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Repowering: An actual possibility for wind energy in Spain in a new scenario without feed-in-tariffs

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ABSTRACT

At the end of January 2012, the Spanish government suspended the economic incentives for electricity generation facilities using renewable energy sources, including wind energy plants.

Spain maintains a high level of energy dependence that can only be reduced by applying measures to increase energy efficiency and using massive amounts of renewable sources. In addition, the target assumed by Spain, i.e., to have at least 20% of the primary energy to be supplied by renewable sources by 2020, has not yet been reached.

In Spain, wind farms, a number of which have been in commercial operation for over 15 years, offer a broad market appropriate for repowering. The use of more efficient wind turbines by means of repowering provides benefits to the electricity sector as a whole by optimizing the use of natural resources and facilitating the grid integration of the energy generated.

This paper analyses existing wind farms to quantify and characterize the market suitable for repowering. We discuss whether repowering is a valid alternative from the point of view of feasibility to enable the continuation of the integration of wind energy in the Spanish energy mix and whether this feasibility is sufficient when the energy generated is charged at the electricity market price in terms of grid parity. The results support that repowering is a profitable alternative and is often even better than the construction of new wind farms under certain conditions.

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1. Introduction

Law 54/1997 of the electricity sector [1] established a new regulatory framework, with the aim of guaranteeing the electricity supply with the highest quality standards and the lowest costs. This new framework was designed based on free competition with only the intervention of the administration to create the specific regulation.

From a retributive perspective, for the power plants under the special regime set up in the Law 54/1997,[2] the regulation established a system supported by a feed-in-tariff (FIT hereinafter) without time limits, which essentially consists of charging a bonus for renewable electricity fed into the grid over the price matched in the daily electricity market. As a second option, it was possible to choose a fixed tariff [2–4].

Under this stable regulatory framework and supported by an adequate legislation to facilitate the administrative authorization of the plants [5], at the end of March 2012, wind energy reached a degree of supply higher than 25% of the electricity demand in the Spanish market central bus-bars[3] [6].

Considering the significant level of primary energy dependence of Spain (75.6% in 2011), which is well above the average for the 27 countries in the European Union, the reduction to a value of approximately 55% at the end of March 2012 [7,8] indicates the success achieved in the implementation of the energetic mix of renewable energy sources (RES hereinafter), especially for wind energy [9–11], which exceeded a participation rate of 18% in the demand supply in 2012 [12].

In January 2012, the Spanish Government suspended the economic incentives for new-generation facilities based on RES, including wind energy [13]. Accounting for the fact that the targets established by the European Union (EU hereinafter) and the Spanish Government to cover 20.8% of the energy demand with renewable energy sources by 2020 have not yet been achieved [8,14], new strategies and regulatory policies are required to continue with the integration of RESs [15–17]. In this work, we examine wind energy as an important step toward attaining such a global objective; because of its degree of maturity, wind energy constitutes an actual possibility in a new setting without a FIT, thereby enabling scenarios that imply the lowest costs for the entire electricity sector [18].

The first wind turbine generators (WTG hereinafter) have been in commercial operation for more than 15 years and can be considered that they are entering the last stage of their nominal lifetime [19]. The repowering of wind farms (WF hereinafter) provides benefits to the electricity system as a whole [20], can improve the social and environmental impact [21,22] and may represent a reasonable option for the Spanish wind industrial sector to address the current critical situation [23].

This work is aimed at determining whether and under what conditions the repowering of a WF is a profitable alternative. We considered the feasibility of two possible alternatives to achieve a reasonable profitability for investors: maintaining the retributive system based on a FIT or charging the price determined in the daily electricity market (spot price hereinafter) for the electricity generated. The volume and the characteristics of the WFs that are suitable to be repowered are also determined.

Below, in Section 2, we analyze existing WFs to define, quantify and characterize the market formed by those suitable for repowering. Afterward, in Section 3, we estimate the expected production of a repowered wind farm (Rep-WF hereinafter) and the changes with respect to an old WF.

In Section 4, we define and estimate the costs of the facilities that form a WF and how these facilities could be reused in a Rep-WF to reduce the construction costs. In addition, the works for dismantling, waste treatment and valorization of the old WTG are also analyzed and considered.

In Section 5, we perform an analysis of the expected profitability of a Rep-WF, introducing a retributive proposal for the electricity generated based on the spot price and comparing the results with those obtained in case of retribution under the present scheme supported by FIT. Sensitivity analyses in relation to the most important parameters are included to consider the effect of their variations in the results.

Finally, Section 6 presents the conclusions of the study.

2. Determination of the market volume and its characteristics

2.1. Lifetime and financing

According to the standard IEC 61400 [24], a WTG should be designed for a lifetime of at least 20 years. During this period, with proper Operation and Maintenance (O&M hereinafter), the WTG will offer a level of mechanical availability[4] of nearly 100% during the first 5–10 years – presently, the typical values guaranteed by the manufacturers are approximately 97% – and over 90% for the remainder of its lifetime.

For most WFs, Project Finance was the method chosen by investors. With this method, the recourse to investor from the lenders is limited or even eliminated. The project itself, the WF in

[2] The article 27 of the Law 54/1997 defines the production of electricity in a special regime, such as that implemented in facilities up to 50 MW of installed power with the following characteristics. (a) The facility uses cogeneration or other electricity production methods associated to non-electric activities, and they suppose a high degree of energetic efficiency. (b) The facility uses as primary energy one of the renewable energies sources (RESs), biomass, or other type of biofuel, and the owner does not develop the production of electricity under the ordinary regime. (c) The facility uses non-renewable waste as primary energy.

[3] Energy fed into the grid from generators and international exchanges deducting the consumption required for generation and pumped storage.

[4] Mechanical availability is defined typically in a yearly period, as the percentage of time (year) in which the WTG is ready to produce electricity.