

Enhancing Power Supply Resilience in the Beijing-Tianjin-Hebei Region under Climate Risk: Planning and Layout Perspectives

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Extended Abstract

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Abstract Summary

Frequent extreme weather events pose significant challenges to power systems. This study focuses on the Beijing-Tianjin-Hebei (BTH) region, analyzing meteorological data from 1980 to 2023 to classify four typical extreme weather patterns: extreme cold, extreme heat, stagnant, and overcast/rainy conditions. A multi-stage power system planning model for 2035–2055 is developed to evaluate the impacts of these events and their temporal evolution on the energy system. Results indicate fundamental shifts in system defense mechanisms and capacity allocation logic under deep decarbonization. First, capacity planning evolves from fossil-fuel-reliant expansion at consumption ends to structural overcapacity in Inner Mongolia photovoltaic generation, complemented by battery storage and hydrogen systems, mitigating resource shortages during stagnant weather. Second, economic impacts transition from dual pressures of consumption-end fuel and transmission-end investment to carbon sink revenue losses under prolonged temperature disturbances, with overall costs of extreme weather diminishing under deep decarbonization. Third, operational strategies in BTH leverage complementary roles: Beijing relies on external transmission and storage, while Hebei and Tianjin combine local generation-storage and imported energy, forming a multi-dimensional network resilient to extreme events. Finally, cross-provincial transmission challenges shift from long-term stress of extreme cold and heat to instantaneous effects of sustained cold and stagnant/rainy weather, with Inner Mongolia channels ensuring continuous supply and Shanxi channels providing flexible backup. These findings provide guidance for regional power planning under climate risk, highlighting the interplay of decarbonization, extreme weather, and system resilience.