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Carbon Emission Forecast Based on Multilayer Perceptron Network and STIRPAT Model

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Abstract

INTRODUCTION: It is of great research significance to explore whether China can achieve the "two-carbon target" on time. The MLP model combines nonlinear modeling principles with other techniques, possessing powerful adaptive learning capabilities, and providing a viable solution for carbon emission prediction.
OBJECTIVES: This study models and forecasts carbon emissions in Jiangsu Province, one of China's largest industrial provinces, aiming to forecast whether Jiangsu province will achieve the two-carbon target on time plan and provide feasible pathways and theoretical foundations for achieving dual carbon goals.
METHODS: Based on the analysis of the contributions of relevant indicators using the Grey Relational Analysis method, a comprehensive approach integrating the STIRPAT model, Logistic model, and ARIMA model is adopted. Ultimately, an MLP prediction model for carbon emission variations is established. Using this model, simulations are conducted to analyze the carbon emission levels in Jiangsu Province under different scenarios from 2021 to 2060.
RESULTS: The time to reach carbon peak and the likelihood of achieving carbon neutrality vary under three scenarios. Under the natural scenario of no human intervention, achieving carbon neutrality is not feasible. While under human-made intervention scenarios including baseline and intervention scenarios, Jiangsu Province is projected to achieve the carbon neutrality target as scheduled, attaining the peak carbon goal, however, proves challenging to realize by the year 2030.
CONCLUSION: The MLP model exhibits high accuracy in predicting carbon emissions. To expedite the realization of dual carbon goals, proactive government intervention is necessary.

Keywords: Carbon emission; Forecast; Path planning; Multilayer Perceptron (MLP) model; Scenario analysis method

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1. Introduction

As early as the mid to late 20th century, global climate warming has garnered widespread attention from the international community. Issues such as its causes, measurement, consequences, and mitigation measures have become focal points in the scientific community. China, being the world's largest emitter of greenhouse gases and a significant consumer of energy, has witnessed a rapid increase in carbon emissions, with its global share consistently rising in the 21st century. In September 2020, in response to global climate change, President Xi Jinping announced during the 75th United Nations General Assembly that China aims to peak carbon emissions before 2030 and achieve carbon neutrality by 2060. The realization of the dual carbon goals is not only a solemn commitment made by China to address global climate change but also an inevitable choice for the country's future economic structural transformation and sustainable development.

To achieve carbon reduction targets, China must seek a negative correlation between economic growth and carbon emissions. This involves two key aspects. Firstly, improving energy efficiency by reducing the energy consumption per unit of GDP can lead to a negative correlation between economic growth and energy consumption. Secondly, increasing the proportion of non-fossil energy consumption, thereby reducing the carbon emissions per unit of energy, can establish a negative correlation between energy consumption and carbon emissions. To implement these strategies effectively, it is essential to establish mathematical models for the analysis, assessment, and

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