A non-cooperative game strategy for provincial hydrogen production capacity planning considering the geographical distribution of renewable energy bases

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Abstract

Apart from technical factors such as hydrogen production efficiency, the proper geographical distribution of renewable energy bases is essential for promoting large-scale hydrogen production from renewable energy sources on a provincial scale. This paper establishes a hydrogen production capacity planning method that takes into account the distribution of renewable energy bases. Based on the trading pattern of the hydrogen energy market in regions with a high proportion of renewable energy, a non-cooperative game pattern of hydrogen production capacity is constructed, where energy hubs acts as players, hydrogen production capacity acts as a strategy, and the minimum cost of hydrogen is a payment. On this basis, hydrogen production, transportation and consumption models are constructed by combining renewable energy utilization rate, population, and transportation network. Thereby, a non-cooperative game planning method for provincial hydrogen production capacity is proposed, and the gaming problem is transformed into an optimization problem solved iteratively to minimize the global hydrogen production cost. Furthermore, the provincial hydrogen production capacity planning arithmetic is constructed with the data of Qinghai Province. The equilibrium solution of the game with eight energy hub nodes as players is obtained, and the effectiveness of the model is verified. Finally, the impacts of population changes, installed renewable energy production capacity and industrial electricity prices on hydrogen production capacity planning and regional hydrogen costs are quantitatively analyzed.

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