Modelling and Control of Doubly Fed Induction Generators in Power Systems

Towards understanding the impact of large wind parks on power system stability

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Abstract

The rapid development of wind power technology is reshaping conventional power grids in many countries across the world. As the installed capacity of wind power increases, its impact on power grids is becoming more important. To ensure the reliable operation of a power system which is significantly fed by wind power, the dynamics of the power system must be understood, and the purpose of this study is to develop suitable analytical tools for analysing the dynamic impact of large-scale wind parks on the stability of a power grid, and to investigate the possibility of improving the stabilisation and damping of the grid by smart control strategies for wind turbines.

Many of the newer, larger turbines now being produced are variable speed turbines, which use doubly fed induction generators (DFIGs). These are induction generators which have their stator and rotor independently excited. When unconventional generators of this type are used in a power system, the system behaves differently under abnormal dynamic events. For example, new types of generators cause different modes of oscillation in the power system, not only because of their dynamic characteristics, but also because they load the system differently.

Very large power oscillations can occur in a power system as a result of internal disturbances. Ordinarily these oscillations are slow and, in principle, it is possible to damp them with the help of wind power. This leads to the idea of using a power system stabiliser (PSS) for a DFIG. In order to damp oscillations in the system, it is necessary to understand the equipment causing these oscillations, and the methods to optimally damp the oscillations.

Voltage stability is another important aspect of the safe operation of a power system. It has been shown that the voltage stability of a power system is affected by induction generators. The voltage stability must therefore be carefully analysed in order to guard against a power system collapse.

By using modal analysis and dynamic simulations, we show that the presence of a wind farm in the vicinity of a power system will improve the angular behaviour of the power system under small disturbances, but may decrease voltage stability under larger disturbances. We compare the performance of wind turbines to that of conventional synchronous generator power plants, and we show that a wind park consisting of DFIGs, which are equipped with PSSs, may be used as a positive contribution to power system damping.