

The Spatial Deployment of Renewable Energy Based on China's Coal-heavy Generation Mix and Inter-regional Transmission Grid

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Executive Summary

China has set a goal of 20% non-fossil energy in total primary energy consumption by 2030. Renewable energy investment is highly capital-intensive, and once built, it creates a “lock-in” effect on the power generation mix for decades. Thus, whether the future low-carbon goals can be achieved depends on the current power system layout. The decision of where to invest in renewable energy, and to what extent, needs to be considered from a forward-looking perspective. However, there are significant differences in resource endowments and electricity demand from region to region. Geographically, the potential for renewable energy is greatest in the north of China, while the power demand in the east and south is higher. The imbalance of resource endowments and electricity loads makes the spatial deployment of renewable energy more difficult.

This article presents a power sector optimization model that integrates unit commitment with a long-term generation expansion planning framework. Power dispatches at an hourly level, including aspects such as ramping limits and start-up and shut-down decisions, are combined with yearly investment decisions for power generation and transmission technologies. This model minimizes the total system-wide costs of meeting regional electricity demand and renewable energy development constraints in China's power sector. Based on the framework, this study addresses two research questions: (1) what is the optimal spatial deployment of renewable energy to achieve relevant low-carbon targets? And (2) what are the effects of a coal-heavy generation mix and electricity transmission infrastructure expansion on the spatial deployment of renewable energy in China?

The results show that the regional differences in non-hydro renewable energy generation are significant. Approximately 75% should be deployed in the north of China. The share of onshore wind in the non-hydro renewable energy generation mix is the largest, reaching 63.9% in 2030. It is followed

by solar PV, which accounts for 22.1% of renewable electricity. With the increase of combined heat and power (CHP), more renewable energy facilities, especially solar photovoltaic, should be located in the south of China because of the conflict between CHP and wind power in the north. Inter-regional power transmission is beneficial to onshore wind power production in resource-rich areas, and could mitigate the conflict between a coal-heavy generation mix and renewable energy. It also has the potential to bring sizeable gains from electricity trade, estimated to be 4.4–13.0 billion RMB per year.

Keywords: Renewable energy; Power sector; CHP; Inter-regional power transmission

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