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## Wind energy rejection in China: Current status, reasons and perspectives

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## ABSTRACT

Currently, parts of the potential energy generated by the wind turbines could not be transmitted to the electric power grid in China, leading to a serious wind energy rejection problem. In some local areas (e.g. Gansu province), the wind energy rejection rate reaches 47% in the first half year of 2016. Wind energy rejection problem is currently the biggest barrier for the further development of the wind energy in China. In this review, the current status of the wind energy rejection (between 2010 and 2016) are reviewed with a detailed analysis of the reasons based on the statistical data released by the authorities. Two cases studies (Inner Mongolia Autonomous Region and Gansu province respectively) are also performed to specify the reasons for the rejection and provide an in-depth discussion on the influences of related policies. Based on the recent trends and policies, several solutions and perspectives are also given together with some specific suggestions for the policy makers. Furthermore, in this review, a brief description of China's electric system is also given for the convenience of the readers. This review is not only informative for solving the wind energy rejection problem in China but also helps the policy makers in other developing countries for building the roadmaps of the renewable energies.

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*Abbreviations:* AC, Alternating Current; CCG, Central China Grid Company Limited; CEC, China Electricity Council; CMA, China Meteorological Administration; CNREC, China National Renewable Energy Center; CSPG, China Southern Power Grid Company Limited; CREIA, Chinese Renewable Energy Industries Association; CWEA, Chinese Wind Energy Association; CWERA, Wind and Solar Energy Resource Center, China Meteorological Administration; DC, Direct Current; ECG, East China Grid Corporation; EPDI, Electric Power Dispatching Institution; GDP, Gross Domestic Product; IMP, Inner Mongolia Power (Group) Co., LTD; IEC, International Electrotechnical Commission; LVRT, Low Voltage Ride Through; NDRC, National Development and Reform Commission; NREL, National Renewable Energy Laboratory; NCGC, North China Grid Company Limited; NEG, Northeast China Grid Company; NCG, Northwest China Grid Company Limited; PHESPP, Pumped Hydro Energy Storage Power Plant; STM, Sample Turbine Method; SWPG, Southwest Power Grid; SERC, State Electricity Regulatory Commission; SGCC, State Grid Corporation of China; TEPC, Tibet Electric Power Company; UHV, Ultra-high Voltage; WPD, Wind Power Density; WTG, Wind Turbine Generator; WWEA, World Wind Energy Association.

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## 1. Introduction

Wind energy is one of the important renewable energies, currently being developed worldwide. In the recent five years, the total installed capacity of wind energy in China increases rapidly, serving as the leading country and occupying 34.03% of the total installed capacity of the world [1, p.7]. Meanwhile, a large amount of wind energy can not be connected with the power grid of China, leading to serious wind energy rejection. Here, rejection means that the electricity dropped by the wind farms due to some undesirable situations (e.g. grid safety and no available transmission lines). For details of the definition of the rejection and related China's national standard, readers are referred to Section 4.

Between 2010 and 2016, the overall wind energy rejection rate in China is above 10% [2,3]. In the first half year of 2016, the wind energy rejection problem becomes more serious. Based on the statistical data released by the National Energy Administration

(China) on July 27<sup>th</sup> 2016 ([http://www.nea.gov.cn/2016-07/27/c\\_135544545.htm](http://www.nea.gov.cn/2016-07/27/c_135544545.htm)), the overall wind energy rejection rate in China is 21%, which is 6% more than the rate of the year of 2015. Specifically, ten provinces out of thirty two provinces (or equivalent cities) in total have wind energy rejection problem and the rejection rate of nine of them is above 10%. Astonishingly, the wind energy rejection rate in the Gansu province and Xinjiang Autonomous Region is 47% and 45% respectively. Hence, a detailed analysis of the reasons for the above phenomenon is of great importance for the wind energy development in China and worldwide.

In this review, current status, reasons and solutions (with perspectives) of wind energy rejection problem are reviewed in great details based on the analysis of a large amount of reliable data and related policies. Many illustrating examples are given for the reader's convenience with many typical figures and informative tables. The following sessions of this review are arranged as follows. In Section

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