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Editorial

Navigating the Complexities of Energy Economics and Sustainable Development: Insights from the Special Issue

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The Special Issue "New Insights into Energy Economics and Sustainable Development" includes a total of eight papers, focusing on different problems related to energy economics and sustainable development.

Reference [1] delves into the evolution of greenhouse gas (GHG) emissions across various countries and sectors from 1990 to 2018. Employing statistical analysis, including the Kaplan–Meier method for determining the empirical distributions of emissions, the authors define utility functions aligned with the European Green Deal's goal of reducing GHG emissions by 55% by 2030 relative to 1990 levels. The study scrutinizes energy transition trends at both national and sectoral levels, emphasizing country-specific transition trajectories through percentile-based time-series analysis of emission data. Additionally, it assesses how sector-wise emission distributions reflect national development strategies' contributions to climate change mitigation. Overall, the research enhances understanding of sectoral energy transition challenges and strategic planning, integrating sustainable development goals, carbon capture, carbon credits, and carbon offsets to offer a comprehensive framework for a global low-carbon energy transition.

In recent years, China's natural gas market has experienced substantial growth, with consumption surpassing 300 billion cubic meters by 2020. However, regional allocation imbalances pose risks of energy poverty, efficiency decline, and resource misallocation [2–5]. Reference [6] conducted a comprehensive study on the spatial convergence of China's natural gas consumption, aiming to uncover the spatial correlations and spillover effects underlying its rapid growth and inter-regional imbalances, and to determine if spatial convergence conditions exist. Through spatial econometric models, the study first revealed the spatial characteristics and correlations of natural gas consumption, identifying agglomeration patterns and a "core–periphery" system. Subsequently, spatial convergence models, including absolute and conditional convergence, were constructed to explore the existence and influencing factors of spatial convergence in natural gas consumption. The findings indicate conditional convergence, with convergence speed significantly influenced by the economic geography matrix, highlighting the substantial role of economic and social conditions in natural gas consumption convergence.

Coal remains a dominant energy source in China, representing 56% of the country's total energy consumption in 2021. Thermal coal, primarily utilized in the power industry, experiences price fluctuations that directly impact the economic benefits of downstream industries. Government intervention and inventory changes are key factors affecting thermal coal prices. The existing literature on thermal coal price determinants often overlooks the impacts of policies and other energy prices [7]. Reference [8] investigated the factors influencing thermal coal prices in China, with a particular focus on the impact of economic policy uncertainty. The study notes that in 2021, China's thermal coal prices reached a decade high, followed by a significant decline due to government intervention. Through cointegration tests and forecast error variance decomposition (FEVD) methods, the research reveals that while the impact of policy uncertainty on thermal coal prices increases over time, it remains negative and less significant than anticipated. Conversely, inventory and other energy prices exert a

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more substantial positive influence. These findings underscore the growing yet limited impact of policy uncertainty on thermal coal prices, emphasizing the greater significance of inventory and other energy prices. This research is crucial for forecasting future thermal coal prices and offers valuable insights for policymakers.

Utilizing clean energy sources such as wind and solar power for electricity generation is vital for China's energy reform. However, with increasing wind and photovoltaic installed capacities, the issue of curtailment has become pressing, affecting power plant profits and leading to energy waste [9]. In 2015, China led the world in wind and photovoltaic installed capacities, yet curtailment data also peaked. After 2015, curtailment continued to rise until 2018 when it eased, but annual abandoned wind and solar power remained at 27.7 billion kWh and 5.5 billion kWh, respectively. Hydrogen storage is favored for integrating large-scale centralized wind and solar power into the grid, offering advantages over other storage methods such as hydraulic, compressed air, wind turbine, electrochemical, and superconducting magnetic storage. Reference [10] address the multi-cycle resource allocation optimization of hydrogen storage systems for coal–wind–solar power generation. Considering the severity of wind and solar power curtailment and the economics of hydrogen production and operation, their study examines node selection, scale setting for hydrogen production and storage, and decision-making regarding new transmission lines, pipelines, and route planning. By prioritizing energy supply satisfaction, the researchers constructed a multi-cycle resource allocation optimization model for an integrated energy system, aiming for maximum system benefit. Using data from the Inner Mongolia, Beijing, and Shanxi provinces, the study analyzes the economic benefits of the hydrogen storage system for coal–wind–solar power generation and explores the effects of national subsidy policies and technological advancements on system economics.

China has pledged to achieve carbon neutrality by 2060, making the grid system a crucial target in this endeavor. Reference [11] conducted a study using the Life Cycle Assessment (LCA) method to investigate the efficiency and system synergies of innovative decarbonized grid systems. The research examined the environmental impacts of traditional grids, renewable energy grids, energy storage grids, and microgrids in Guangdong Province, revealing that system improvements can substantially decrease carbon emissions. Specifically, substituting traditional fuels with renewable energy results in a reduction of 0.05 kg CO_2 equivalent in greenhouse gas emissions per kilowatt-hour of electricity produced, which is 7.9% of the baseline. Additionally, microgrid technology offers a higher potential for carbon emission reduction, achieving 23.8% of the baseline. The study also highlights that the contribution of energy storage has been undervalued due to data limitations. This research offers valuable insights for grid enterprises in assessing environmental impacts and optimizing systems under the objective of carbon neutrality.

Reference [12] explored the prediction methods for the potential of electric power substitution in Beijing. The article analyzed the factors influencing electric power substitution and conducted predictions by constructing various machine learning models. The results indicate that the Gaussian kernel support vector machine model based on grid search has good performance in predicting the potential of electric power substitution in Beijing, providing certain guidance for the analysis of electric power substitution potential. The paper also points out that electric power substitution is one of the key measures to achieve the goal of carbon neutrality. As the capital of China, Beijing has set a target of achieving carbon neutrality by 2050, making the study of electric power substitution potential highly significant. Additionally, the paper discussed the shortcomings of existing prediction methods and proposed an improved method based on grid search support vector machines to enhance the accuracy and reliability of predictions.

Reference [13] explored the main driving factors of carbon dioxide emissions in China's electric power industry. Based on provincial data from China from 2003 to 2019, the study combined a spatial Durbin model and relative importance analysis to find that gross domestic product (GDP), power supply structure, and energy intensity are key factors affecting carbon dioxide emissions in China's electric power industry. The study also pointed out that the self-supply ratio and spatial spillover effects have a smaller impact on carbon dioxide emissions, while the energy demand of the industrial and residential sectors has a larger impact on carbon dioxide emissions. To achieve the peak of carbon dioxide emissions ahead of schedule, the government should prioritize the development of renewable energy and regional power trading, while promoting energy-saving technologies, especially tapping into the energy-saving potential of the industrial and residential sectors.

Reference [14] explored the impact of agricultural mechanization level, rural infrastructure construction level, and rural economic development level on the utilization of high-quality straw energy in China under the background of achieving carbon neutrality. The study employed a ridge regression model with panel fixed effects to analyze the utilization of straw energy in 24 provinces and cities in China from 2009 to 2017. The results showed that the improvements in agricultural mechanization level, rural infrastructure construction, and rural economic development level all promoted the use of high-quality straw energy, with the level of rural economic development playing a mediating role. The study recommended that the government increase investment in agricultural machinery in rural areas, pay attention to regions with backward rural energy infrastructure, ensure the steady development of the rural economy, provide the necessary economic foundation for agricultural supply, and thereby promote the utilization of high-quality straw energy.

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