

RESEARCH ARTICLE

Variability in large-scale wind power generation

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ABSTRACT

The paper demonstrates the characteristics of wind power variability and net load variability in multiple power systems based on real data from multiple years. Demonstrated characteristics include probability distribution for different ramp durations, seasonal and diurnal variability and low net load events. The comparison shows regions with low variability (Sweden, Spain and Germany), medium variability (Portugal, Ireland, Finland and Denmark) and regions with higher variability (Quebec, Bonneville Power Administration and Electric Reliability Council of Texas in North America; Gansu, Jilin and Liaoning in China; and Norway and offshore wind power in Denmark). For regions with low variability, the maximum 1 h wind ramps are below 10% of nominal capacity, and for regions with high variability, they may be close to 30%. Wind power variability is mainly explained by the extent of geographical spread, but also higher capacity factor causes higher variability. It was also shown how wind power ramps are autocorrelated and dependent on the operating output level. When wind power was concentrated in smaller area, there were outliers with high changes in wind output, which were not present in large areas with well-dispersed wind power. Copyright © 2015 John Wiley & Sons, Ltd.

KEYWORDS

wind power; variability; net load; variable generation; power systems

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Received 30 October 2014; Revised 14 September 2015; Accepted 29 September 2015

1. INTRODUCTION

Wind power varies naturally with fluctuation in wind patterns. On short timescales, variations are driven by turbulent eddies and on longer timescales by atmospheric pressure gradients associated with synoptic-scale weather patterns. Ramps in wind power production due to turbulent gusts are uncorrelated over relatively short distances such that aggregating generation from several wind farms filters out these fluctuations almost completely. Ramps of interest from a power system perspective are thus usually associated with the passage of large-scale weather systems. The geographical cross-correlation