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Leveraging A Multi-Criteria Decision-Making Approach with AHP & TOPSIS Method for the Selection of IoT-Based Inverter Smart Grid System and Smart Meter in Solar Photovoltaic and Wind Turbine Installations at Pelabuhan Ratu CFPP

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ABSTRACT

The effective selection of inverters plays a critical role in optimising the efficiency and performance of solar photovoltaic (PV) and wind turbine systems. Inverters have a direct impact on overall energy conversion efficiency and system output by influencing their efficiency and reliability. Inverter selection also involves essential criteria such as cost, compatibility with renewable energy sources, and environmental considerations. Therefore, a comprehensive and systematic approach is necessary to thoroughly assess and compare various inverter options. This study utilises a multi-criteria decision-making methodology to address these challenges. It assesses the identified criteria using the Analytical Hierarchy Process (AHP) and ranks them to determine the most suitable solution through the Technique for Order of Preference by Similarity to the Ideal Solution (TOPSIS). As a result, the investigation identifies smart grid and smart metre inverters as the optimal solutions, effectively addressing concerns related to power stability, communication and connectivity, security, data management, and cost. The proposed methodology yields a substantial total equity portion of USD 9,325.71, along with impressive annual earnings before interest, taxes, depreciation, and amortisation (EBITDA) of USD 1,734.09. The estimated payback period is 6.85 years, and the return on investment (ROI) reaches a remarkable 338.07%. Additionally, the nett income significantly reduces the production cost, amounting to USD 40,853.34 in a single period.

Keywords: *inverter selection, solar photovoltaic, wind turbine, multi-criteria decision-making, efficiency, reliability, smart grid, smart meter, power stability, cost, AHP, TOPSIS*

1. INTRODUCTION

Electricity consumption in Indonesia impacts national development and increases economic growth. According to the Electricity Supply Business Plan (RUPTL) for 2021–2030, the average projected electricity demand growth is 4.9%, with 40,575 MW in planned power plant development. Renewable energy power plants account for 20,923 MW, or 51.6%, of total power-producing capacity [1]. However, as of 2022, renewable energy power plants account for just 11.3% of total current power output [2].

One of the natural resources that can be utilised in tropical regions to close the gap between the goal and its realisation is solar energy production. Solar cell modules can be used to generate electricity from sunlight. The average solar radiation intensity in Indonesia is approximately 4.8 kilowatt-hours per square metre per day [3]. This is a significant figure; high solar radiation intensity directly translates to a higher potential for solar energy production.

Solar energy is an energy source that has the potential to be developed in Indonesia, considering that Indonesia is a country located on the equator. The solar energy that can be generated for Indonesia, which has an area of ±2 million km2 with an irradiation distribution of 4.8 kWh/m2/day, is equivalent to 112.000 GWp [3]. Therefore, solar energy has advantages compared to fossil energy. Solar energy is a low-cost, environmentally friendly energy source that is adaptable to a variety of geographical circumstances and relatively simple to install, use, and maintain [4].

Furthermore, Indonesia has enormous potential for wind energy, particularly in its hilly and coastal regions. According to the Meteorology, Climatology, and Geophysics Agency (BMKG), the average wind speed in Indonesia is 4-5 metres per second [5]. To meet its electricity needs, Indonesia has a tremendous chance to use wind energy as a sustainable energy source. Wind energy will only contribute around 0.3% of Indonesia's total power-producing capacity by 2022 [5]. The Indonesian government has set a target of raising the percentage of renewable energy to 23% by 2025, and wind turbines are one of the renewable energy sources projected to contribute to this goal's attainment [1]. Therefore, to help the government achieve the energy mix target in 2025, Pelabuhan Ratu Coal Fired Power Plant (CFPP) also wants to contribute green power by utilising solar energy and wind energy.

However, an electricity-efficient and cost-effective configuration system is required due to the utilisation of multiple generating sources (CFPP grid, solar photovoltaic, and wind turbine). In addition, to optimise the distribution system and use of electrical energy in the digital age, the following system is required:

- Increase efficiency in the use of electrical energy by monitoring and managing energy use more effectively.
- Improving the safety of using electrical energy by detecting and preventing disturbances in the electrical network system
- A real-time system that can monitor electricity consumption is required to reduce the likelihood of electrical energy theft or loss.
- A more consistent supply of electrical energy necessitates a system of distribution that can more effectively regulate electric current.

The main topic of this scientific paper is how to choose the best Internet of Things (IoT)-based inverter, smart grid system, and smart metre for Pelabuhan Ratu CFPP. The Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) are used. By employing these multi-criteria decision-making techniques, it aims to evaluate and rank potential systems based on various criteria such as reliability, interoperability, scalability, cost-effectiveness, and environmental impact.

A thorough assessment of the literature and data collection will result in the development of a set of evaluation criteria as well as a decision matrix for the selection process. Using AHP and incorporating expert viewpoints will identify the relative weights of criteria and sub-criteria, ensuring a well-balanced evaluation. Furthermore, the TOPSIS method will calculate the closeness coefficients and rank the candidate systems, considering both positive and negative ideal solutions.

2. METHODOLOGY

2.1. Identification of Problems

Several problems that can be identified with the addition of renewable sources of electrical energy to the existing power system can be identified using the root cause analysis method described below in Figure 1.

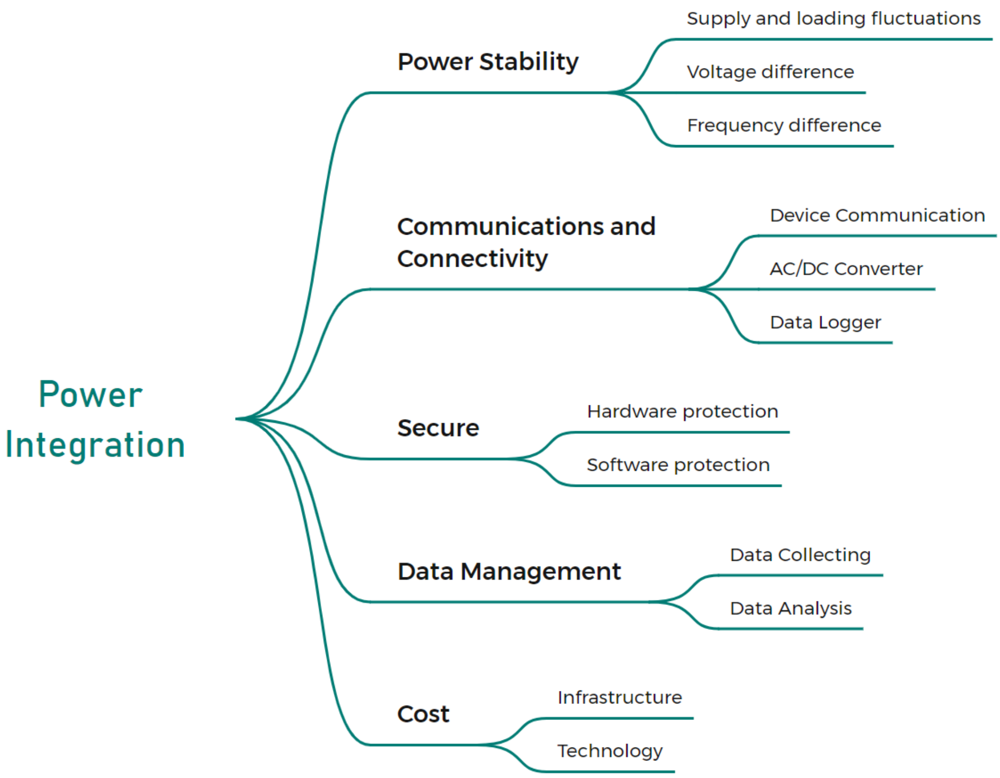

Figure 1. Root cause analysis.

1. Power Stability: Installing solar panels and wind turbines can lead to oscillations in the grid's power supply, compromising its stability. Consequently, a power supply regulation system that can account for fluctuations is required.
2. Communication and connectivity: IoT-based smart grid systems and smart metres need robust and dependable communication to gather and process data from solar photovoltaic (PV) and wind turbine installations.
3. Secure: The IoT-based smart grid system and smart meters collect and process sensitive data, such as specifics on electricity consumption and the configuration of solar PV and

wind turbines. A robust security system is required, and hardware protection is connected to tampering.

4. Data management: Smart metres and IoT-based smart grid systems gather and analyse massive amounts of complex data. Therefore, processing and creating helpful information requires an efficient and effective data management system.
5. Cost: The infrastructure and technology required to deploy IoT-based intelligent grid systems and smart metres in solar PV and wind turbine installations are expensive. Therefore, this is a barrier to the widespread use of this method.

2.2. Problem Solving

The Multi-criteria Decision-Making (MCDM) approach is used to conduct problem-solving analysis to find the best decision from several criteria based on previously identified problems, as described below in Figure 2. This study combines two MCDM techniques: the Analytical Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS). Based on the concerns mentioned, this study's preference is for a solar PV and wind turbine inverter system.

Figure 2. Criteria based on the problems that have been identified.

Based on the availability of inverters on the market, here are some inverters that we use as alternative solutions.

1. On-Grid Inverter (On-Grid): Inverters directly connected to the network or grid won't work if they don't recognise a network supply. A unique circuit in an on-grid inverter allows it to sync the grid voltage, frequency, and phase of the PV network with the grid.
2. Off-Grid Inverter (Off-Grid): Inverters not connected to the grid have their system (stand-alone) from generation to load, are separated from the network, and require a battery for energy storage.
3. Microinverter (Micro-Inv): A small inverter is installed on each solar panel. This type of solar panel inverter can be directly installed under the solar panel. A microinverter is more expensive overall than other inverters.
4. Smart Grid Smart Metre Inverter (SGSM-Inv): Inverters that can synchronise with the network and support the load according to the output produced based on IoT, where operating, production, and disturbance parameters can be displayed visually and monitored online and in real-time.

2.3. Integrated AHP-TOPSIS Method

The Analytic Hierarchy Process (AHP) represents a methodology within the realm of multi-criteria decision-making (MCDM) that facilitates decision-makers in selecting the optimal alternative from a multitude of choices while concurrently taking into account diverse criteria or factors. In support of the analysis conducted in this research, Microsoft Excel is employed.

The AHP technique provides decision-makers with more specific information regarding the relative priority or weight assigned to each criterion connected with the option. AHP divides decision-making into three steps: first, the decision maker lists the alternatives and criteria to be evaluated; second, the decision maker uses a relative scale to perform a pair-wise comparison analysis between each criterion and alternative; and third, AHP calculates the alternative priority score against the criteria and the alternative overall score against all criteria.

The following mathematical formulas are utilised to analyse the AHP analysis in this work, as well as the AHP method steps.

Table 1. Numeral Representation Of Importance Level

Importance Numerical Intensity	Interest Level
1	Equivalent Importance
3	Moderate Positioning
5	Strong Positioning
7	Very Strong Importance
9	Extreme Positioning
2,4,6, and 8	Intermediate Values

Step-1: Making a pair-wise comparison matrix While weighing the importance of one criterion over another, a conclusion was reached [6].

$$A = \begin{vmatrix} a_{11} & a_{12} & .. & a_{1m} \\ a_{21} & a_{22} & .. & a_{2m} \\ .. & .. & .. & .. \\ a_{m1} & a_{m2} & .. & a_{mm} \end{vmatrix}, \text{where } a_{ji} = \frac{1}{a_{ij}} \quad (1)$$

Step-2: The normalising approach with Equation (2) was utilised in matrix calculations to estimate significant amounts of factors in the decision matrix [6]. As demonstrated below, a normalised matrix B is formed.

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{m} a_{ij}} \quad (2)$$

$$B = \begin{vmatrix} b_{11} & b_{12} & .. & b_{1m} \\ b_{21} & b_{22} & .. & b_{2m} \\ .. & .. & .. & .. \\ b_{m1} & b_{m2} & .. & b_{mm} \end{vmatrix} \quad (3)$$

Step-3: Calculation of the criterion weight. The criteria weights generated in this phase are represented by the column vector W. The priority vector, often known as a measure of importance, is generated from Equation (4) and is the arithmetic average of matrix B's row components [6].

$$W = \begin{vmatrix} w_1 \\ w_2 \\ .. \\ w_m \end{vmatrix}, w_i = \frac{\sum_{j=1}^{m} b_{ij}}{m} \tag{4}$$

Step-4: The determination of eigenvalues is carried out through the utilisation of Equations (5), (6), and (7). As described subsequently, matrix D is generated.

$$D = [A][W] \tag{5}$$

The Eigenvalue (λ) is obtained by taking the arithmetic mean value of E values, which is calculated as shown below.

$$E = \frac{d_i}{w_i} \ (i = 1,2,3, \ldots m) \tag{6}$$

$$\lambda = \frac{\sum_{i=1}^{m} E_i}{m} \tag{7}$$

Step-5: Check for consistency. Equations (8) and (9) are used to check for data consistency. After calculating (λ), Equation (8) can calculate the consistency indicator (CI). Table 2 and Equation (9) can also be used to determine the consistency ratio (CR).

$$\text{CI} = \frac{\lambda - \text{m}}{m-1} \tag{8}$$

$$\text{CR} = \frac{\text{CI}}{\text{RI}} \tag{9}$$

Table 2. Random Consistency Index (RI)

N	RI
1	0
2	0
3	0,58
4	0,9
5	1,12
6	1,24
7	1,32
8	1,41
9	1,46
10	1,49

The consistency test is completed when CR is determined numerically. If the CR is less than 10%, the obtained data is consistent. If the CR is greater than or equal to 10%, the results are inconclusive. As a result, the comparison matrix must be modified [7].

The distances from positive and negative ideal solutions are chosen using this procedure. The TOPSIS technique prioritises options based on predefined criteria. As the first stage in this process, a choice matrix is constructed. In the following phase, the choice matrix was normalized. In the third stage, the choice matrix is weighted. Calculating ideal-solving and negative ideal-solving solutions is the fourth level. The fifth stage involves calculating both positive and negative ideal distances. The relative scores of each option are determined in the sixth phase [8].

Step-6: Making an experimental data matrix the initial stage is to create an experimental emission data matrix for various criteria (columns) and alternatives (rows), as shown in Equation (10).

$$A = \begin{vmatrix} a_{11} & a_{12} & .. & a_{1m} \\ a_{21} & a_{22} & .. & a_{2m} \\ .. & .. & .. & .. \\ a_{q1} & a_{q2} & .. & a_{qm} \end{vmatrix} \tag{10}$$

Step-7: Normalisation of the matrix. The square of each aij value is computed, and normalised values are established using Equations 11 and 12. N is the normalised matrix.

$$N_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{q} a_{ij^2}}} \tag{11}$$

$$N_{ij} = \begin{vmatrix} n_{11} & n_{12} & .. & n_{1m} \\ n_{21} & n_{22} & .. & n_{2m} \\ .. & .. & .. & .. \\ n_{q1} & n_{q2} & .. & n_{qm} \end{vmatrix} \tag{12}$$

Step-8: Matrix creation using weighted normalisation the weight computations performed by AHP resulted in a weighted, normalised decision matrix as shown in Equation (13).

$$U_{ij} = \begin{vmatrix} n_{11}w_1 & n_{12}w_2 & .. & n_{1m}w_m \\ n_{21}w_1 & n_{22}w_2 & .. & n_{2m}w_m \\ .. & .. & .. & .. \\ n_{q1}w_1 & n_{q2}w_2 & .. & n_{qm}w_m \end{vmatrix} \tag{13}$$

Step-9: Negative ideals and positive Ideal solution values are calculated. Equation (14) produces minimum values for each column after constructing a weighted, normalised decision matrix. (Negative) Ideal solution values:

$$A^- = \{\min u_{ij}\} \rightarrow A^- = \{u_1^-, u_2^-, \dots u_m^-\} \tag{14}$$

The maximum values for each column are now obtained.

$$A^+ = \{\min u_{ij}\} \rightarrow A^+ = \{u_1^+, u_2^+, \dots u_m^+\} \tag{15}$$

Step-10: Getting a negative ideal (S_i^-)and positive ideal (S_i^+) distance value:

$$S_i^- = \sqrt{\sum_{j=1}^{m} (u_{ij} - u_j^-)^2} \qquad (16)$$

$$S_i^+ = \sqrt{\sum_{j=1}^{m} (u_{ij} - u_j^+)^2} \qquad (17)$$

Step-11: Calculate C_i^* (relative proximity to the best solution).

Equation (18) uses ideal and non-ideal point spacing to calculate the relative closeness to the ideal solution.

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^+} \qquad (18)$$

In this study, the Analytic Hierarchy Process (AHP) is utilised to assign weights to criteria. For the best inverter, the following evaluation stages are considered:

- Creating a hierarchy of evaluation criteria,
- Using the AHP technique, compute the weights of these criteria,
- Using the TOPSIS technique to generate the final ranking.

The hierarchy modelling of the AHP and TOPSIS methods is used to determine the selection of an inverter system for solar PV and wind turbines based on criteria determined by the results of problem identification shown in Figure3.

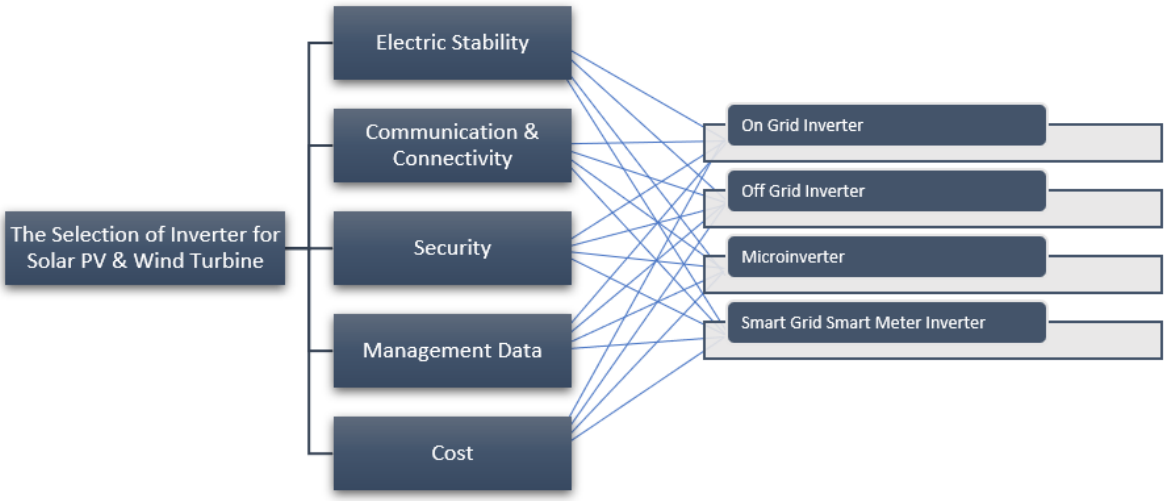

Figure 3. Diagram Hierarchy AHP-TOPSIS.

3. RESULT & DISCUSSION

3.1. Analytical Hierarchy Process (AHP Solution)

After identifying the criteria like cost, safety, and security (S&S), management data (Man-Data), communication and connectivity (C&C), and power stability (PS) for the assessment to be carried out and determining the preferred candidate, the first step is to do the weighting, as shown in Table 3.

Table 3. Pair-Wise Comparison Matrix using AHP Method.

Criteria	Cost	S&S	Man-Data	C&C	PS
Cost	1,00	0,20	1,00	3,00	3,00
S&S	5,00	1,00	3,00	5,00	3,00
Man-Data	1,00	0,33	1,00	3,00	1,00
C&C	0,33	0,20	0,33	1,00	0,33
PS	0,33	0,33	1,00	3,00	1,00
Total	7,67	2,07	6,33	15,00	8,33

Criteria weighting is done by comparing it with other criteria. This treatment is called pair-wise comparison. The evaluation guidelines are based on Table 1, followed by normalisation of the matrix in Table 4.

Table 4. Normalization Pair-Wise Comparison

Criteria	Cost	S&S	Man-Data	C&C	PS	Weight Criteria
Cost	0,13	0,10	0,16	0,20	0,36	0,95
S&S	0,65	0,48	0,47	0,33	0,36	2,30
Man-Data	0,13	0,16	0,16	0,20	0,12	0,77
C&C	0,04	0,10	0,05	0,07	0,04	0,30
PS	0,04	0,16	0,16	0,20	0,12	0,68

Table 5. Eigen Matrix Value

Eigenvalue	5,42	5,59	5,28	5,21	5,03	
Weight Criteria	0,95	2,30	0,77	0,30	0,68	
Criteria	**Cost**	**S&S**	***Man-Data***	**C&C**	***PS***	**Weight Value**
Cost	0,95	0,46	0,77	0,90	2,05	5,12
S&S	4,73	2,30	2,31	1,50	2,05	12,88
Man-Data	0,95	0,77	0,77	0,90	0,68	4,06
C&C	0,32	0,46	0,26	0,30	0,23	1,56
PS	0,32	0,77	0,77	0,90	0,68	3,43

Perform normalisation by dividing the results of pair-wise comparisons by the total value of each criterion. Then calculate each criterion's weight by adding up the results of the normalization of each criterion on Table 5.

Multiply pair-wise comparisons with the weight criterion to check for consistency. Then, to decide each criterion's weight, summarise the findings from assessing its consistency. Table 7 shows a CR value of 0.068, where 0<CR<0.1. This proves that the data has met consistency requirements so that the weighting criteria can be used in further analysis.

Table 6. Final Value

Parameter	Value
Eigenvalue Max	5,306
N	5,000
CI	0,076
RI	1,120
CR	0,068

3.2 TOPSIS Solution

After the weighting value on the criteria is proven consistent, we can use it to evaluate alternative solutions and rank the best solution.

Table 7. The Matrix Value and The Total Number of Columns

Criteria	Cost	S&S	Man-Data	C&C	PS
On-Grid	4	4	2	2	4
Off-Grid	3	1	4	4	3
Micro-Inv	2	3	4	3	2
SGSM-Inv	3	4	3	4	4
Total	12	12	13	13	13
Attribute	benefit	benefit	benefit	benefit	benefit

Table 7 gives the weighting value of each solution based on the problem identification criteria formulated in Table 8 to evaluate alternative solutions and rank the best solution.

Table 8. Index Weighted Score Based on Effect

Score	Description
Score 1	very low positive impact
Score 2	low positive impact
Score 3	high positive impact
Score 4	very high positive impact

Squaring each score, then calculating the sum of the squares (TSS), is followed by rooting to get a weighting value representing each criterion for normalising, as shown in Table 9. Then calculate the total square root (TSR) for each criterion.

Table 9. Calculating The Total Sum of Square Roots

Criteria	Cost	S&S	Man-Data	C&C	PS
On-Grid	16	16	4	4	16
Off-Grid	9	1	16	16	9
Micro-Inv	4	9	16	9	4
SGSM-Inv	9	16	9	16	16
TSS	38	42	45	45	45
TSR	6,16	6,48	6,71	6,71	6,71

Table 10. Normalizing The Decision Matrix

Criteria	Cost	S&S	Man-Data	C&C	PS
On-Grid	0,65	0,62	0,30	0,30	0,60
Off-Grid	0,49	0,15	0,60	0,60	0,45
Micro-Inv	0,32	0,46	0,60	0,45	0,30
SGSM-Inv	0,49	0,62	0,45	0,60	0,60

Table 10 shows how to normalise the results of the decision matrix by dividing the values obtained for each criterion by the total number of square roots. Give weight to the decision matrix by multiplying the results of the decision matrix with the weight criteria based on Table 4, as shown in Table 11.

Table 11. Giving Weight to Normalized Decision

Criteria	Cost	S&S	Man-Data	C&C	PS
Weighted	0,95	2,30	0,77	0,30	0,68
On-Grid	0,61	1,42	0,23	0,09	0,41
Off-Grid	0,46	0,36	0,46	0,18	0,31
Micro-Inv	0,31	1,07	0,46	0,13	0,20
SGSM-Inv	0,46	1,42	0,34	0,18	0,41

To determine the data distribution range, look for the maximum and minimum values for each criterion to find out the data distribution limit range as shown on Table 12.

Table 12. Best and Worse Ideal Value

	Cost	S&S	Man-Data	C&C	PS
Attribute	benefit	benefit	benefit	benefit	benefit
V+ (ideal+)	0,61	1,42	0,46	0,18	0,41
V- (ideal-)	0,31	0,36	0,23	0,09	0,20

Table 13. Positive Ideal Solution Distance (D+)

Criteria	Cost	S&S	Man-Data	C&C	PS	*Total*	*D+*
On-Grid	0,00	0,00	0,05	0,01	0,00	0,06	0,25
Off-Grid	0,02	1,14	0,00	0,00	0,01	1,17	1,08
Micro-Inv	0,09	0,13	0,00	0,00	0,04	0,26	0,51
SGSM-Inv	0,02	0,00	0,01	0,00	0,00	0,04	0,19

Table 13 shows calculation of the distance of the decision matrix with the maximum data by squaring the decision matrix, summing, and doing a root square to obtain information on the ideal solution distance with the maximum value of each criterion.

Table 14. Negative Ideal Solution Distance (D-)

Criteria	Cost	S&S	Man-Data	C&C	PS	*Total*	*D-*
On-Grid	0,09	1,14	0,00	0,00	0,04	1,27	1,13
Off-Grid	0,02	0,00	0,05	0,01	0,01	0,09	0,31
Micro-Inv	0,00	0,51	0,05	0,00	0,00	0,56	0,75
SGSM-Inv	0,02	1,14	0,01	0,01	0,04	1,22	1,11

Tabel 14 shows calculation of the distance of decision matrix with the minimum data by squaring the decision matrix, adding, and doing a root square to get the ideal solution distance with the minimum value of each criterion.

Calculate performance (V) by dividing the ideal worst by the ideal value (best + worst) to get the performance value as a reference for ranking as shown on Table 15.

Table 15. Euclidian Distance and Performance Score

Criteria	D(+)	D(-)	V	Rank
On-Grid	0,25	1,13	0,82	2
Off-Grid	1,08	0,31	0,22	4
Micro-Inv	0,51	0,75	0,59	3
SGSM-Inv	0,19	1,11	0,85	1

Table 16. Alternative Solution Ranking

Criteria	Rank
SGSM-Inv	1
On-Grid	2
Micro-Inv	3
Off-Grid	4

Based on the results of the multi-criteria decision-making ranking of the four popular inverter options proposed as alternative solutions using the AHP and TOPSIS methods on Table 16, it is determined that the Smart Grid Smart Meter Inverter is the most optimal and has a positive impact on solving problems of electricity network stability, communication and connectivity, security, data management, and costs.

3.3 Financial Benefit

Financial analysis is conducted using the kWh rate, as stipulated in Board of Directors Regulations 0283.P/DIR/2016, which pertains to the utilisation of electricity by non-PT PLN power providers. These regulations specify service tariffs, particularly for payments related to imported kWh, which are set at 17.62 cents per kWh [9]. The annual total power generation comprises 8255 kWh/year for solar PV and 1843.2 kWh for the wind turbine.

Table 17. Financial Projections

PT PLN Indonesia Power			
PLTU Jawa Barat 2 Pelabuhan Ratu - Power Generation Unit			
NO	**DESCRIPTION**	**RECAPITULATION**	
A	**RENEWABLE ENERGY PROJECTION ON KWH**		
1.0	Solar PV Capacity	6.000,0	Wp
1.1	Wind Turbine Capacity	4.800,0	Watt
1.2	Production	10.098,20	kWh/years
B	**OPERATING EXPENSES**		
2.1	Project Value (CAPEX)	$ 9.325,71	USD
2.2	Depreciation Period	25	year
2.3	Depreciation Value	$ 373,03	$/years
C	**RATES OF POWER PURCHASE**		
3.0	Rates kWh (0283.P/DIR/2016)	0,1762	$/kWh
D	**INCOME STATEMENT**		
4.1	Revenue Solar PV	$ 1.779,30	$/years
4.2	Maintenance Cost	$ 177,93	$/years
4.3	EBITDA	$ 1.601,37	$/years
E	**RETURN ON EQUITY**		
5.1	Net profit	$ 1.228,34	$/years
5.2	Total Profit	**$ 30.708,60**	$/Pd
5.3	Pay Back Period	**7,59**	Year
5.4	Discount Rate = Cost of Equity	**17,41**	Year
5.5	Return on Investment	**329,29%**	/Pd

EBITDA is derived through the subtraction of total revenue from maintenance costs, resulting in a figure of USD 1,601.37. Following the consideration of interest, taxes, depreciation, and amortisation, the EBITDA value is adjusted to yield a net profit of USD $1,228.34, the same as the annual profit. Over the course of 25 years, the cumulative profit totals USD 30,708.60, and the investment will reach its payback period (PBP) in 7.59 years. The return on investment (ROI) for this venture stands at an impressive 329.29% within a single period.

4. CONCLUSION

The utilisation of inverters in power generation holds promise as a viable alternative to mitigate carbon emissions associated with thermal power generation, thanks to the integration of renewable energy sources. We use the AHP-TOPSIS method along with the Multi-Criteria Decision-Making (MCDM) approach in this study to find the best inverter choice based on our experiments. The following results were obtained:

1. Safety and security were found to be the top-weighted criteria among all criteria by the AHP. According to the comparison of AHP-TOPSIS analysis results, the smart grid and smart metre inverter were the best choices, followed by the on-grid inverter, microinverter, and off-grid inverter.
2. Therefore, the Smart Grid Smart Metre Inverter is the most optimal and has a positive impact on solving problems of power grid stability, communication and connectivity, security, data management, and costs.
3. The total equity portion for this renewable energy project is worth USD 9,325.71 with an EBITDA of USD 1601.37/year, a pay-back period of 7.59 years, an ROI of 329.29%, and a net income as a decrease in production cost of USD 30,708,6 in one period.

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