

Participation of wind parks in voltage control of power system networks

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Abstract summary

In Spain, voltage regulation in transmission networks is mainly done by controlling the reactive power in conventional generators. In the other hand, in wind energy, an incentive payment related to the reactive power compensation is applied. The maximum value of incentive payment and the objective power factor depend on the period of the day: peak, valley or flat. In this paper, a different behavior is proposed, thus the influence of participation of wind parks in the voltage regulation is analyzed. The behavior of generators, lines, voltages... are taken into account in order to compare the proposed situation with the current one.

Introduction and objectives

The wind power installed in Spanish parks is more than 16500MW, where fixed speed wind turbines with asynchronous generators represent approximately the 40% of the installed power. In wind parks with asynchronous machines, reactive power compensation can be done by means of capacitors banks, installed in the LV side of wind turbines and in the MV side of substation.

The main objective of this paper is to demonstrate that participation of wind farms in voltage regulation has a better impact in transmission and distribution network operation than the actual scheme based on a bonus/penalty payment related to power factor.

Methodology

The method is based on the implementation of an Optimal Power Flow (OPF) on real power flow data obtained from the Spanish TSO (REE). In this paper, real situations with high and low wind power generation as well as different geographical distributions of generation have analyzed (fig. 1).

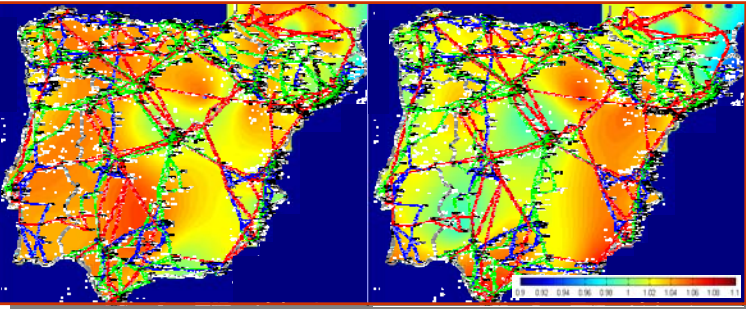


Fig. 1 Network voltage for different geographical distributions of wind energy generation. In order to analyze the impact of wind generation behavior on network voltages, the following scenarios have been considered (fig. 2):

- A. Fixed power factor during the different periods of the day (peak, valley or flat).
- B. Transition behavior between periods in scenario A has been also analyzed.
- C. Voltage regulation control is implemented in all wind parks. Reactive generation is limited to a PF between 0,95 inductive and 0,95 capacitive.

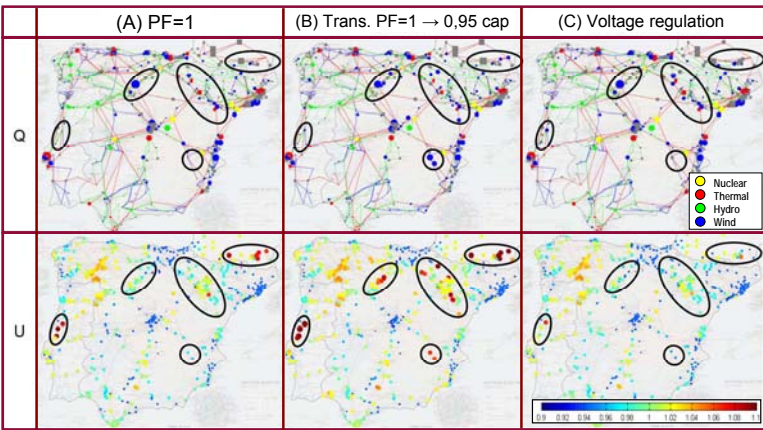


Fig. 2 Active power and nodal voltages in transmission network in three scenarios: (A) using fixed PF=1, (B) during the transition from PF=1 to PF=0,95 cap. and (C) with voltage regulation implemented in wind generation. Zones with excessive reactive injection (biggest circles) or voltage deviation (red circles) for (A) and (B) scenarios are marked. This behavior is corrected in the scenario (C).

Results

In the following figures, results of nodal voltages and wind farm reactive injection are shown. The difference between the results with the wind parks working at a fixed PF and participating in the regulation of tension is shown.

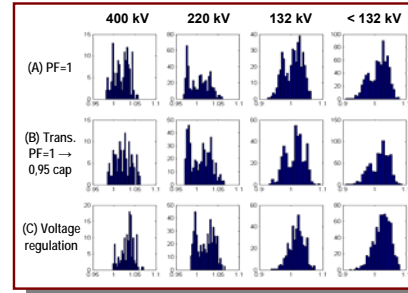


Fig. 3 Nodal voltage histogram

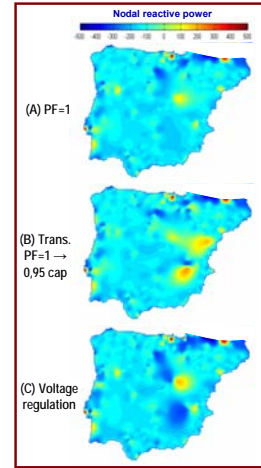


Fig. 4 Nodal reactive power

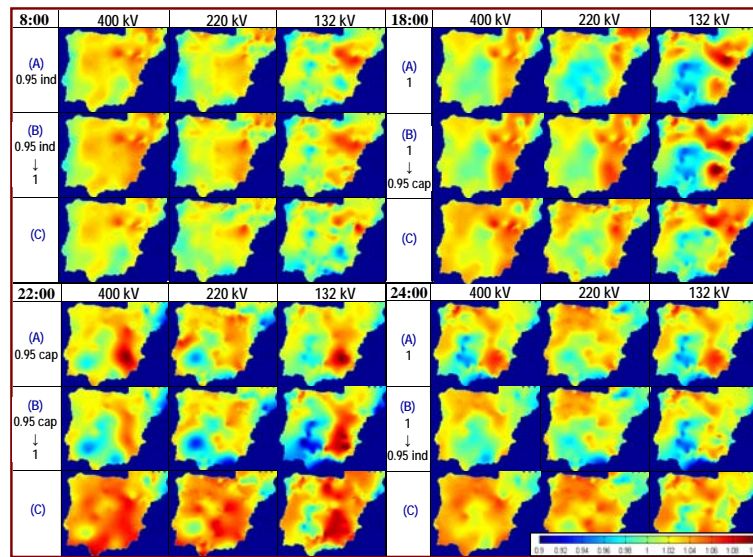


Fig. 5. Nodal voltages in transmission and distribution network with fixed PF strategy and with voltage control strategy at different situations are shown.

Conclusions

This paper deals with the impact of including wind parks in the network voltage control. For the sake of this study, an optimal power flow approach has been accomplished, and the obtained results under different situations have been analyzed. Main conclusions are:

1. The increase in wind energy penetration implies a reduction in the capacity of conventional generation to regulate nodal voltage. Participation of wind generation in the regulation of voltage would improve the operating conditions of the network, reducing the margin of voltage variation and the reactive power to be generated..
2. With the participation of wind farm in the voltage regulation, problems related to voltage variations in power network caused by abrupt PF variation during transition of periods (peak, valley and flat) are reduced. Nodal voltage deviation and margin of reactive injection is reduced.
3. Reactive control in wind parks provides regulation capacity distributed throughout the entire network. A voltage regulation scenario would contribute to a higher stability in the transmission and distribution voltage.

References

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4. Spanish Grid Codes (www.ree.es)