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The Effect of Green Power Trading Mechanism on Interregional Power Generation and Transmission in China

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Abstract : Background and significance of the study: Both green power trading schemes and interregional power transmission are effective ways to increase green power absorption and achieve renewable power development goals. China accelerates the construction of interregional power transmission lines and the green power market. A critical issue focusing on the close interaction between these two approaches arises, which can heavily affect the green power quota allocation and renewable power development. Existing studies have not discussed this issue adequately, so it is urgent to figure out their relationship to achieve a suitable power market design and a more reasonable power grid construction.Basic methodologies: We develop an equilibrium model of the power market in China to analyze the coupling effect of these two approaches as well as their influence on power generation and interregional transmission in China. Our model considers both the Tradable green certificate (TGC) and green power market, which consists of producers, consumers in the market, and an independent system operator (ISO) minimizing the total system cost. Our equilibrium model includes the decision optimization process of each participant. To reformulate the models presented as a single-level one, we replace the producer, consumer, ISO, and market equilibrium problems with their Karush-Kuhn-Tucker (KKT) conditions, which is further reformulated as a mixed-integer linear programming (MILP) and solved in Gurobi solver. Major findings: The result shows that: (1) the green power market can significantly promote renewable power absorption while the TGC market provides a more flexible way for green power trading. (2) The phenomena of inefficient occupation and no available transmission lines appear simultaneously. The existing interregional transmission lines cannot fully meet the demand for wind and solar PV power trading in some areas while the situation is vice versa in other areas. (3) Synchronous implementation of green power and TGC trading mechanism can benefit the development of green power as well as interregional power transmission. (4) The green power transaction exacerbates the unfair distribution of carbon emissions. The Carbon Gini Coefficient is up to 0.323 under the green power market which shows a high Carbon inequality. The eastern coastal region will benefit the most due to its huge demand for external power.

Keywords : green power market, tradable green certificate, interregional power transmission, power market equilibrium model
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