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Assessment of Electric Energy Generation and Installed Power Capacity in Turkey

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Abstract
Renewable energy is one of the sustainable energy sources, the use of which has increased considerably in the recent years. Today, the wind energy is an essential renewable energy source that does not have a depletion problem. In this work, electricity generation from the wind energy and installed power capacity in Turkey is examined. First, the dataset of electrical energy production (GWh) and the installed power capacity (MW) between 2010 and 2019 are used. Then the electrical energy generation and installed power capacity are evaluated by the trend analysis. Different models are used in the trend analysis, and the results obtained from these models are evaluated with MAPE, MAD, and MSD. Finally, the most suitable models for electric power generation and installed power capacity are determined by evaluating the results.

Keywords: *Renewable energy, Electrical energy production, Installed power capacity, Wind energy, Turkey.*

1. Introduction

Energy is a vital issue for the social welfare and economic growth of the countries [1]. Energy sources are divided into two main groups: non-renewable and renewable energy sources [2-5]. There are four main types of non-renewable energy sources: oil, natural gas, coal, and nuclear energy. Non-renewable fuels have been used as the leading resource in order to obtain energy but their use has numerous adverse effects such as global warming and air pollution [6]. Meanwhile, non-renewable resource exhaustion has also been identified as an upcoming challenge [7]. Therefore, numerous countries are exploring the renewable energy sources in order to resolve all these subjects [8].

The renewable sources are wind energy, hydro energy, geothermal energy, solar energy, and biomass energy [9]. The wind energy is a clean energy [10, 11]. The use of wind energy has increased rapidly in the recent years. Today it is a vital renewable energy source in electricity generation [12, 13].

In the past few years, energy has developed the keyword in all countries' nationwide and worldwide economic development. Energy is indispensable to most economic events. The demand for electricity and electrical energy consumption has increased in Turkey in the recent years due to the population growth and industrial development [14]. In this work, the electrical energy production (GWh) and installed power capacity (MW) obtained from wind energy between 2010 and 2019 in Turkey are examined.

2. Materials and Method

2.1. Location

Turkey is located in Europe and Asia, and covers an area of 780000 km^2. Turkey has open sea areas as it is surrounded on three sides by the sea. Furthermore, the Marmara Sea is situated within the country's boundaries [15]. Therefore, Turkey has a very high offshore wind power capacity.

2.2. Dataset

The dataset on electrical energy production (GWh) and installed power capacity (MW) from wind energy between 2010 and 2019 was taken from the website of the Ministry of Energy and Natural Resources of the Republic of Turkey [16]. After carrying out the trend analysis using this data, the results obtained are presented in the following sections.

2.3. Trend Models

Trend, a time series towards a specific direction, is the progress it shows in the long run. While analyzing the trend, the selected year data values in the following years consider the trends they show [17].

In this work, the trend models in time series are used. These models are linear model ($Y_t = \beta_0 + \beta_1 t$), quadratic model ($Y_t = \beta_0 + \beta_1 t + \beta_2 t^2$), and s-curve trend model ($Y_t = \frac{10^a}{\beta_0 + \beta_1 \beta_2^t}$).

Y shows the electrical energy production, t is the trend of time series data over time, and β_0, β_1, and β_2 are the parameters involved.

2.4. Estimation Methodologies

The estimation methodologies criteria are given in equations 1-3 [18].

$$\mathbf{MAPE} = \frac{\mathbf{\Sigma|(y_t - \hat{y}_t)/y_t|}}{\mathbf{n}}\mathbf{100} \quad (1)$$

$$\mathbf{MAD} = \frac{\mathbf{\sum_{t=1}^{n}|y_t - \hat{y}_t|}}{\mathbf{n}} \quad (2)$$

$$\mathbf{MSD} = \frac{\mathbf{\sum_{t=1}^{n}|y_t - \hat{y}_t|^2}}{\mathbf{n}} \quad (3)$$

Where y_t is the actual value, $\hat{y}_t$ presents the fitted value, and n is the number of observations.

3. Results and Discussion

In this work, Turkey's electrical energy production (GWh) and installed power capacity (MW) obtained using wind energy between 2010 and 2019 are evaluated. For this, the trend analysis models are applied to the data. These models are the linear model, quadratic model, and s-curve trend model.

The electrical energy production (GWh) graphics of the models are given in figures 1-3. Among these models, the model with the lowest MAPE, MAD, and MSD values was preferred. When the models were examined, it was seen that the model with the smallest MAPE, MAD, and MSD value was the quadratic trend model (Figure 2).

The installed power capacity (MW) graphics of the models are given in figures 4-6. Between these models, the model with the lowest MAPE, MAD, and MSD was chosen. After the models were observed, it was seen that the model with the smallest MAPE, MAD, and MSD value was the S- curve trend model (Figure 3).

4. Conclusions

Wind energy has the probability of playing a vital role in the forthcoming energy supply. One of the most critical issues of wind energy is electrical energy production and installed power capacity. Therefore, it is essential to examine the evolution of electrical energy generation and installed power capacity over the years. In this work, Turkey's electrical energy production and installed power capacity were evaluated using the trend analysis models.

The models presented that electrical energy production and installed power capacity increased over the years. Although the model is used for the electrical power generation and installed power capacity data set, it is believed that the trend analysis models can be used for many energy sources.

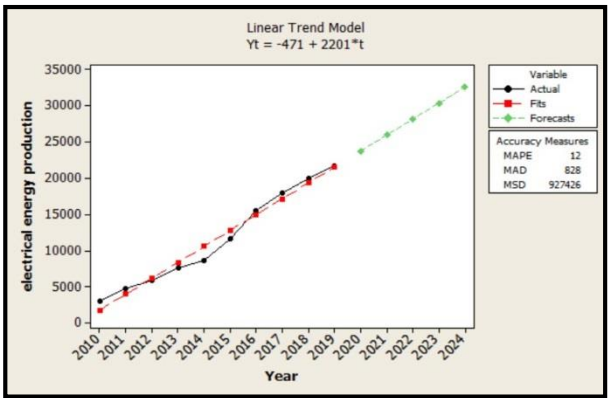

Figure 1. Linear trend model of electrical energy production.

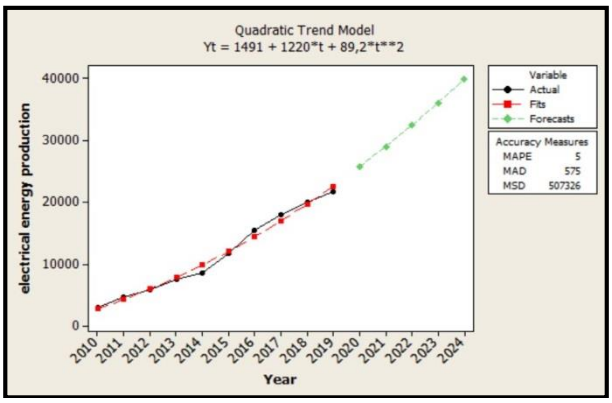

Figure 2. Quadratic trend model of electrical energy production.

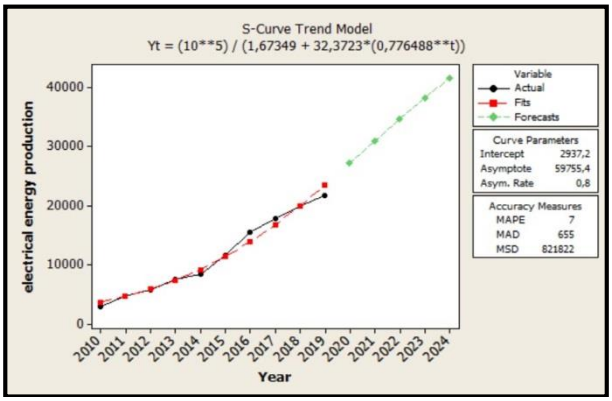

Figure 3. S-curve trend model of electrical energy production.

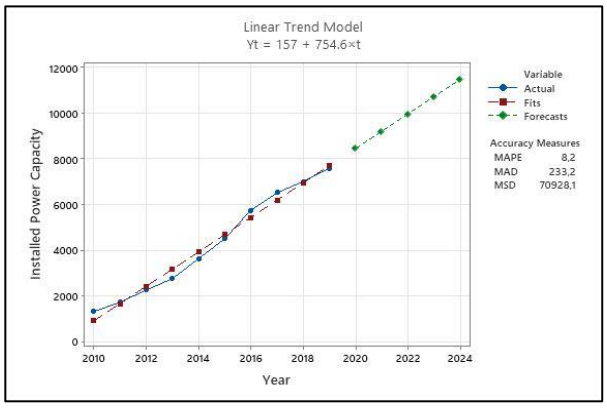

Figure 4. Linear trend model of installed power capacity.

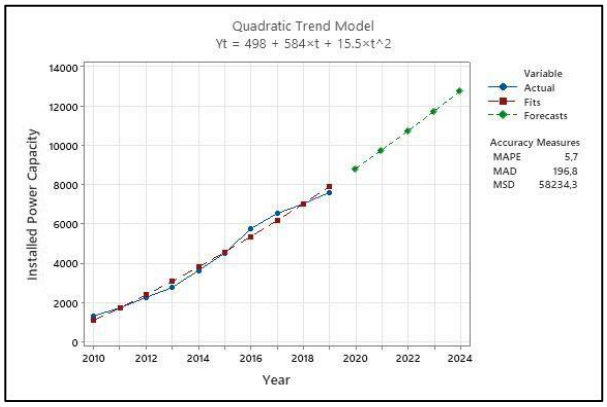

Figure 5. Quadratic trend model of installed power capacity.

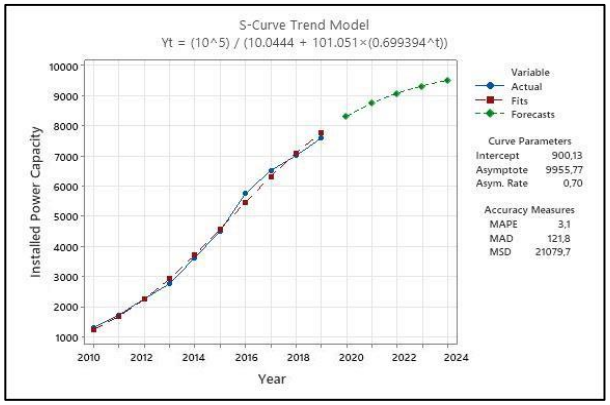

Figure 6. S-curve trend model of installed power capacity.

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