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SHORT-TERM FORECAST FOR THE GROWTH OF INDONESIA'S NEW RENEWABLE ENERGY USING THE ADAPTIVE NEURO-FUZZY INFERENCE SYSTEM

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ABSTRACT- Electric power plants always use fossil fuels such as coal, oil, etc. However, the fossil fuel supply in Indonesia is decreasing from year to year. This causes power plants to be powered by using fuels that will not run out, such as solar Energy, water, wind, and others. Solar Energy, water, wind, and others are Alternative Energy or can also be called New and Renewable Energy. To guarantee a power plant powered by alternative Energy, it must be analyzed regarding the growth of new and renewable Energy. The method used in analyzing the development of new and renewable Energy is the Adaptive Neuro Fuzzy Inference System Method.MW or 0.599%. This result has increased yearly in Indonesia's new and renewable energy growth.

Keywords: ANFIS, Forecasting, Energy.

1. INTRODUCTION

Energy is needed for human, financial, family, modern, business, and transportation activities. Most of the world's energy supply comes from petroleum products which are an inexhaustible asset. Energy needs are relied upon to continue to grow while saving sources of oil, and coal is increasingly being depleted[1]. In addition, using petroleum products as Energy adds to the abundance of carbon in the environment, which causes harmful damage to the atmosphere[2]. In addition to this, fossil energy can also drive a power plant. Therefore, the Indonesian government, especially under the auspices of the Ministry of Energy and Mineral Resources, has advocated and indicated that electricity generation must be driven other than fossil energy. This Energy is called new and renewable Energy. New and renewable energy (EBT) is an alternative to energy supply because it has a low impact on ecological damage and guarantees energy preservation for what will come. To meet the collection of power plants, new and renewable energy growth must be analyzed in the short, medium, and long term. In this case, we also have to know the use of fossil energy in the past.

2. RESEARCH CONTENT

Indonesia has a variety of fossil and renewable energy resources. Coal, petroleum, flammable gas, and coal methane gas (CBM) are potential fossil energy. In contrast, the potential for environmentally friendly Energy includes geothermal, large-scale water, mini-hydro, biomass, wind, solar-oriented, marine, and thermal. Strength. Coal assets increased by 105.2 billion tons in 2010, according to data from the Ministry of Energy and Mineral Resources, with reserves of 21.1 billion tons, mainly in Kalimantan and Sumatra. The amount of oil stored is estimated at 7.76 billion barrels, and the amount of gas fuel stored is 157.14 TSCF, spread over most of the Natuna Islands, South Sumatra, East Kalimantan, and Tangguh (West Papua)[3]. With 453.3 TSCF, CBM gas savings are seen as more significant than conventional gas storage, particularly in the South Sumatra and Kutai Basin. Geothermal storage is expected to have total assets of 29,038 MW and a value of 15,867 MW in various districts. According to the 1983 review, 75,000 MW of enormous hydro potential was covered, which was repeated in the 1993 review. However, according to the 2011 Nippon Koei concentrate report, the coverage of colossal hydro potential was 26,321 MW, which includes 4,338 MW of activity. Previously implemented, and 5,956 MW of projects have been prepared and are being developed. And a new capacity of 16,027 MW. Mini hydro, biomass, solar-oriented, wind, and ocean Energy are additional accessible sustainable resources[4]. Mini-hydro energy potential is 500 MWe, 49,810 MWe for biomass, 4.80 kWh/m2/day for solar-oriented systems, 9,290 MWe for wind, and 240 GWe for marine systems.[5].

2.1 Adaptive Neuro Fuzzy Inference System

The neuro-Fuzzy System with the structure of ANFIS (Adaptive Neuro Fuzzy Inference System or Adaptive Network-based Fuzzy Inference System) is remembered for artificial neural networks but considering its capacity with fuzzy inference systems. Within the Neuro Fuzzy framework, the learning system resides in a neural organization with various

combinations of helpful information to refresh the boundaries of the Fuzzy Inference System.

The information, ANFIS boundaries, and exam information used for the learning system (preparation) are all from the ANFIS preparation period. Learning interactions on this information are then carried out so that other results are by the expected results. Half-breed learning computation is used in a setup with ANFIS. It includes a Least-Squares Error (LSE) strategy to guarantee initial values and Error Backpropagation (EBP) and retrogressive slope descent to calculate the error in each layer. Five layers make up ANFIS[6]. The fuzzification interactions form the primary layer. In this interaction, information and information targets are plotted according to their level of participation. The derivation cycle, which uses Sugeno's deduction to determine better guidelines for how results will be handled in subsequent estimates, is completed in the second and third layers. LSE is used to complete the value investigation process at layer 4. Coating 4 experiences a second rundown cycle at layer 5. Fuzzy system inference (FIS) in ANFIS can be found in layers 1, 2, 3, and 4. FIS is the determinant of neural network hubs[7].

The backward current calculation follows the forward current count to determine the error value for each layer and change the information limit value through the slope. The previous computational interaction will be repeated until the error value reaches the highest error value that is not determined. The interaction flow in the ANFIS framework consists of five layers and is described in Figure 1.

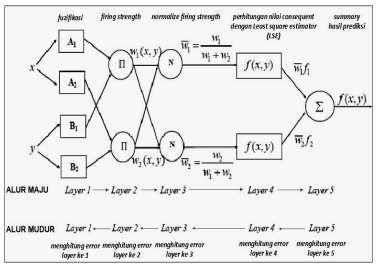

Figure 1. ANFIS structure
(Source: Own Results)

After getting the final result, it will look for the error value in the final result using the formula:

$$MAPE=\frac{\sum\frac{a-b}{a}}{n}x$$

100 %.....1

Where :
a = Actual data;
b = Prediction data results;
c = Estimated number of years.

The process of carrying out this research will be explained in Figure 2.

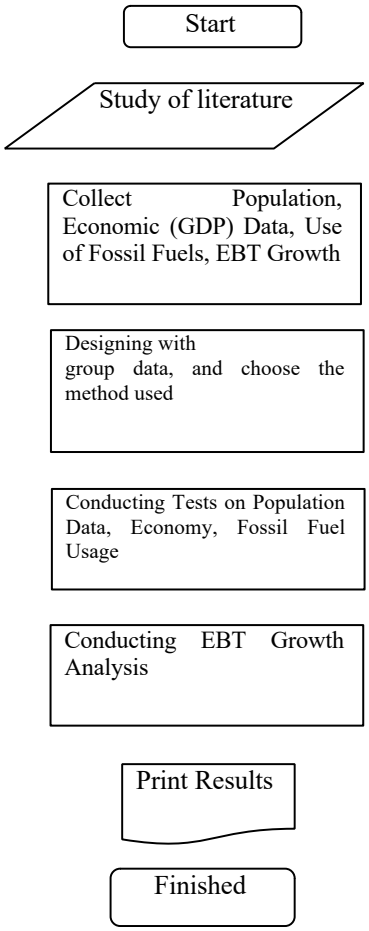

Figure 2. Research Flowchart
(Source: Own Results)

3. CONCLUSION

The research data obtained from the Indonesian Central Bureau of Statistics and the Ministry of Energy and Mineral Resources can be seen in tables 1,2,3, and 4.

Table 1. Population Growth Data in Indonesia
(Source: Central Bureau of Statistics)

Year	Number of Population (Million People)
2016	258,49
2017	261.33
2018	264,16
2019	266.91
2020	269.60
2021	271.60

Table 2. 2010 Constant Price GDP Economic Growth Data in Indonesia (Source: Central Bureau of Statistics)

Year	Total HK GDP 2010 (Trillion Rupiah)
2016	9433,0
2017	9813,3
2018	10211.5

2019	10615,1
2020	11010,1
2021	11890,2

Table 3. Fossil Fuel Usage Growth Data (Central Bureau of Statistics)

Year	Total Use of Fossil Fuels (Million TOE)
2016	67,41
2017	72,13
2018	77,18
2019	82.58
2020	88.36
2021	91.45

Table 4. Indonesia EBT Growth Data (Source: RUPTL PT. PLN (Persero))

Year	New Renewable Energy (MW)
2016	312
2017	632
2018	512
2019	560
2020	933
2021	1251

1. Results of Indonesia's New Renewable Energy Short-Term Growth Forecast

When entering data into the ANFIS program for testing, it will form a block diagram of an adaptive neuro-fuzzy inference system. Can be seen in figure 3.

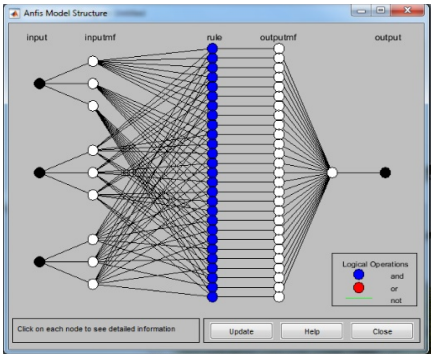

Figure 3. Structure of the adaptive neuro-fuzzy inference system
(Source: Own Results)

Figure 3 shows that the adaptive neuro-fuzzy inference system produces many nodes: 78, many linear parameters: 27, some nonlinear parameters: 27, a total number of parameters: 54, many training data pairs: 5, the number of checking data pairs: 0, the fuzzy number rules: 27. Fuzzy rules can be seen in Figure 4.

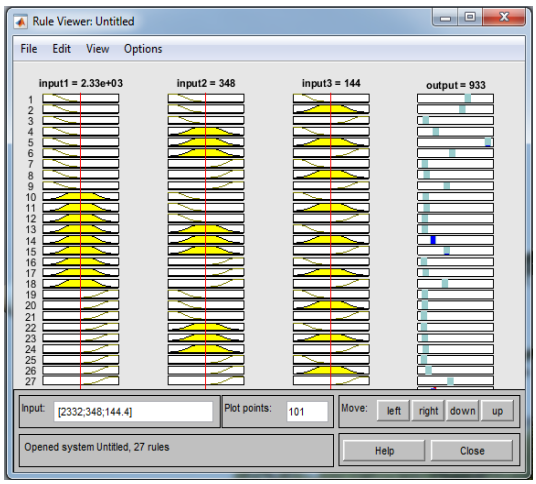

Figure 4. Fuzzy Rules
(Source: Own Results)

In Figure 4, the fuzzy rules show that there are 27 rules formed from testing data on the growth of new and renewable Energy in Indonesia. Of the 27 regulations started by fuzzy, there is 1 rule that has the correct result, which is contained in the 14th fuzzy rule. So when testing the data, it has an error of 0.0059934%. The results of the error (error) can be seen in Figure 5.

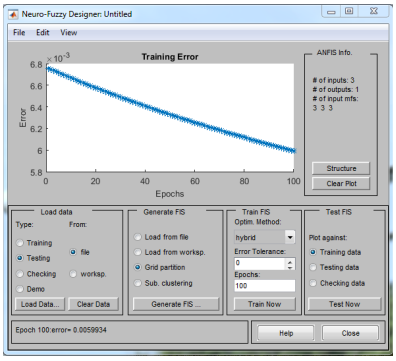

Figure 5. ANFIS results
(Source: Own Results)

Based on Figure 5, the projection results on the adaptive neuro-fuzzy inference system have a minimal error value with the actual data, have linear growth, and produce a gain of 0.599% annually. So that the projected results of new renewable energy growth in Indonesia for 2021-2026 can be seen in table 5.

Table 5. Short-Term Forecast of Indonesia's New and Renewable Energy Growth in 2021-2026

Year	Projected Results of EBT Growth in Indonesia (MW)
2021	1243.50
2022	1250.95
2023	1258,44
2024	1265.98
2025	1273.56
2026	1281,19

The results of the short-term forecast for the growth of Indonesia's new and renewable Energy in 2026 using the adaptive neuro-fuzzy inference system for 2026 are presented in table 5. Then the Mean Absolute Percentage Error (MAPE) value will be calculated using the equation:

MAPE = ((1251-1243.50)/1251) x 100% = 0.599%

4. CLOSING

Electric power plants always use fossil fuels such as coal and oil. However, the fossil fuel supply in Indonesia is decreasing from year to year. This causes power plants to be driven using fuels that will not run out, such as solar Energy, water, wind, and others. To guarantee a power plant powered by alternative Energy, it must be analyzed regarding the growth of new and renewable Energy. The method used in analyzing the development of new and renewable Energy is the Adaptive Neuro Fuzzy Inference System Method. The results obtained in predicting the growth of Indonesia's new and renewable Energy in 2026 using the adaptive neuro-fuzzy inference system method are as follows:1281,19MW or 0.599%. This result has increased yearly in Indonesia's new and renewable energy growth.

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