# Analyzing Wind Power Ramps for High Penetration of Variable Renewable Generation

*Walid Atef Hafez Elmetwally Omran,Hossam Eldin Abdallah Talaat ,Said Fouad Mohamed Mekhemar ,M Saber Eltohamy, M Said Abdel Moteleb, S Fouad Mekhemer*

**Abstract**

One of the greatest issues connected with incorporating high penetration levels of variable renewable generation into the power system is the capability to handle the unlimited ramps in the renewable power production. It is essential for power system operators to have statistical information on the power ramping features of renewables generation. This information can be utilized in power system operations to mitigate ramping events for the sake of power system flexibility, reliability and economic considerations. Grid operators had successfully balanced the variability of collective power output at low penetration of variable renewable generation, but as the installations of renewable energy continue to grow, the ability to manage these fluctuations has become a difficult task. At high renewable penetration, more power ramps with short durations occurred as the number of ramping events increased with increasing penetration level [1]. In this paper the output power of wind generation will be analyzed to get information about the wind power ramping behavior by analyzing the historical data of power-time curve in two directions, vertical and horizontal. While the forecast of wind power has been improved, the forecast errors are still relatively high. As a result, with the increase in the participation rate of variable generation, these errors will significantly affect the balance of generating capacity and consumption. Consequently, from the perspective of grid operators, it will be necessary to gain a deeper understanding of the aggregate ramping scale and the periods that collective ramp events are most likely to occur. The analyzing method will be demonstrated by analyzing the output power of aggregated Belgium's wind farms, 3.16 GW, in the year of 2018.

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