Assessing the ramping behaviour and its system impact for wind-based hybrid power plants

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Over the last years, renewable energy sources have become a cost competitive and clean option to supply power to the grid all around the world. Nonetheless, their intermittent nature is challenging as they disrupt the daily operation of the electric grid. Hybrid renewable systems combine the advantageously complementary renewable sources in a region to provide a more reliable and stable power profile compared to individual renewable sources. However, it is still unclear whether the hybrid wind-PV power plants can be competitive in terms of reliability and cost against conventional fossil fuel systems or individual wind only plants. One of the biggest challenges associated with the integration of large amounts of renewable energy into the energy mix is the ability to handle severe fluctuation incidents with large magnitudes and short durations known as ramps in the power profile. Down ramps in the generation while there is an up ramp in the load can cause severe damage and possible failure of the grid in a renewable energy dominant future. In order to ensure system reliability and dispatchability, it is essential for the power system operators and providers to better understand the ramping features.

Several definitions of ramp events are available in literature and there is no universally accepted metric. The concept of complementarity of renewable sources for hybrid power plants is often mentioned but the clear practical application of the analysis is not provided in the literature. Although there might be a seasonal anti-correlation, the daily correlation may not be always as distinct. The correlation indices need to be verified with other parameters such as ramp events to study the system security. A metric that quantifies the smoothening of the power profile to verify the advantages of the inclusion of hybrid power plants is unavailable. Based on the current review on the ramp events of hybrids, the knowledge gap is to identify an effective way to gauge the impact of hybrid renewable energy plants on reliability and dispatchability in terms of ramp events.

The aim of this research is to characterize the ramping behaviour and its system impact for wind-based hybrid power plants. The most effective metric to characterize the ramp features of a wind-based hybrid power plant will be analyzed. The thesis also aims to look at the results of complementarity on different time scales and how they compare with the ramp events in the power profile. Further, the role of the installed wind to PV ratio on the ramp events of the hybrid power plant will be examined. The effect of inclusion of battery storage on the ramp events in the form of wind-storage and wind-PV-storage plants will be explored.

Figure 1: Ramp events in a wind power time series

References: