



## Corporate Renewable Energy Procurement Prioritization Using Analytic Hierarchy Process (AHP) by Energy Service Company Perspective in Response to COP26

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**ABSTRACT:** To be able to participate in the COP26 commitment to work together to make clean and sustainable solutions, making clean power is the most affordable and reliable option for Indonesia to meet its power needs efficiently by 2030. The purpose of this research is to create a prioritization of prospective renewable energy projects from the point of view of a service company as an oil and gas company's contractor. These include Indonesia's prospective projects, which are geothermal or carbon capture and utilization, and decarbonization or reduction emission from existing services. This research also decides criteria that important for service company in providing renewable energy. A literature study, interviews with key decisionmakers in the company, questionnaires to company experts, and a questionnaire to practitioners in the industry were done to determine the criteria and prioritization technique. Four criteria of governance, marketing and sales, financial and project management were found to support the prioritization process using the Analytical Hierarchy Process (AHP). Among the nine sub-criteria, the sub-criteria with the highest global weights are profitability, cashflow, and service quality assurance.

**KEYWORDS:** Analytic hierarchy process, Business strategy, Decision making, Renewable energy.

### INTRODUCTION

COVID-19 has impacted global financial, commodities, and oil and gas markets. Domestic gasoline demand plunged 45 percent, or 5 million barrels per day, in April and won't recover until 2020. In Q1 and Q2 2020, due to a pandemic, oil prices fell to 37.63 USD per barrel in April 2020. This affected Indonesia's oil and gas operations, and rig owners stopped and postponed drilling new wells. In Q3 and Q4, contractors bid ridiculously cheap to get contracts for the sake of the firm.

Even if oil and gas drilling and development increase in early 2021, service firms like Merah Delima (Pseudo name) must be ready to support renewable energy company. To be able to participate in COP26's promise to make clean and sustainable solutions, notably Power Breakthrough: making clean power the most cheap and dependable choice for all countries to satisfy their power demands efficiently by 2030. Merah Delima must find a way to set its imprint in Renewable Energy as part of its mission and business strategy.

### EXPLORATION OF BUSINESS ISSUE

Indonesia contains an estimated 28 billion tons of coal reserves, or 3.1% of the world's total reserves. It also contains between 300 to 450 TSCF of prospective Coalbed Methane deposits. The majority of electric power plants in Indonesia rely on coal. With the existing patterns of coal use and export, it is anticipated there will be a coal deficit in 2046. Indonesia has created a National Energy Policy (Kebijakan Energi Nasional/KEN) as a roadmap for energy management to increase energy security and independence.

It outlines a quantitatively objective national target for emissions reduction across five major sectors: energy, waste, industrial processes and product use (IPPU), agriculture, and land use, land-use change, and forestry (LULUCF). The core of Indonesia's NDC is a commitment to cut greenhouse gas emissions by 29 percent or 41 percent with international help by 2030.

### EXTERNAL ANALYSIS

#### A. *Macroeconomic Outlook: PEST Analysis*

PEST analysis is a framework or methodology used in business and management to study the environment in which they operate or intend to launch new activities, or monitor the macro-environmental (external) elements that affect that environment. PEST analysis is comprised of the following elements: political, economic, social, and technological.



**Political :** Based on Indonesia Energy Transition Outlook 2022 assessment, it is shows that the current regulatory framework is still unstable as PLN's RUPTL is updated almost every year, leading to frequent changes in the power system planning. Climate ambition for energy sector in the updated NDC is still incompatible with Paris Agreement.

**Economic :** The investment trend of renewable energy is not improving and the access to local finance is limited. Process of obtaining permits is time consuming and leading into high transaction cost. Current fiscal and financial support is still insufficient and suggests government to provide FiT, VGF, and soft loans.

**Social :** Most of Indonesian citizen acknowledge that climate change is an urgent problem to address and agree to Renewable Energy movement. However, people were less supportive on an increase in electricity prices. It is important to establish a clear strategy on preparing workforce for the transition both in terms of supporting workers in existing fossil industries and building capacity of future workforce in low carbon industries.

**Technological :** The present power system planning is more accommodating for renewable energy than the previous RUPTL, with 51.6 percent of anticipated capacity growth over the next 10 years allocated to renewable energy sources. More than sixty percent of developers reported to have access to the least expensive technology (mostly imported).

## **B. Indonesia Energy Outlook**

According to BPPT's Business as Usual (BAU) Indonesia Outlook Energy 2020, energy consumption will rise 3.9% per year from 2018 to 2050. As the key economic driver, industrial energy consumption is predicted to rise and dominate total energy needs by 2050. In 2050, fossil fuel will dominate energy diversification, followed by electricity, gas, coal, biofuel, and biomass.

Renewable energy supply grew 6.5% per year. Nonrenewable energy sources are replacing oil and natural gas. Along with rising fossil energy prices and environmental concerns, NRE supplies are growing. NRE will supply less than a fifth of the world's energy by 2050. RE is mostly biofuels, biomass, hydropower, and geothermal. Solar, wind, garbage, and biogas are small nonrenewable energy sources.

## **C. COP26 and Indonesia's Commitment**

Indonesia has established targets for reducing emissions and reaching net zero emissions by 2060 or sooner. NRE would be the sole source of capacity addition beginning in 2035. The government plans to invest heavily in solar PV and electric vehicles. Indonesia will be able to meet its NDC obligations by lowering CO<sub>2</sub> emissions in the energy sector by 314 million tonnes by 2030.

Reducing emissions to mitigate the detrimental consequences of climate change has become a consensus goal of the global community in recent years, with more nations and industry committing to net-zero emissions, primarily by mid-century. The race to carbon or climate neutrality is associated with an increase in extreme weather events, a decrease in the cost of renewable energy, and increased awareness of climate change. Despite its reputation as a climate-vulnerable archipelago, Indonesia is now lagging other countries in its attempts to achieve net-zero emissions by 2060.

## **INTERNAL ANALYSIS**

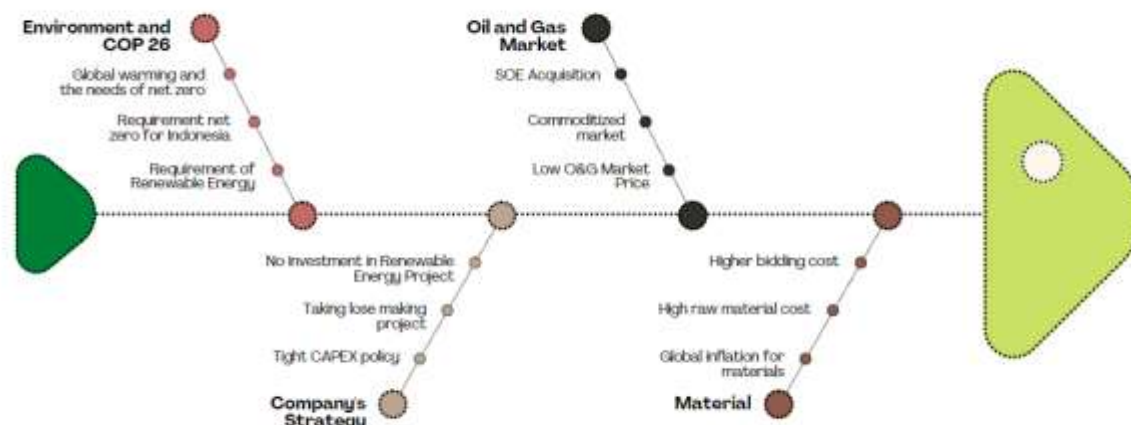
### **A. Company Performance Outlook and Market Share**

In 2018, Merah Delima received less winning contracts and maintained a reasonable profitability index. The oil price fell in 2016, causing a major hit to the entire oil and gas industry, as well as a decrease in the number of operations compared to previous years. In 2019, it will receive a number of jobs in 2020, but the operation's execution is delayed in Q1 and Q2 due to the Covid-19 pandemic and rising oil prices.

Oil and gas service companies are classified as having elastic demand and pricing. To boost its profitability, Service Provider will need to win the tender with the lowest bidding number, as in Indonesia. As a result, market pricing knowledge and forecast of competition behavior or strategy are the most important factors in Indonesia services provider tender.

### **B. Situation Analysis and Problem Analysis**

The internal and external environmental analysis of Merah Delima is further articulated in the root-cause analysis by implementing Ishikawa's (1976) Fishbone Diagram to four significant components. These components include the environment and COP26, the oil and gas market, the company's strategy, and material.



Merah Delima must take corrective action to overcome the saturated oil and gas market, deal with rising material costs, and face the Indonesian and worldwide needs for Renewable Energy. The Company's Strategy and Market is one of the areas to be emphasized due to its close relationship with all of the fundamental causes. By developing a priority strategy, the company's money will be better allocated, and value generation will be more efficient.

#### AHP FOR PROJECT PRIORITIZATION MODEL FOR SERVICE COMPANY

The AHP has its origins in the 1970s, when Saaty (1980) merged his theories on decision process structuring. AHP, according to Golden (1989, 13), could be more precisely described as follows:

- Analytic. Based on logical concepts and realistic computations, the problem is dissected.
- Hierarchy. Decomposing an issue into criteria and sub-criteria enables you to see it in terms of fewer and more, independent and dependent variables considered with changing degrees of relevance and preference..
- Process. The issue is contained in the systemic variables that are less or more essential and must be considered accordingly.

#### PAIRWISE COMPARISON MATRICES

In AHP, the pairwise comparison scale and the placement of the scale throughout the assessment process are key elements of the analysis and design of data aggregation. Due to the focus on professional experts, the number of respondents does not conform to the minimum sample size required by statistical theory. Instead of the arithmetic mean, the geometric mean is used to construct data aggregation from research survey.

Numerical Scale	Verbal Scale	Interpretation
1	Equal importance	Two factors contribute equally to achieve the objective
3	Moderate importance of one over another	Experience and judgement favor one factor over another
5	Strong or essential importance of one over another	Experience and judgement strongly favor one factor over another
7	Very strong importance of one over another	A factor is strongly favored and its dominance demonstrated in practice
9	Extreme importance of one over another	The evidence favoring one factor over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed

After obtaining the pairwise comparison matrix model, basic matrix algebra is used to derive a weight in the form of eigenvalue and eigen vector. The matrix is then translated to decimals and squared. The rows of the square matrices is then totaled and normalized.



Consistency Index and Consistency Ratio should be used to assess whether a pairwise comparison of two sets of data is consistent and contains the fewest contradicting findings. In a procedure that is somewhat autonomous from the weighing of criteria, the quantitative rating should be applied to the parameters of alternatives. This method, aims to translate qualitative elements of the parameter into quantitative ones so that prioritizing calculations may be performed. After calculating the global weight and getting the quantitative rating, the next step is to acquire the ranking of the alternative in the format of a prioritization index by multiplied the combined record for each sub-criteria by its associated quantitative rating, and then summing the results.

## BUSINESS SOLUTION

Indonesia's Energy Diversification Strategy aims to diversify the country's energy supply by developing and implementing renewable energy projects. There are three Renewable Energy Project possibilities to prioritize: geothermal projects, carbon capture utilization and storage, and decarbonization/emission reduction. These alternatives have been examined in this study because they are already known and implemented in Indonesia's energy policy.

## GEOTHERMAL PROJECTS

Geothermal energy is the heat generated by global geological processes inside the Earth. Depending on the nature of the geothermal resource, steam turbines and binary plants are often used to produce energy. Conventional steam turbines need fluid temperatures of at least 150 °C and may be supplied with atmospheric (back-pressure) or condensing exhausts.

Geothermal district heating systems are expensive to install, but running expenses are lower than in conventional systems. The thermal load density, or the district's heat demand divided by its land area, is a crucial factor in determining the initial cost of the system. In climate-permissive places, combining heating and cooling might be economically advantageous. A resource-plant system (geothermal power facility) consists of geothermal wells, pipelines transporting geothermal fluids, a utilization plant, and, in certain instances, a re-injection system. The distance between the resource and the consumption location should be minimized to the greatest extent feasible. Adopting integrated systems with a higher utilization factor may result in significant cost savings.

## CARBON CAPTURE STORAGE AND UTILIZATION PROJECTS

Carbon capture, utilization, and storage (CCUS) is a series of approaches for keeping carbon dioxide from entering the environment. The burning of fossil fuels, as well as other industrial processes like cement or steel manufacture, emit carbon dioxide. To extract it in concentrated form, a number of capture processes are utilized. The carbon dioxide may thereafter be stored or used. Carbon dioxide gas is often compressed for pipeline transport. At pressures greater than 74 atmospheres, it enters the dense phase, which has the density of a liquid but the compressibility and viscosity of a gas. Northern Lights in Norway is creating an innovative technology that will enable emissions from around Europe to be collected by truck and transported to ports.

## DECARBONIZATION/ REDUCTION EMISSION IN OPERATION

Decarbonisation (also known as decarbonization across the Atlantic) is the process of lowering carbon dioxide (CO<sub>2</sub>) emissions in the atmosphere caused by human activities. The current (and optimistic) goal of decarbonisation is to eradicate CO<sub>2</sub> emissions. This project aims to detect and repair leaks as well as capture natural gas from hydraulically fractured oil and gas wells.

## SELECTED CRITERIA AND SUB-CRITERIA

The first primary data that will be collected before building the AHP hierarchy structure is an initial survey referring to the proposed initial criteria and sub-criteria of project prioritization.



## EXPERTS FOR PAIRWISE COMPARISON

Experts are selected by Merah Delima based on relevance to the topic of research, level of competence and length of experience. This is purposed so survey results will be more thorough, removing potential biases in the AHP study. Senior middle management, middle management and junior management make up the experts.

No.	Position in Company	Experience (Year)	Quantity
1.	Country Business Dev. Manager	13	1
2.	Country Sr. Manager Directional Svcs	20	1
3.	Country Sr. Manager Wireline Perforating Svcs	17	1
4.	Country Sr. Manager Cementing Svcs	18	1
5.	Business Segment Manager	19	1
6.	Repair & Maintenance (R&M) Sr. Manager	24	1
7.	Account Manager	14	1
8.	Sr. Operation Manager Completion Svcs	18	1
9.	Field Service Quality Manager	10	1
10.	Global Technical Advisor Support	10	1
11.	Country Sr. Technical Advisor	21	1
12.	Country Legal Specialist	12	1
13.	Country Finance Manager	14	1
<b>TOTAL</b>			<b>13</b>

## PAIRWISE COMPARISON

The following process is to use pairwise comparison to determine the weighting of the criteria and implement the rating to each alternative's parameter, and measure the priority index. The priority index is calculated by multiplying the weight of each sub-criteria by the rating for its respective alternative's parameters..

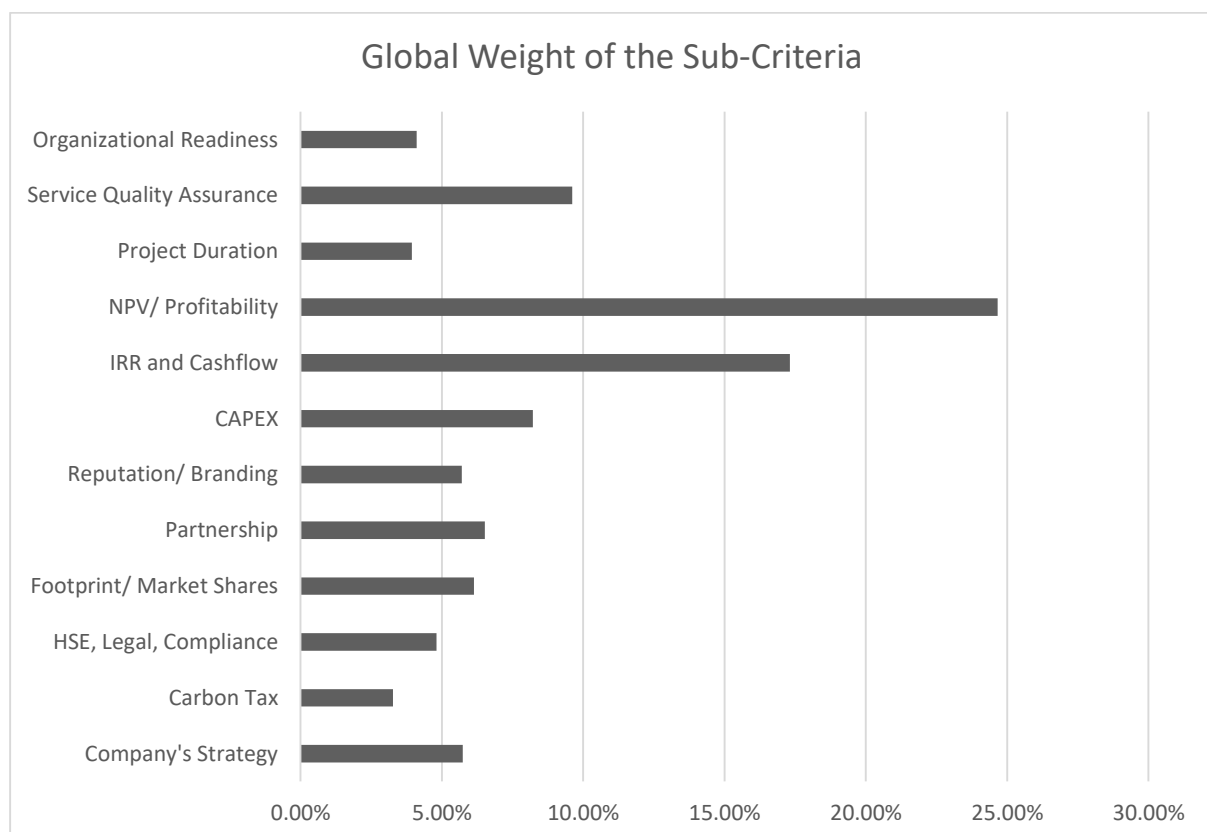


QUESTIONNAIRE																												
Main Criteria																												
	Extreme Importance									Equal									Extreme Importance									
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9											
Strategy and Governance																		Marketing and Sales										
Strategy and Governance																		Financial Feasibility										
Strategy and Governance																		Project Management/ Operation										
Marketing and Sales																		Financial Feasibility										
Marketing and Sales																		Project Management/ Operation										
Financial Feasibility																		Project Management/ Operation										
Sub Criteria Governance																												
	Extreme Importance									Equal									Extreme Importance									
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9											
Company's Strategy																		Carbon Tax										
Company's Strategy																		HSE, Legal, Compliance										
Carbon Tax																		HSE, Legal, Compliance										
Sub Criteria Marketing and Sales																												
	Extreme Importance									Equal									Extreme Importance									
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9											
Footprint/ Market Shares																		Partnership										
Footprint/ Market Shares																		Reputation/ Branding										
Partnership																		Reputation/ Branding										
Sub Criteria Financial Feasibility																												
	Extreme Importance									Equal									Extreme Importance									
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9											
CAPEX																		IRR and Cashflow										
CAPEX																		NPV/ Profitability										
IRR and Cashflow																		NPV/ Profitability										
Sub Criteria Project Management/ Operation																												
	Extreme Importance									Equal									Extreme Importance									
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9											
Project Duration																		Service Quality Assurance										
Project Duration																		Organizational Readiness/ Alignment										
Service Quality Assurance																		Organizational Readiness/ Alignment										

After computing the weights for each criterion and sub-criterion, the consistency of the results must be validated using the Consistency Ratio. According to the computation findings, all of the weights are consistent. The weight of the criteria and sub-criteria used in this analysis has been determined, as well as the global weight for each selection. In the future, the determined global weight will be included to the quantitative assessment for each choice. After obtaining all of the criterion weights, the next step is to increase the weight of each of the selected criteria by the sum of the weightings for each category plus their respective sub-sub-category.



No	Main Criteria Description	Main Weight	Criteria	Sub-Criteria Description	Sub-Criteria Weight	Global Weight
1.1	Strategy and Governance	13.81%		Company's Strategy	41.56%	5.74%
1.2		13.81%		Carbon Tax	23.64%	3.27%
1.3		13.81%		HSE, Legal, Compliance	34.80%	4.81%
2.1	Marketing and Sales	18.35%		Footprint/ Market Shares	33.41%	6.13%
2.2		18.35%		Partnership	35.49%	6.51%
2.3		18.35%		Reputation/ Branding	31.10%	5.71%
3.1	Financial Feasibility	50.19%		CAPEX	16.37%	8.22%
3.2		50.19%		IRR and Cashflow	34.49%	17.31%
3.3		50.19%		NPV/ Profitability	49.14%	24.66%
4.1	Project Management/ Operation	17.65%		Project Duration	22.30%	3.94%
4.2		17.65%		Service Quality Assurance	54.45%	9.61%
4.3		17.65%		Organizational Readiness	23.25%	4.10%
TOTAL						100.00%





### QUALITATIVE SCORING OF THE ALTERNATIVES

The rating of alternative is obtained by quantification and normalization. By utilize the normalized rating, which is obtained by comparing it to other alternatives scoring.

#### Geothermal Projects

	Qualitative	Quantitative	Normalized
Company's Strategy	The alternative is partially-aligned with Company's overall strategy for answering Renewable Energy challenges. 1st priority: Set footprint in the Country level (Indonesia), 2nd priority: operation stability, and 3rd: increasing footprint in Region Asia Pacific.	80	36.36%
Carbon Tax	The alternative able to meet above requirement and improve Carbon Tax strategy for Energy Company.	100	38.46%
HSE, Legal, Compliance	The alternative satisfies the regulation's mandatory request while causing no additional HSE issues.	100	45.45%
Footprint/ Market Shares	The alternative dominates the project footprint in Indonesia.	100	50.00%
Partnership	The alternative improves partnership with the existing Renewable Company and Oil & Gas Company.	60	42.86%
Reputation/Branding	The alternative improves corporate reputation up to regional stakeholders.	80	36.36%
CAPEX	The rating will be 80 if the Capex is between 50-200 million.	80	40.00%
IRR and Cashflow	Lower IRR compared to other alternatives.	60	30.00%
NPV/ Profitability	Higher Profitability compared to other alternatives.	80	44.44%
Project Duration	The duration is between 12-18 months.	60	37.50%
Service Quality Assurance	It contains moderate reliability, efficiency, and material availability, as well as a strong compliance to industry 4.0 component	80	33.33%
Organizational Readiness/ Alignment	The organization is prepared and ready to go, and the management team is fully committed.	100	45.45%

#### Carbon Capture Storage and Utilization

	Qualitative	Quantitative	Normalized
Company's Strategy	The alternative is partially-aligned with Company's overall strategy for answering Renewable Energy challenges. 1st priority: Set footprint in the Country level (Indonesia), 2nd priority: operation stability, and 3rd: increasing footprint in Region Asia Pacific.	80	36.36%
Carbon Tax	The alternative able to meet above requirement and improve Carbon Tax strategy for Energy Company.	100	38.46%
HSE, Legal, Compliance	The alternative satisfies the regulation's mandatory request but has some HSE consequences.	80	36.36%
Footprint/ Market Shares	The alternative being the third market leader in Indonesia.	60	30.00%





<b>Partnership</b>	The alternative improves partnership with the existing Renewable Company and Oil & Gas Company.	60	42.86%
<b>Reputation/Branding</b>	The alternative improves corporate reputation up to global stakeholders.	100	45.45%
<b>CAPEX</b>	The Capex is between 350-500 million.	40	20.00%
<b>IRR and Cashflow</b>	Higher IRR Compared to other alternatives.	80	40.00%
<b>NPV/ Profitability</b>	Lower Profitability compared to other alternatives.	40	22.22%
<b>Project Duration</b>	The duration is between 18-24 months.	80	50.00%
<b>Service Quality Assurance</b>	It contains moderate reliability, efficiency, and material availability, as well as a strong compliance to industry 4.0 component	80	33.33%
<b>Organizational Readiness/ Alignment</b>	The organization is prepared, but not well-prepared, and the management team is completely committed.	80	36.36%

#### Decarbonization/ Reducing Emission in Operation

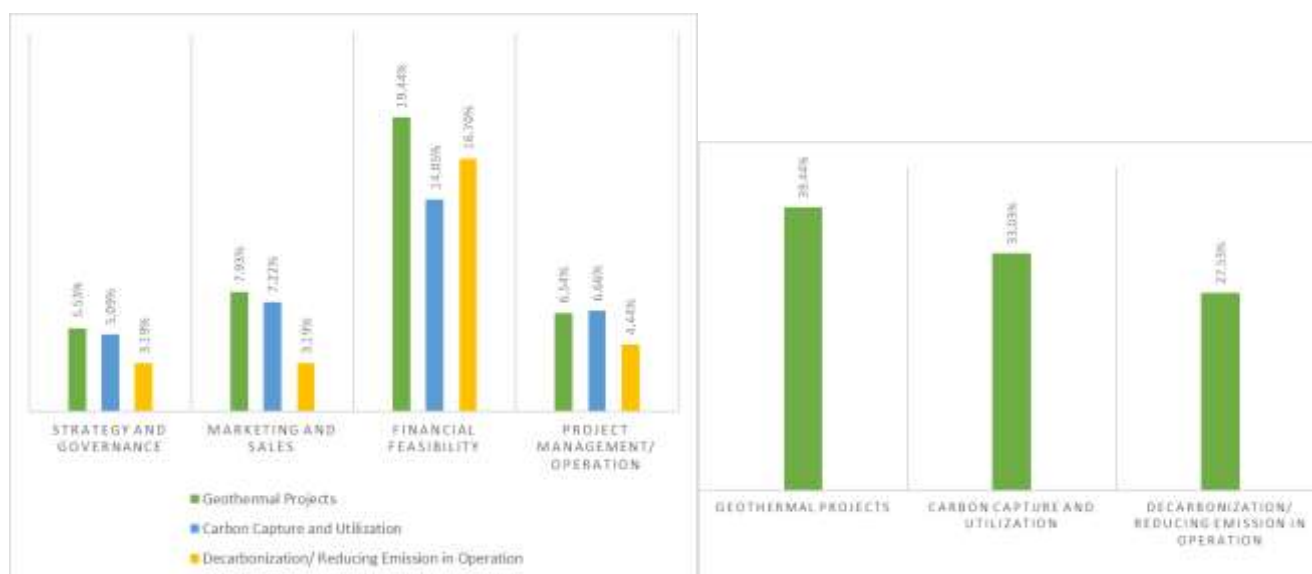
	<b>Qualitative</b>	<b>Quantitative</b>	<b>Normalized</b>
<b>Company's Strategy</b>	The alternative is partially-aligned with Company's overall strategy for answering Renewable Energy challenges. 1st priority: Set footprint in the Country level (Indonesia), 2nd priority: operation stability, and 3rd: increasing footprint in Region Asia Pacific.	60	27.27%
<b>Carbon Tax</b>	The alternative able to meet minimum requirement for Carbon Tax for Energy Company.	60	23.08%
<b>HSE, Legal, Compliance</b>	The alternative satisfies general regulation but has some HSE implications.	40	18.18%
<b>Footprint/ Market Shares</b>	The alternative set some Renewable Energy footprint in Indonesia	40	20.00%
<b>Partnership</b>	The alternative does not improve partnership with Oil & Gas Companies.	20	14.29%
<b>Reputation/Branding</b>	The alternative improves corporate reputation up to local stakeholders.	40	18.18%
<b>CAPEX</b>	The Capex is between 50-200 million.	80	40.00%
<b>IRR and Cashflow</b>	Lower IRR compared to other alternatives.	60	30.00%
<b>NPV/ Profitability</b>	On par profitability due to low cost required but not improved revenue.	60	33.33%
<b>Project Duration</b>	The duration is less than 6 months.	20	12.50%
<b>Service Quality Assurance</b>	It contains moderate reliability, efficiency, and material availability, as well as a strong compliance to industry 4.0 component	80	33.33%
<b>Organizational Readiness/ Alignment</b>	Although the organization is prepared and ready, the management team is not fully committed.	40	18.18%

## FINAL CALCULATION

According to the final calculation result, Geothermal Projects is ranked top with 39.44% of the prioritizing index, followed by Carbon Capture and Utilization Storage on 33.03%, and Decarbonization/Reducing Emissions in Operation in last position with 27.53%.

When selecting whether to undertake the priority project, management might take into account the following factors in addition to the aforementioned scenario and conversations with research experts:

- Geothermal Project should be considered if Merah Delima intends to achieve high margins with low capital expenditure. The strategy for retaining the market by removing new local players with a larger market share should also be prepared to ensure that the Geothermal market continues to grow and generate money.
- At the same time, Merah Delima must continue to improve in order to secure resources to carry out other Renewable Projects, in this instance Carbon Capture, Storage, and Utilization, which is the second priority and has a prioritization index similar to Geothermal Project but with a higher CAPEX. Overall, CCUS is a new market in Indonesia that has the potential to expand further based on the Indonesia Energy Diversification Plan.
- Decarbonization/Reducing Emissions in Operations is the least recommended option due to a plethora of unfavorable technical resource and commercial acumen data. To improve manufacturing costs and supply chain material balance, this project might be executed later in the corporate transformation horizon provided the business has gained sufficient finance, resources, and technical expertise.



## CONCLUSION AND RECOMMENDATION

The pairwise comparison, quantitative rating, and matrix algebra are used to develop an AHP-based decision support system in line with the Merah Delima project prioritization criteria. The following is the result of alternatively ranking various project prioritizations:

- Geothermal Project is the 1st priority with the score of 37.40%
- Carbon Capture Storage and Utilization is the 2nd priority with the score of 37.16%
- Decarbonization/Reduction Emission is the 3rd priority with the score of 25.44%.

Several suggestions may be made as the management implication to further exercise the business solution by monitoring the dynamics of project prioritizing problem-solving:



- The choice of Geothermal Project is aligned with the organizational strategy and the AHP-based decision-making outcome. Certain extra marketing techniques to ensure market captive and product acceptance must be devised to boost the execution phase.
- In terms of the future potential CCUS market, the corporation should spend more CAPEX to CCUS in order to strengthen its market leadership.
- Merah Delima's decision to execute either CCUS or Decarbonization should be accompanied with advancements in technology and Project Management alignment.

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