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Wind generation imbalances penalties in day-ahead energy markets: The Italian case

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ABSTRACT

Today there is a lot of interest in wind energy exploitation. It has been emphasized by adopted incentive mechanisms and by the possibility to sell energy to the electrical market in different ways. The rise of wind installed power requires more energy for ancillary services. Moreover, imbalance costs have to be sustained by the Transmission System Operator (TSO) which could charge them to all the consumers where wind power producers are not penalized for their imbalances. To solve this problem some solutions can be adopted depending on market rules that are different from one country to another. In particular referring to the current Italian market framework and taking into account to the state-of-the-art wind power forecasting, an economic assessment of imbalance for some wind farms have been compared to balancing costs of the TSO. Different stochastic approaches have been adopted, using available historical data, in the analysis of various scenarios both for the TSO and for wind plant owners. Also possible mechanisms for imbalance settlements have been proposed in order to maintain grid safety costs within a reasonable level for electricity consumers, and to avoid an excessively penalizing treatment for wind energy source investments in order to satisfy environmental targets of the European Community.

1. Introduction

During the last decade wind power has grown more than any other renewable energy source. Noticeably, among different technologies for power generation, the use of wind capacity has been increased in many electrical systems.

Wind power has impacts on power system operational security, reliability and efficiency. Therefore several studies address different impacts, and different time scales involved usually mean different models (and data) used in impact studies. Case studies for the system wide impacts have been divided to three focus areas: balancing, adequacy of power and grid.

An updated state of art of them on design and operation of power systems is reported in [1], where the most relevant wind power grid integration studies have been analyzed especially regarding methodologies and input data within the IEA WIND R&D Task 25 on "Design and Operation of Power Systems with Large Amounts of Wind Power". Further several issues that impact on the amount of wind power that can be integrated have been identified.

Concerning specifically balancing costs, [1] shows the results from estimates for the increase in balancing and operating costs due to percentage wind power penetration (% gross market) in some countries. Of course there is a spread in the results because an increase in balancing requirement will depend on region size relevant for balancing, initial load variations and how distributed wind power is sited. Also operational routines of the power system are relevant (e.g. how often forecasts of load and wind are updated).

The rise of wind power in the world and in Italy, with the detail of Sicily, is shown respectively in Figs. 1 and 2 since 2000 [2,3].

Investments have been mainly made in Sicily because it is a windy region where several hundreds of MW will be installed within next ten years in order to exploit the big energetic potential. However owing to the lack of sufficient transmission grid and of firm capacity (large hydro and thermal plants) the penetration of new wind power, and above all their imbalances, will be economically heavier than other regions for the TSO.

Due to the technological progress made in wind turbine production and to the reduction of investment costs, levelized cost of the produced kWh has become close to that resulting from conventional sources [4].

Therefore today it is possible to see an increase of grid connection requests where an exploitable primary source is identified and where there are profitable incentives provided by regulations (e.g. green certificates).

The growing exploitation of wind in last years has been at the same time followed by a deregulation process in electric power

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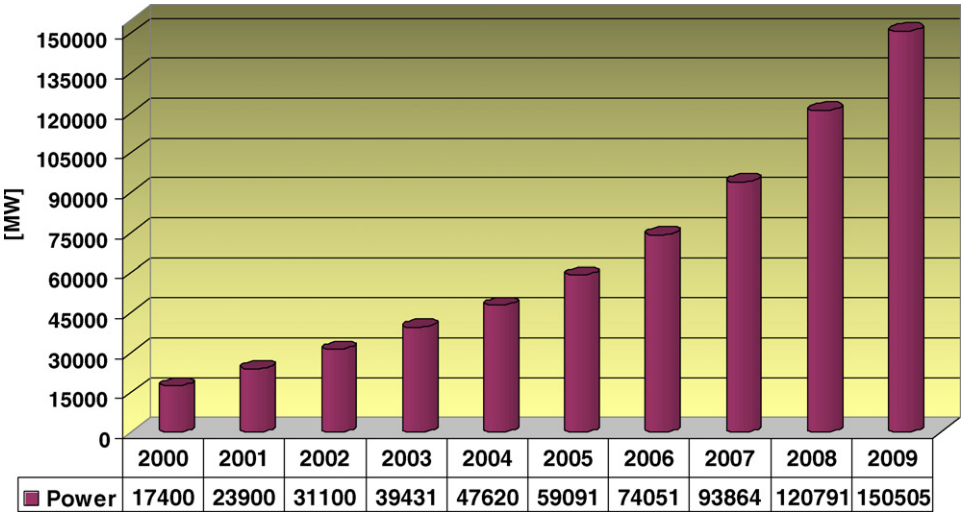

Fig. 1. Global cumulative installed wind power capacity in the world 2000–2009.

systems, which has included production, wholesale market and distribution sectors in many countries.

Due to the stochastic behaviour of primary source, additional wind power capacity needs adequate actions from the TSO regarding both necessary grid development and new short term balance methodologies. These changes bring about a rise in power system costs, which have to be partially or totally paid for by the final electrical consumer, according to specific Italian regulations.

In current electrical market frameworks the forecast uncertainty in wind power scheduling means a loss of value for the produced kWh especially in comparison with traditional plants. Actually they can schedule their production with high reliability and can compete in ancillary services markets where they increase their revenue providing reserve and balancing services to the TSO.

Nevertheless, with environmental benefits (e.g. CO_2 emissions lowered, dependency from fossil fuels reduced) brought by this kind of renewable electrical generation, the overall social advantage becomes more effective compared to other energy sources.

In [5] authors take into account the following purpose: to make a comparison between costs of balancing for wind power producers and for the power system. This analysis is applied to Finland case. Our additional purpose is to assess a possible scheme to get a fair trade-off between power system (to lower and to save some of balancing costs) and wind power producer (not to have heavy imbalance costs).

In this paper different stochastic approaches have been analyzed and, moreover, some mechanisms for imbalance settlements have been proposed in order to maintain the grid safety costs within a reasonable level for electrical consumers and, at the same time, to avoid an excessively penalizing treatment for wind energy source. The proposed approaches can be applied in those nations where wind balancing costs are completely transferred to consumers.

This paper is organized as follows. Section 2 presents respectively an overview about European and Italian regulations in the electrical sector with a particular reference to wind power dispatching. Forecasting approaches will be analyzed in Section 3 in order to study their impact on imbalances. The assessment of balancing cost will show whether these approaches reduce wind energy balancing cost. The assessment is in Section 4. Then in Section 5 numerical results of improved settlement mech-

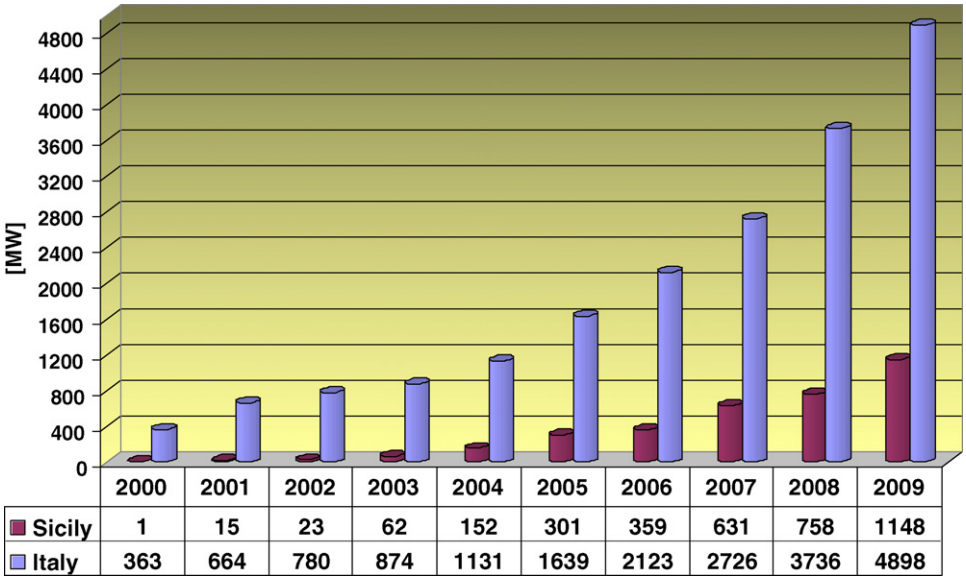

Fig. 2. Global cumulative installed wind power capacity in Italy and Sicily 2000–2009.