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Management of the Energy Sector and Coal Phase-Out in East Java Province to Support the State Defense

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Abstract:- Indonesia is an island country with a strategic location and huge natural resource potential. National resources are critical to meeting energy needs and maintaining national resilience. One of them is East Java, a province in the east of Java Island, with an area of 47,803.49 square kilometers and a population of 40,665,696 by the end of 2020. East Java has quite rich potential energy resources, etc.; geothermal (PLTP), hydropower (PLTA/PLTMH), wind (PLTB), trash (PLTSa), solar energy (PLTS), ocean currents (PLTAL) and biomass (PLTBm). Coal emissions have a large amount of carbon emissions. The use of new energy and renewable energy as environmentally friendly energy is the need to eliminate PLTU, suspend the development of PLTU, and improve the technical efficiency of low-carbon PLTU (co-firing) Net zero emissions. Gain knowledge of energy management for East Java's economy and emissions reduction, as well as prioritizing strategic knowledge related to EBT management in support of defense. The methods used are econometric method and SWOT method. This study found that government efforts to phase out, deploy low-carbon technologies (co-firing with coal), and EBT had a significant impact on global emissions reduction targets. EBT must be used as a form of national defense in the energy sector and protected by law. NRE is the energy of the future, plentiful and sustainable, environmentally friendly, and the only alternative energy source to maintain energy security and energy independence. The methods used are econometric method and SWOT method. This study found that government efforts to phase out, deploy low-carbon technologies (co-firing with coal), and EBT had a significant impact on global emissions reduction targets. EBT must be used as a form of national defense in the energy sector and protected by law. New Renewable Energy (NRE) is the energy of the future, plentiful and sustainable, environmentally friendly, and the only alternative energy source to maintain energy security and energy independence. The methods used are econometric method and SWOT method. This study found that government efforts to phase out, deploy low-carbon technologies (co-firing with coal), and EBT had a significant impact on global emissions reduction targets. EBT must be used as a form of national defense in the energy sector and protected by law. NRE is the energy of the future, plentiful and sustainable, environmentally friendly, and the only alternative energy source to maintain energy security and energy independence.

Keywords:- *Management, NRE , Coal, Phase-out, Econometric, SWOT.*

I. INTRODUCTION

Indonesia is an archipelagic country and has a strategic location with abundant natural resource potential, national resources are indispensable in meeting energy needs and maintaining national resilience. However, until now the fulfillment of national energy needs is still dominated by the use of fossil fuels, one of the centers for energy fulfillment is in East Java, namely the Java-Bali Power Plant which is managed by PLN.

East Java is a province in the eastern part of Java Island with an area of 47,803.49 km², and a population of 40,665,696 people at the end of 2020. (BPS, 2021)

The electricity infrastructure in East Java is still dominated by Steam Power Plants (PLTU) which are mainly fueled by coal. East Java has a projected electricity consumption of 35.838 GWh, which comes from various sectors, including the industrial sector at 44%, households at 37%, and trade/business at 13%. With available power of 9.522 MW and peak load of only 5.939 MW, so that electricity can still be used to supply 523.23 MW to Central Java and 56.62 MW to Bali. Although the supply of PLTU reaches to Java and Bali, the electrification ratio of East Java in 2021 has not yet reached 100%, the electrification ratio of East Java has only reached 99.07%, the ratio is relatively low compared to the provinces in Central Java and West Java. (ESDM, 2022)

Management of the energy sector in meeting national energy needs is an effort to encourage energy independence and the Indonesian economy, especially East Java and to support energy security in the national defense effort, this is something that needs to be considered consideringEast Java has a large potential for energy resources, including: Geothermal Power Plant (PLTP), Hydro/Micro Hydro Power Plant (PLTA/PLTMH), Wind Power Plant (PLTB), Waste Power Plant (PLTSa).), Solar Power Plant (PLTS), Marine Power Plant (PLTAL) and Biomass Power Plant(PLTBm). (ESDM, 2021)

Map 1: (EMR Onemap, East Java EBT Potential 2021)

Indonesia's Primary Energy Mix is still dominated by fossil energy, coal dominates the share of national energy use. However, the carbon emission released by coal is very large, the utilization of New and Renewable Energy as an environmentally friendly source is still low to date. Meanwhile, East Java's carbon emissions in 2021 will reach 99,760,400 tons of CO2e.

The PLTU Phasing Out plan, a moratorium on PLTU development, and increasing technological efficiency in low-carbon PLTU or mixing main raw materials with biomass (Co-Firing) launched by EBTKE will be able to contribute to reducing emissions in the power generation sector based on the right regulatory design. so that it is carried out according to the EBTKE plan for the PLTU phase out until 2060. (EBTKE, 2021)

The holding of COP 26 on November 2, 2021, Indonesia is committed to being able to contribute more quickly to realizing the World's Net Zero Emissions, with that required alternative energy to support Indonesia's energy transition roadmap towards Net Zero Emission 2060, where EBT reaches 100% which is dominated by PLTS, Hydro, wind and all infrastructure are based on electricity, thereby reducing emissions of 1,526 million tons of CO2. (EBTKE, 2021)

II. RESEARCH METHODS

The method used in this research is the econometric approach and the SWOT approach. The econometric approach is to determine the significance of policies that have been implemented until 2021. Meanwhile, the SWOT approach is carried out to determine future energy development decision strategies by considering internal and external criteria.

III. ECONOMETRIC MODEL

The method in this research is the econometric model using the Full Modified ordinary least square (FMOLS) in accordance with the Granger causality test theory (Saidi, 2020). The sample period taken in this study was for the last 10 years, namely 2011-2021 with the locus of East Java Province, the State of Indonesia. The test was carried out in two stages, first, to determine the effect of Renewable Energy Development on East Java's Economic Growth. The second is the effect of renewable energy development on reducing greenhouse gas emissions. More focused on emissions, the measured emissions are Greenhouse Gas emissions from the energy industry sector.

IV. RESULTS AND DISCUSSION OF ECONOMETRIC MODELS

The first discussion is to determine the effect of Renewable Energy Development on East Java's Economic Growth which can be simplified by the following function:

Economic Growth Function:
Yt = f(ETt , TKt)

According to the Granger causality test theory, it can be converted into the following function:

$$LnY_{it} = {}_0 + {}_1 LnET_{it} + {}_2 LnTK_{it} + e_{it}$$

Where Y is the Economic Growth of East Java Province, ET is Renewable Energy, and TK is the workforce.

Coefficient*lnNET*and*LnTK*have the same interpretation, so that when the use of renewable energy and labor increases by 1%, the total output value will increase by 1% and 2%, respectively.

The second discussion is to determine the effect of Renewable Energy Development on reducing greenhouse gas emissions in East Java Province which can be simplified with the following function:

GHG Emission Function:
Emission = f(Yt; ETt)

According to the Granger causality test theory, it can be converted into the following function:

$$LnEmisit = 0 + 1LnYit + 2LnETit + eit$$

Where Emission is East Java Province Greenhouse Gas Emission, Y is East Java Province Economic Growth, ET is Renewable Energy.

CoefficientlnY and LnET have the same interpretation, so that when the use of renewable energy and labor increases by 1%, the total output value will increase by1% and2%.

The analysis in this study used multiple linear regression, so that a basic test was carried out on the variables used. As described by Gujarati (2008), the test must meet the basic assumptions that must be met to produce the BLUE (Best Linear Unbiased Estimator) parameter. The BLUE assumptions in question are a) the expected mean value is zero, b) the variance still exists (homoscedasticity), c) there is no relationship between the independent variable and the error term, d) there is no relationship between the error (no autocorrelation), e) there is no multicollinearity occurs.

The first test that was carried out was the Normality Test with P-plot and Kolmogorov-Smirnov.

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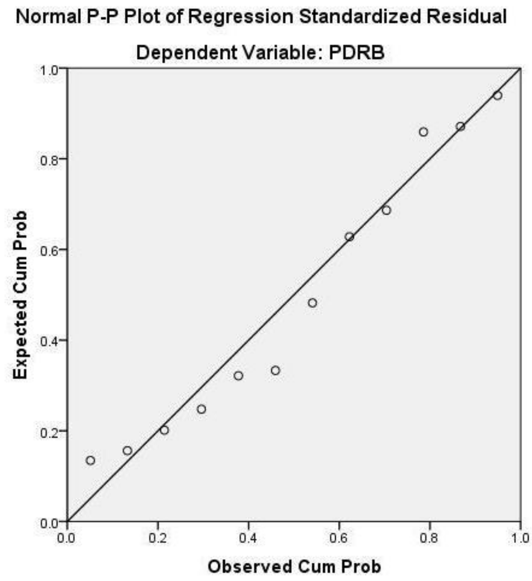
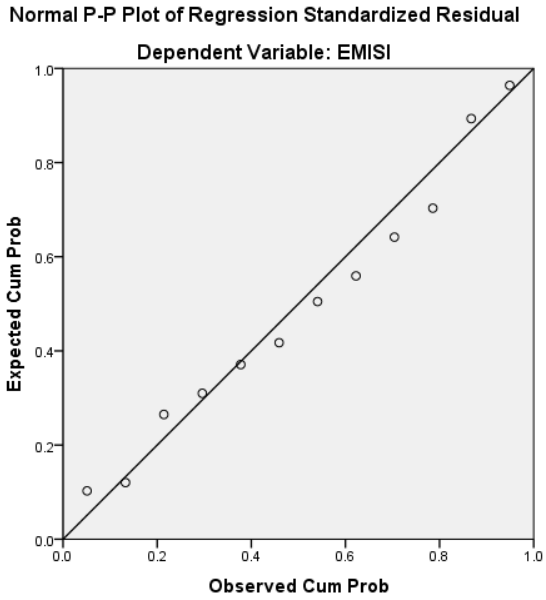


Graph 1: Normality Test with P-Plot on economic growth variables



Graph 2: Normality Test with P-Plot on Emission variable

The regression on economic growth can be seen in graph 1. In graph 1 it can be seen that there are points approaching the diagonal line, according to the provisions of the normality test, it can be said that the data used are normal. The same is true for the regression on GHG emission reductions. It can be seen in graph 2 that the points approach the diagonal line and it can be said that the data used is normal.

In the Kolmogorov-Smirnov normality test, the results can be seen in graph 3. Asymp value. Sig. (2-tailed) where the condition for passing the normality test is the Asymp value. Sig. (2-tailed) > 0.05. In the test of economic growth, it is known that Asymp. Sig. (2-tailed) of 0.200, so it can be said that the data is normal.

Likewise, the test for reducing GHG emissions in graph 4 is known as Asymp. Sig. (2-tailed) of 0.200, so it can be said that the data is normal.

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		12
Normal Parameters^{a,b}	Mean	.0000000
	Std. Deviation	.06172996
Most Extreme Differences	Absolute	.183
	Positive	.183
	Negative	-.133
Test Statistic		.183
Asymp. Sig. (2-tailed)		.200^{c,d}

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.

Graph 3: Kolmogorov-Smirnov normality test on the variable economic growth

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		12
Normal Parameters^{a,b}	Mean	.0000000
	Std. Deviation	.10032173
Most Extreme Differences	Absolute	.111
	Positive	.111
	Negative	-.082
Test Statistic		.111
Asymp. Sig. (2-tailed)		.200^{c,d}

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.

Graph 4: Kolmogorov-Smirnov normality test on emission variables

The second test carried out is Multi collinearity with VIF test and Tolerance. Its function is to detect the relationship between independent variables.

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-78.651	21.012		-3.743	.005		
	ET	.000	.000	-.705	-1.965	.081	.101	9.888
	TK	6.205	1.408	1.581	4.407	.002	.101	9.888

a. Dependent Variable: PDRB

Graph 5: Multicollinearity Test VIF and Tolerance on variable economic growth

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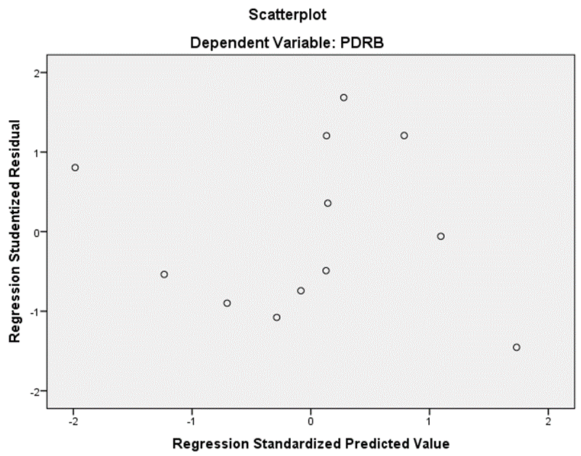
Coefficients[a]							
Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
(Constant)	-1.509	3.900		-.387	.708		
PDRB	.433	.279	.376	1.550	.155	.427	2.341
ET	.000	.000	.560	2.308	.046	.427	2.341

a. Dependent Variable: EMISI

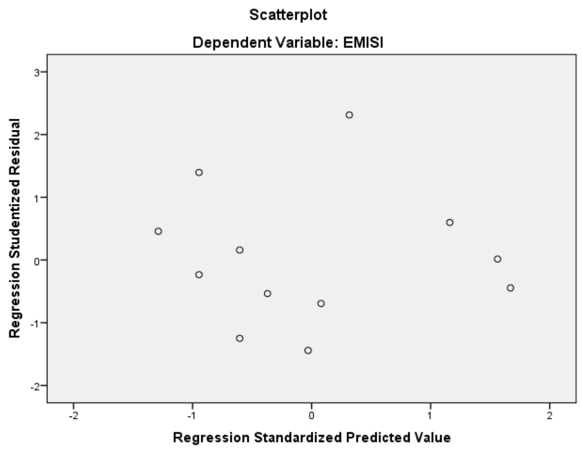
Graph 6: V . Multicollinearity Test IF and Tolerance on variable emission

In the multicollinearity test, the conditions that must be met in order to pass the test are the VIF value which must be greater than 0.1 (VIF > 0.1) and the tolerance value is less than 10 (Tolerance <10). In this study, it can be seen in Tables 5 and 6 that the VIF value for the economic growth variable is 9,888 for each independent variable and the VIF for the emission variable is 2,341 for each independent variable. Thus it can be seen that the relationship between the independent variables does not exist.

The third test is Heteroscedasticity using Scatter Plot.



Graph 7: Scatter-plot Heteroscedasticity Test on economic growth variables



Graph 8: Scatter-plot Heteroscedasticity Test on the variable on the emission variable

In scatter plot analysis, the requirement to pass the test seen from the points must be randomly distributed, not forming a certain pattern and not piling up.

The last test in this first discussion is the Autocorrelation Test with the Runs Test.

Runs Test	
	Unstandardized Residual
Test Value[a]	-.01625
Cases < Test Value	6
Cases >= Test Value	6
Total Cases	12
Number of Runs	4
Z	-1.514
Asymp. Sig. (2-tailed)	.130

a. Median

Graph 9: Runs Test autocorrelation test on economic growth variables

Runs Test	
	Unstandardized Residual
Test Value[a]	-.01091
Cases < Test Value	6
Cases >= Test Value	6
Total Cases	12
Number of Runs	6
Z	-.303
Asymp. Sig. (2-tailed)	.762

a. Median

Graph 10: Runs Test autocorrelation test on variables on emission variables

The condition for passing the runs test is if the Asymp value. Sig. greater than 0.05 (Asymp. Sig. >0.05). In graph 9 and graph 10 it can be seen that Asymp. Sig. (2-tailed) has a value of 0.130 and 0.762 which means it is greater than 0.05 which means it passes the autocorrelation test.

The regression results from the first discussion can be described as follows:

Y_i= -78,651+0.000ET+6,205TK+ e
(tstat= -1.96) (tstat=4.4)
R2: 0.88 Adj R2=0.85 F=33.9

From the equation, it is known that the constant of -78.651 can be interpreted that if all independent variables are equal to 0 (zero), then economic growth in the East Java Province will have a value of -78.651. Then the coefficient of TK is 6.205, meaning that for every additional 1 unit of power, economic income will increase by 6.205 units.

From this output, the R2 value is 0.88. This value is defined that the regression model is able to explain or represent 88% of the data variation.

Researchers tested the hypothesis to see whether statistically the use of NRE energy in that period affected economic growth in East Java Province.

The first hypothesis test was conducted. The initial hypothesis was that the development of NRE did not significantly affect the economic productivity of East Java Province. The final hypothesis of NRE development significantly affects the economic productivity of East Java Province.

The condition for rejection is = 5%, then the critical area for rejecting H0 is t < -1.96 and t > 1.96. In this study t-stat = -1.96, because t-stat < 1.96, then H0 is acceptedand H1 is rejected. So it can be concluded with a 95% confidence level, it can be stated statistically, that the development of EBT does not significantly affect the economic productivity of East Java Province.

The second hypothesis test was carried out with the initial hypothesis that labor did not significantly affect the economic productivity of East Java Province. The final hypothesis of labor significantly affects the economic productivity of East Java Province.

The rejection requirement is that is 5%, then the critical area for rejecting H0 is the t-stat value less than -1.96 and the t-stat value greater than 1.96. In the regression results, the t-stat value is 4.4, because the t-stat is greater than 1.96, then H0 is rejectedand H1 is accepted. Thus it can be said that with a 95% confidence level, it can be stated statistically, that Labor significantly affects the economic productivity of East Java Province.

The regression results from the second discussion can be described as follows:

Emission = -1.509 + 0.433Y + 0.00ET + e
(tstat=1.55) (tstat=2,3)
R2: 0.77 Adj R2=0.72 F=15.3

From the equation it is known that the constant of-*1.509*it can be interpreted that if all independent variables are equal to zero, then emissions in the East Java Province will have a value of-*1.509*. Then the coefficient Y has a value of*0.433*, it can be said that for every additional 1 unit of power, economic income will increase by*0.433*unit.

From this output, the R2 value is 0.77. This value is defined that the regression model is able to explain or represent 77% of the data variation.

Researchers tested the hypothesis to see whether statistically Economic Growth and NRE development and during that period affected GHG reduction in East Java Province.

The first hypothesis test was conducted. The initial hypothesis is that economic growth does not significantly affect the reduction of GHG emissions in East Java Province. The final hypothesis of economic growth significantly affects the reduction of GHG emissions in East Java Province.

The condition for rejection is = 5%, then the critical area for rejecting H0 is t-stat less than -1.96 and t-stat greater than 1.96. In this study, the t-stat is 2.3, because the t-stat is greater than 1.96,then H0 is rejectedand H1 is accepted. So it can be concluded with a 95% confidence level that it can be stated statistically that economic growth significantly affects the reduction of GHG emissions in East Java Province.

The second hypothesis test was carried out. The initial hypothesis was that the development of NRE did not significantly affect the reduction of GHG emissions in East Java Province. The final hypothesis is that the development of renewable energy will significantly reduce GHG emissions in East Java Province.

The condition for rejection is = 5%, then the critical area for rejecting H0 is t < -1.96 and t > 1.96. t-stat = 2,3, because t-stat > 1.96, then H0 is rejectedand H1 is accepted. So it can be concluded with a 95% confidence level that it can be stated statistically, that NRE development significantly affects GHG Emission Reduction in East Java Province.

In the first discussion, it is known that the development of NRE does not significantly affect the economic productivity of East Java Province, it can be used as a strategy in determining the decision to develop NRE in East Java through a SWOT analysis and is categorized as a threat.

Meanwhile, in the second discussion, it is known that the development of EBT significantly affects the reduction of GHG emissions in East Java Province, which can be used as a strategy in determining the decision to develop EBT in East Java through a SWOT analysis and is categorized as an opportunity.

V. SWOT ANALYSIS

A SWOT analysis is carried out to find out priority strategies related to NRE management to support national defense which is formulated into four aspects, namely, strengths, weaknesses, opportunities and threats. Aspects of strengths and weaknesses come from the internal conditions of NRE in East Java Province. Meanwhile, the opportunities and aspects come from external conditions of NRE development in East Java Province.

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VI. RESULTS AND DISCUSSION

The following is the result of the SWOT analysis formulation as outlined in the table.

STRENGTHS				
No.	Faktor Internal	Bobot	Rating	Skor
1	Potensi EBT sebesar 24.420MW (Objek Vital Pertahanan Negara)	0,13	5	0,65
2	SDM terlatih	0,08	2	0,16
3	Konsumen Banyak (Industri dan Masyarakat)	0,08	2	0,16
4	Punya lahan luas	0,12	4	0,48
5	Sangat diterima oleh masyarakat	0,09	3	0,27
	Jumlah Strengths	0,5		1,72

WEAKNESSES				
No.	Faktor Internal	Bobot	Rating	Skor
1	Regulasi EBT belum rampung	0,15	1	0,15
2	Teknologi Mahal	0,07	3	0,21
3	Interkoneksi terbatas	0,08	4	0,32
4	Anggaran tidak mencukupi	0,07	3	0,21
5	Investor kurang tertarik	0,13	2	0,26
	Jumlah Weaknesses	0,5		1,15
	Total IFAS	1		
	S-W			0,57

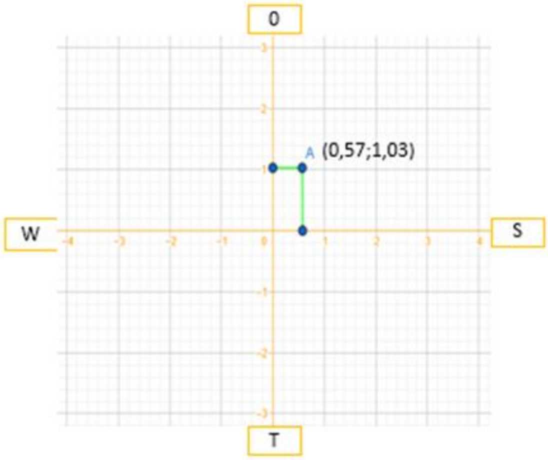
OPPORTUNITIES				
No.	Faktor Eksternal	Bobot	Rating	Skor
1	Pengembangan EBT menambah income	0,12	5	0,6
2	Energi Terbaharukan SIGNIFIKAN mengurangi GRK	0,12	5	0,6
3	Insentif Pemerintah dalam mendukung EBT	0,08	3	0,24
4	Membuka lapangan kerja	0,07	2	0,14
5	Transisi teknologi	0,11	4	0,44
	Jumlah Opportunities	0,5		2,02

THREATS				
No.	Faktor Eksternal	Bobot	Rating	Skor
1	Target Phase out (cofiring) batubara signifikan meningkatkan perekonomian Jatim	0,1	2	0,2
2	Target Penurunan Emisi GRK 34 juta tCO2eq	0,09	3	0,27
3	Meningkatkan Ratio Elektrifikasi di Jatim	0,12	1	0,12
4	Target Net Zero Emision 2060	0,07	4	0,28
5	Pengurangan PLTU	0,12	1	0,12
	Jumlah Threats	0,5		0,99
	Total EFAS	1		
	O-T			1,03

The table above shows the results of the weighting of each strategy formulated based on the results of the FGD and Literature Studies related to the development of NRE in East Java Province. Based on the first table shows the difference between the strength and weakness factors get a value of 0.57 where the strength value is 1.72 while the weakness value is 1.15. This means that the strength factor can be used as a reference in the development of NRE in East Java Province. This value is also supported by a factor that states the potential of NRE is 24,420 MW.

On external factors, the difference between opportunities and threats produces a value of 1.03 which consists of an opportunity value of 2.02 and a challenge value of 0.99. This shows that the opportunity for the development of NRE is very influential in increasing the income of the East Java Province. And the biggest threat is increasing the electrification ratio in East Java and the PLTU Phase Out.

Next, the researcher draws a SWOT diagram on the Cartesian plane. It should be noted that the X axis shows the relationship between strengths and weaknesses, while the Y axis shows the relationship between opportunities and challenges. The value (x, y) obtained is based on the calculation of IFAS and EFAS. The following is a SWOT diagram that has been made.



Based on the diagram above, it shows that the potential for NRE development in East Java is in quadrant 1, which means it has a strong position and has many opportunities. So it is recommended to use a progressive or growth strategy.

The progressive or growth strategy in question is the East Java regional government's steps to be able to develop, expand and enlarge the maximum NRE growth through:

- Increased development of power plants from NRE (land, technology, capital, incentives)
- Increasing the potential of Human Resources for EBT management in East Java.
- The central government and local governments must synergize in resolving the problem of regulating the development of PLT from EBT because the industry's potential is growing rapidly and will have a large economic impact as well.

VII. CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

The main conclusions of this research can be described in 3 parts, namely: First, the government's efforts with Phase out, the use of low-carbon technology (coal co-firing) and NRE have had a significant effect on the world's emission reduction targets. The second is the use of NRE as a form of state defense from the energy sector, so it must be utilized and protected under the legal umbrella. Third, NRE is future energy that is abundant and environmentally friendly and is an alternative energy source to maintain energy security and energy independence.

The main recommendations from this research include: first, Expert Judgment and further research is needed to determine the most suitable type of EBT (Air, Wind, Solar, etc.) to support a large economy for East Java Province (AHP Method or QSPM method)

Second is the need for further analysis of alternative EBT power plants by considering the 4A + 1S criteria (availability, accessibility, affordability, acceptability, and sustainability).

Third, East Java's energy potential is very large, but it must be managed properly for development and community welfare.

Lastly is the need for a more optimal and realistic review of the Phase out plan with strong legal support so that it can be carried out by Business Entities to support the energy transition to Net Zero Emission 206.

Limitations related to this research include that the econometric model used in provincial coverage is due to inadequate district/city data.

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