Chapter 2
Nature-Inspired Approach Using Seasonal Comparison of Wind Speed With Spectral and Statistical Analysis

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ABSTRACT

Seasonal analysis of wind speed includes elements of its evaluation and analysis for wind energy production in complex geographical areas. These analyses require wind energy systems to be set up, integrated, operated, and designed according to seasonal differences. Istanbul wind speed data were collected hourly and analyzed seasonally. When the results of the analysis are examined, no significant increase in seasonal transitions was observed, while certain changes were observed between summer and winter. Here, statistical analysis, Weibull distribution function, and signal processing-based PSD analysis for wind speed is performed. In addition, correlation analysis was made between the seasons. Although significant results were obtained in signal-based analyses, results were obtained for seasonal transitions in correlation analyses. Seasonal spectral densities were calculated in the spectral analysis of wind speed data. This study has important implications in terms of extraction of seasonal characteristics of wind speed, resource assessment, operation, investment, and feasibility.

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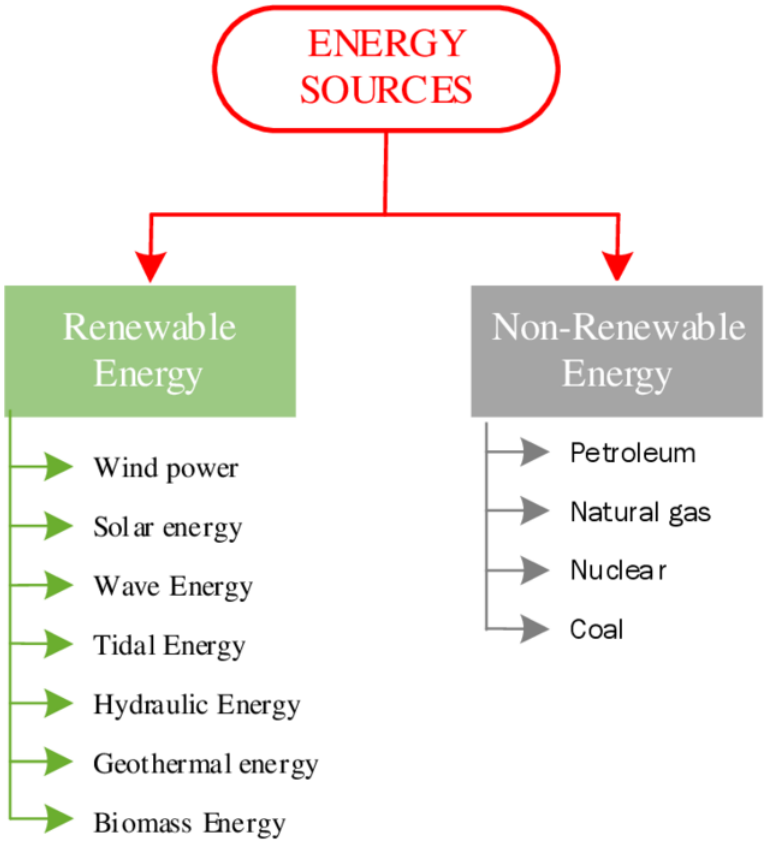
1. INTRODUCTION

The rise of global warming to high levels in the world, the increase in environmental pollution by industrialization and the inability to meet the energy demand cause fossil fuels to be replaced by renewable energy [Akanwa, and Joe-Ikechebelu, 2012). Among the renewable energy sources, there are many types of energy, especially wind, solar geothermal, hydrogen and biomass energy (Panwar at al., 2011; Gosunpro, 2021). Renewable energy sources and non-renewable energy sources are given in Figure 1 below.

Figure 1. Classification of Energy Resources



The use of renewable energy resources continues to increase in the world (Gielen at al, 2019; Wuebbles, and Sanyal, 2015; Kumar, 2020). The main reasons for preferring renewable energy production are; being friendly with nature and being inexhaustible (economical). Even initial investment costs in renewable energy sources can often be lower than non-renewable energy generation (Singh, Nyuur, and Richmond, 2018). Countries are increasing their investments in renewable energy resources. In Figure 2, investment statistics for renewable energy generation in the last ten years are given. In addition, governments aim to establish 488 gigawatts of hydroelectric capacity by 2030 in their energy investment programs (Fs-unep, 2020).