Comparison between the short-term observed and long-term estimated wind power density using Artificial Neural Networks. A case study

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Abstract

The economic feasibility of a wind project is dependent on the wind regime since it relies on the power output of the turbines over the installation's working life. Consequently, the interannual variability of wind speed at a potential wind energy conversion site is an issue of capital importance.

Usually a wind data measurement campaign is limited to a period no longer than one year (i.e. short-term). Therefore, the process of decision-making for wind farm constructors must be based in this short-term data.

Various methods have been proposed in the scientific literature for estimation of the long-term wind speed characteristics at such sites. These methods use simultaneous measurements of the wind speed at the site in question and at one or several nearby reference sites with a long history of wind data measurements.

In this paper, long-term wind power densities which have been estimated through the use Artificial Neural Networks (ANNs), will be compared to those which have been calculated by means of the short-term wind data (i.e. considered to be representative of long-term wind performance).

Mean hourly wind speeds and directions calculated in a 10 year period of time at six weather stations located on six different islands in the Canarian Archipelago (Spain) were used in this study.

Among the different conclusions which this study revealed, we can highlight that the wind resource estimation based on ANNs is better than that dependant on short-term wind data. This is true when the correlation coefficient between the reference and candidate weather station is of 0.6.

Keywords: Wind Power, Long-Term, Artificial Neural Network, Wind Speed, Wind Farm

1 Introduction

Given that there is a cubic relationship between wind speed and wind power density, it is understandable that the electrical energy obtainable with a wind power turbine is very conditioned to the wind regime.

As stated by Hiester and Pennell [1], the interannual variability of wind speed at a potential wind energy conversion site is a very important issue.
The first concern about a site under consideration for a wind power station is with the long-term (many years) mean wind speed [2-8].

However, on many occasions there are no historical wind data measurement series available for the candidate site. This is a major obstacle for the assessment of the economic feasibility of a wind farm project on a time horizon equivalent to the useful life of the installation [9-11].

One option that can be used to get around this lack of data for the candidate site is to conduct a wind data measurement campaign that covers a sufficient number of years. According to Hiester and Pennell [1], accurate estimation of the mean values of the wind performance is difficult with less than 10 years worth of data. This option entails an inevitable increase in the costs of the measurement campaign and, more importantly, the postponement of any final decision-taking for a normally unacceptably long period of time.

In the particular case of the Canary Islands, the installation of wind farms is regulated through wind power tenders instigated by the Canarian Government through legislative decrees [12]. Normally only a short period of time is given between publication of these legislative documents and the deadlines for the presentation of proposals. As a consequence, a