25th IERE General Meeting and RWE TI Germany Forum
Düsseldorf, Germany
December 2–5, 2025

Integrating Meteorology and AI Technology: Enhancing Climate Resilience for China's Power System

***Shu WANG [1], Bo WANG [2], Shuanglei FENG [3], Yuehui HUANG [4]**
[1] Senior Engineer, Department of Renewable Energy, China Electric Power Research Institute (CEPRI)
[2] Division Director, Department of Renewable Energy, China Electric Power Research Institute (CEPRI)
[3] Department Director, China Electric Power Research Institute (CEPRI)
[4] Chief Engineer, Department of Renewable Energy, China Electric Power Research Institute (CEPRI)

Keywords: *Climate resilience, New-type Power System, High Impact Weather, meteorological and AI, weather extremities*

Abstract

China's ambitious transition towards a New-type Power System (NTPS), characterized by a high penetration of renewable energy and power electronics and source-load interaction, introduces significant climate vulnerability, especially in such a climate change "hot spot" area of China. NTPS's inherent dependence on weather-dependent resources like solar irradiation, wind speed, and hydrological cycles makes it acutely sensitive to climate variability and weather extremities, as well as even phenomena which are not very extreme like wind/solar lulls or "Dunkelflaute". Key vulnerabilities include the compounding risks of extreme heatwaves simultaneously increasing cooling demand while reducing thermal and photovoltaic efficiency; droughts curtailing hydroelectric output; and tropical cyclones or ice storms causing physical damage to transmission and distribution infrastructure and generation assets. Temperature-sensitive electricity demand tends to peak during temperature extremities. Furthermore, the reduced system inertia from fewer conventional generators exacerbates frequency and voltage instability during rapid fluctuations caused by these High Impact Weathers (HIW) defined in this study.

Addressing these challenges necessitates the critical integration of advanced Electric Power Meteorology (EPM) technology. EPM serves as the foundational tool for enhancing the climate resilience of the NTPS. This involves developing ultra-high-resolution numerical weather prediction (NWP) models tailored for renewable energy forecasting, enabling grid operators to anticipate sharp ramps in generation. Series of AI-based algorithms for RE forecasting are developed and put into practice with 97% RMSE across State Grid Corporation of China. AI-based Weather Foundation Model is also under R&D. Furthermore, refined risk assessment tools that integrate climate projections are essential for the climate-proofing of infrastructure, informing siting, design, etc. For China, prioritizing EPM is a strategic imperative for electricity supply security. This entails deep collaboration between meteorological agencies and grid operators, investing in dedicated monitoring networks (e.g., for OHL icing or solar irradiance), and developing next-generation forecasting platforms. By seamlessly integrating sophisticated meteorological intelligence into every facet of planning, operation, and emergency response, China can fortify its NTPS against climate threats, ensuring a reliable and resilient pathway to its dual carbon goals.

Enhancing the climate adaptability of power systems is of global primary importance. The academia and industry should join hands to improve weather/climate service for TSOs, O&M, RE plants, marketing, etc. which is crucial for addressing the challenge of climate change.