

Integration of renewable energy sources in spinning reserve for weak grids

By nature the loads are generally random in a power network. Now, with the introduction of renewable energy, the sources start also to be random. In case of high penetration of renewable energy on power system a problem may occur in term of spinning reserve. Indeed, the dynamic stability of an electrical is based on the possibility for classical source to increase (or decrease) their production within few seconds in case another source is tripping. This supposes to keep a spinning reserve dispatched on several power plants. In case of renewable power source, the power produced is always the maximum available at each moment with no spinning reserve available. If the renewable production is increasing, the classical production will decrease which could lead to a lack of spinning reserve. Transmission system operator are aware of this problem and write some constraints of spinning reserve even for renewable energy sources in new version of grid codes but these recommendations are not effective yet.

In weak grids as for French insular grids, or remote areas, this will be compulsory soon for renewable sources to propose this spinning reserve. A first solution is to add some storage elements which can guaranty this reserve but the cost is still very high. Another solution could be to limit the production of wind turbine when needed to keep this spinning reserve. Depending on local circumstances, the cost could be less than the storage solution and an in-depth study has to be done for each case.

For doing so, it is needed to characterize the quality of the reserve proposed by the wind turbines because it depends on the level of wind in the area where the wind turbines are located. How can we characterize the reliability of the spinning reserve based on renewable power plant? This is a quite new question which will become more and more accurate with the increasing penetration of this type of production.

Even though, powerful statistical tools have been developed to predict the behaviors of wind production, the predicted powers don't match perfectly the real powers produced. It is now necessary to take into account such uncertainty on the powers into order to increase the stability of the network Numerical Tools start being available to quantify the effects of the uncertainties on the stability of the power networks. These tools are based on a probabilistic consideration of the uncertain loads and sources that are modeled by random variables or fields. Then, methods of sampling (Monte Carlo Simulation Method) or Reliability Method (FORM/SORM) are coupled with models of power networks to deal with these uncertainties [1]. Indices related to probability of failure, shortage of supplied power for example can be extracted. Moreover, sensitivity analysis tools can help to determine which uncertain parameters have the most impact on a given index. According to this information, modifications can be done on the network (starting another power production in case of a lack of spinning reserve for example) to guaranty an acceptable margin stability.

Some experimentation on distributed energy facility will be achieved to prove the validity of the proposed methodology. An actual SCADA (supervisory control and data acquisition) system is available; it will supervise a real-time simulated weak grid included high level of wind turbine production. The algorithm of supervision will include statistical analysis to determine the optimal partition of spinning reserve on the base of experimental wind production profiles.

[1] Reliability evaluation of power system with large-scale wind farm integration using First-Order Reliability Method, M. T. Do, J. Sprooten, S. Clenet, B. Robyns, Wind Chapter EPE, Trondheim (Norvege), mai 2011

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