman.2021.113962

Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. Journal of Mathematical Psychology, 15(3), 234–281.

Saaty, T.L (2004). Fundamentals of the Analytic Network Process: Dependence and Feedback in Decision Making with a Single Framework, Journal of Systems Science and Systems Engineering, Vol 13, pp 129-157

Taoufik, M., & Fekri, A. (2021). GIS-based multi-criteria analysis of offshore wind farm development in Morocco. Energy Conversion and Management: X, 11, 1–11. https://doi.org/10.1016/j.ecmx.2021.100103

Toloie-Eshlagy, Abbas., Homayonfar, Mahdi (2011). MCDM Methodologies and Applications : A Literature Review from 1999 to 2009. Research Journal of

International Studies. Issue 21 (October,2011) 86 – 137, Islamic Azad University, Teheran, Iran.

Toopshekan, A., Rahdan, P., Vaziri Rad, M. A., Yousefi, H., & Astaraei, F. R. (2022). Evaluation of a stand-alone CHP-Hybrid system using a multi-criteria decision making due to the sustainable development goals. Sustainable Cities and Society, 87. https://doi.org/10.1016/j.scs.2022.104170

Troldborg, M., Heslop, S., & Hough, R. L. (2014). Assessing the sustainability of renewable energy technologies using multi-criteria analysis: Suitability of approach for national-scale assessments and associated uncertainties. Renewable and Sustainable Energy Reviews, 39, 1173–1184. https://doi.org/10.1016/j.rser.2014.07.160

Wang, J.-J., Jing, Y.-Y., Zhang, C.-F., & Zhao, J.-H. (2009). Review on multi-criteria decision analysis aid in sustainable energy decision-making. Renewable and Sustainable Energy Reviews, 13, 2263–2278.

Wu, Y., Xu, C., & Zhang, T. (2018). Evaluation of renewable power sources using a fuzzy MCDM based on cumulative prospect theory: A case in China. Energy, 147, 1227–1239. https://doi.org/10.1016/j.energy.2018.01.115

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