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The importance of mean time in power resource assessment for small wind turbine applications

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ABSTRACT

Wind turbine for low power applications is a clean energy alternative to contribute global warming mitigation. The correct description of wind speeds is crucial to determine the economic viability of a wind power project. The sampling technique used in resource assessment is supported by van der Hoven's work, which concludes that minimum dispersion occurs between 0.1 and 2 hours mean time. International standards for wind turbine power characterization are also based on this work. Here we analyze the influence of using different mean times over data dispersion and wind resource assessment and analyze an adequate mean time for small wind turbine (*SWT*) applications that contributes to the development of reliable resource assessments. We found a maximum dispersion around 1 minute mean time. The stable wind conditions region was not found in the dispersion analysis presented here. Using this time in *SWT* resource assessment will detect the largest amount of changes in the time series that may contribute to power production. Resource assessments calculated show that using 1 and 10 minutes as mean times generates power resource assessments with a difference around 17%, which may be a factor that prevents *SWT* penetration. There exist at least two factors to obtain reliable power resource assessment, the *SWT* selection and ensemble mean time.

Introduction

The Intergovernmental Panel on Climate Change (*IPCC*) working group III report indicates that in 2010, the building sector consumed 32% of the final used energy in the world. One of the mitigation options is the renewable energy building integration (IPCC, 2014). The resource assessment for small wind turbine (*SWT*) urban applications is studied given the complexity of the system (Ledo et al., 2011) where the knowledge about wind interaction with suburban topology and the turbulence fields are determinant factors for *SWT* adequate location (Araújo et al., 2012; Drew et al., 2013; Sunderland et al., 2013). Recent works (Abraham et al., 2012; Ayhan and Sauglam, 2012; Bhutta et al., 2012) affirm that wind turbines recommended for building sector are the vertical axis wind turbines (*VAWT*); they showed the advantages of *VAWT* over horizontal axis wind turbines (*HAWT*) for small scale power generation.

Furthermore, some features of locally manufactured *SWT* used in rural electrification are the potential to accelerate the local economy as long as all processes involved must be socially embedded ensuring long-term sustainable development (Leary et al., 2012; Zhang and Qi, 2011). Besides, *SWT* as renewable energy source provides a clean source of electric energy that contributes to the increase in the human development index (Leary et al., 2012). Therefore, a key factor for this source penetration is to develop reliable resource assessment methodologies.

The main differences between small and large wind power generation systems are the power demand to meet, the devices' characteristics (Abraham et al., 2012; Dragomirescu, 2011; Kamada and Mikkelsen, 2011), their interactions with complex urban or suburban topography (Ledo et al., 2011; Mertens et al., 2003; Walker, 2011), the fewer requirements of installation, transportation, and technical skills to install, operate, maintain, and repair. Furthermore, deployment of small wind turbine systems avoids substantial investment needed for generating, transmitting, and distributing electricity. Therefore, small and large wind turbine applications should do not be analyzed as equal problems (Ameku et al., 2008; Elizondo et al., 2009).

One of the arguments against massive implementation of small wind turbines is the possibility of perturbing the stability of the electrical grid. However, recent studies have shown that the use of decentralizing power sources, as small scale wind turbines, may facilitate the onset of synchronization in modern power grids (Rohden et al., 2012).

The main element that determines wind power penetration is the resource assessment. This process consists of using only theoretical knowledge of wind speed region conditions, power curves of wind turbines properly selected, and their related costs to estimate power

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production cost. This methodology not only allows studying a particular region but is also useful to model country viability studies (Bortolini et al., 2014), so it can be considered a common and important methodology.

Accurate wind resource assessments are crucial to the successful development of wind farms (Singh et al., 2006). In common practice, the data acquisition system should have a sampling rate of the wind speed at least 0.5 Hz (one measurement per 2 seconds). This raw data is then processed into 10 minute averages where the data sets should be composed of mean, standard deviation, and maximum and minimum values (IEC, 2005).

Ten minute mean ensemble described before is based on van der Hoven's results (van der Hoven, 1957). He introduced the idea that stable wind conditions may be represented by the 10 minute mean ensembles time series. According to their observations, 10 minutes was the time with minimum dispersion among different mean times. The study used data measured in Brookhaven National Lab, Long Island, Upton, New York, located at 40° 52′ 24″ N, 72° 52′ 19″ W. Phenomena of stable wind conditions were also reported by (Wan, 2005). However, in a similar analysis, Rodriguez-Hernandez et al. (2013) described changes in statistical parameters from data located at the intertropical region.

In addition, previous work (Rodriguez-Hernandez et al., 2013) showed that the method of wind resource assessment based on 10 minute mean ensemble could lead to an underestimation of the energy production. The use of averaged velocities eliminates the highest values of the sample leading to lower dispersion values as well central tendency values. Also, it has been shown that different sampling interval of wind speed has an important bearing on the cumulative frequency curves. This will in turn lead to different wind turbine performances calculated based on these data (Makkawi et al., 2009).

Another use of the 10 minute mean ensemble is the methodology described in the international standard (IEC, 2005) about wind turbine power performance, which is mainly oriented to large wind turbines applications. Annex H of the standard is related to *SWT* performance test and is defined as the characterization time of the 1 minute average. Therefore, it is necessary to modify the characterization process in order to improve the reliability of the power curves calculated (Whale et al., 2013) since they are the key factors in techno-economic feasibility studies (Simic et al., 2013); however, there is no mention about the time to use in *SWT* resource assessment.

Moreover, *SWT* applications following this methodology by a user who intends to supply energy for home is not an easy task, which is an obstacle that prevents the penetration of this renewable energy source as electric supplier in domestic applications reducing the social sustainability impact that this renewable energy is capable to provide.

The work presented by Lubitz (2012) showed that for *SWT* under turbulent conditions, the power production is affected. It also mentioned that power curves calculated using IEC methodology do no account this effect of turbulence. Resource assessment using the methodology of the wind turbine power curves and probabilistic distributions presents limitations for the application of *SWT* in urban areas (Walker, 2011).

Here, we analyze the resource assessment methodology with statistical elements that are easy to reproduce and interpret that to help determine project reliability and contribute to social penetration in *SWT* applications. Besides, in the specific case of *SWT*, it is determined if the mean time presented in the standard is a valid value in the intertropical region.

To reach the objective, we discuss and present a mean time adequate for *SWT*. We take into consideration the capacity of small wind turbines to react to sudden gusts, the wind speed power spectrum dispersion analysis, complemented by a study of the influence of the average time in terms of power resource assessment.

Several resource assessments are calculated in order to demonstrate the impact of using a shorter mean time under mean ensemble technique. Three wind speed data samples were calculated by mean ensemble technique from a sampling rate of the wind speed of 1 second. Data used were recorded at Instituto de Energías Renovables, during a period of 50 days at Temixco, Morelos, México. (18° 50′ 23″, 99° 14′ 11″). The data were measured during a period of time of 50 days, with an anemometer "Vaisala Weather Transmitter WXT510" with an accuracy of $\pm 2\%$ installed at 24 m high from ground level, data logger was adjusted to measured and record wind speed with a frequency of 1 Hz. The mean times were established as 1/60, 1/12, and 1/6 of 1 hour. These new data sets, together with power curves of three models of small wind turbines, were used to compute wind power production.

Although it would be reasonable to question the 50 days used in this work, we consider it enough time because we are interested in studying the differences among mean times for a fixed period. In analogy power performance testing for a wind turbine section (n) of Annex H of IEC61400-12-1 (IEC, 2005), only 60 hours of data with specific characteristics are used. Increasing the period of time assessed will result in larger amounts of energy estimated; however, the analysis objects still are the energy differences under several mean times, which are presented and analyzed by percentage amounts.

This paper is organized as follows: first, we present the theoretical elements related to mean ensemble time technique, then we develop the conceptual frame, analysis, and discussion to wind speed dispersion spectrum and *STW* resource assessment. To complement our analysis, a wind resource assessment calculation is developed in order to clearly establish a relation between mean ensemble time and power resource assessment. Finally, the main conclusions are presented.

Wind speed spectrum for *SWT*

In this section, a wind dispersion analysis for wind data is proposed to determine an appropriate average time for *SWT* applications for intertropical regions. Next, the conceptual elements related to mean ensemble techniques are presented, and finally, the power resource assessment using a *SWT* power curve and the experimental data is calculated and explained.

Mean ensemble

Studies related to wind resource assessment are based on data sets calculated by mean ensemble sampling technique with a mean time of 1/6 of 1 hour. With the purpose of establishing a clear idea of this technique, we briefly explain it below.

Let U_{1s}, the set of all wind speeds recorded at intervals of 1 second[1] and has the form

$$U_{1s} = \{u_1, u_2, u_3, u_4, \ldots, u_n\}, \tag{1}$$

Where u_i is the velocity recorded at the i-second. That is, for all U_{1s}, the mean ensemble m with k-seconds as mean time is given by the Eq. (2),

$$\begin{aligned} m_K &= \frac{1}{k}\left(\sum_{w=1}^{k} U_w, \sum_{w=k+1}^{k+k} U_w, \ldots, \sum_{w=jk+1}^{jk+k} U_w\right) \\ &= (m_k, m_{k+k}, \ldots, m_{jk+k}), \end{aligned} \tag{2}$$

where j is the number of sets with k elements that can be computed from a sample with n elements.

As a result of using Eq. (2) over the 1 second record data, it is possible to obtain an extra time series for the standard deviation for each k set. This information is obtained from Eq. (3), were sub-index K corresponds

[1] We assume in this work continuous data.

to the same rate time used to calculate the averages by mean ensemble technique in Eq. (2).

$$STD_K = \frac{1}{\sqrt{k}}\left(\sqrt{\sum_{w=1}^{k}(x_w - m_k)^2}, \sqrt{\sum_{w=k+1}^{k+k}(x_w - m_{k+k})^2}, \ldots, \sqrt{\sum_{w=jk+1}^{jk+k}(x_w - m_{jk+k})^2}\right) = (STD_k, STD_{k+k}, \ldots, STD_{jk+1}) \quad (3)$$

These dispersion time series are used in the "Horizontal wind speed spectrum" section to develop a wind speed power dispersion analysis associated with *SWT* applications. In the "Wind resource assessment" section, three data sets were calculated with $k = 60, 300, 600$ seconds ($m_{1\mathrm{min}}$, $m_{5\mathrm{min}}$, and $m_{10\mathrm{min}}$, respectively). These wind speed data sets are then used to study the influence of mean ensemble time over power resource assessment.

The following section describes the concepts related to the analysis of wind speed power spectrum dispersion which will provide useful elements to determine an appropriate mean time for *SWT* projects.

Horizontal wind speed spectrum

The fact of using 1/6 of 1 hour as mean time is based on van der Hoven's work which provides an interpretation of the minimum in the horizontal wind speed spectrum minimum. He states that this minimum represents stable wind conditions since around this rate time the lowest dispersion is located (van der Hoven, 1957).

In Fig. 1, we redraw the horizontal wind speed spectrum, in which we observe two major eddy-energy contributions: one peak occurs at a mean time of 4 days, and a second peak occurs a mean time of 1 minute. According to van der Hoven's work (van der Hoven, 1957), the former peak is due to wind speed fluctuations caused by migratory pressure systems of synoptic weather-map scale. The latter peak is in the micro-meteorological range. From here, it is clear that in a standard wind speed spectrum, there will be major eddy energy at low frequencies, of the order of 1 minute. These variations of wind speed are out of the range of steady situations observed on 10 minute periods.

Thus, the mean time of 10 minutes is supported by the existence of a region of small variations in the spectrum which are called of quasi-stable wind conditions. This time may be a good approach for some geographical regions where the dispersion presents such minimum; however, in those where a wide range of variations exists over time, it will not.

Moreover, large wind turbines cannot follow fast changes in wind speed. The main difference between large and small wind turbines is their capability to react to sudden changes of wind speed. We will call this capacity as dynamic response to wind speed change. This capacity for an *SWT* to react to sudden gusts is an element that contributes to power production, but it is not presented in large turbines. From this fact, we consider that using an average time of 10 minutes by mean ensemble technique results as a high-frequency filter that may be consistent for the dynamics of a large wind turbine, but not for a small one. Thus, when large wind turbines are used in resource exploitation, it is prudent to select an average time that presents minimum dispersion or "stable wind conditions"; unexpected gusts of an order lesser than 10 minutes will not be followed by these devices and hence will not contribute in power production. Therefore, using 10 minute mean ensemble as mean time is consistent with the dynamic characteristics of the modern large wind turbines, but *SWT* may use a shorter mean time due to the variable speed and faster response.

In this paper, we focus on *SWT* where sudden gusts will provide contributions to power production due to the fast dynamic response of the device (Dragomirescu, 2011; Ozgener, 2006; Wright and Wood, 2004) and its interaction with the micro-meteorological site conditions. Therefore, using a 10 minute average rate does not seem to be a reasonable procedure for *SWT*. The fact of considering a 10 minute mean ensemble in resource assessment for *SWT* for a fast wind variation region leads to an underestimation of the resource which has as main consequence the rejection of the site as a clean electric supplier (Rodriguez-Hernandez et al., 2013).

In order to evaluate the 1 minute average time by mean ensemble technique as appropriate for *SWT* applications, a methodology to study the influence of mean ensemble mean time with data dispersion is presented. This methodology is computed from 1 second wind speed data records, and we obtained two new data sets based on mean ensemble and its corresponding standard deviations *STD* under the following average times:

$$K = \{2\ldots9, 10\ldots90, 100\ldots900, 1000\ldots4000\}$$

with increments of 1, 10, 100, and 200 seconds, respectively. Time series m_K and STD_K represent data sets calculated under mean ensemble and the consequent dispersion arrange, both share the k-th mean time.

To each STD_i computed, a power spectrum analysis (Koopmans, 1995) is calculated. The maximum power spectrum contribution is detected and plotted. This graphic representation provides useful information to establish the maximum dispersion of the wind speed that will represent the micro-meteorological conditions where an *SWT* has its interactions. To develop the analysis of wind speed dispersion spectrum, a Matlab code was written following the flow diagram presented in Fig. 2.

The first element that we present as a result is the graphic representation of one of the m_K and STD_K time series. In Fig. 3, we graph the first 30 minutes of the 1 minute average time series $m_{1\mathrm{min}}$ represented by

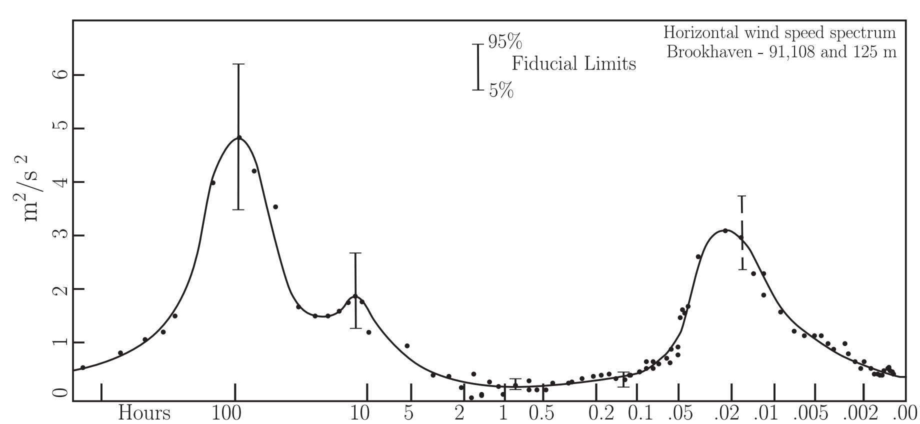

Fig. 1. Van der Hoven's horizontal wind speed spectrum; the minimum is located in the neighborhood of 10 minute mean ensemble; the second peak represents micro-meteorological phenomena. Reconstructed from van der Hoven (1957).

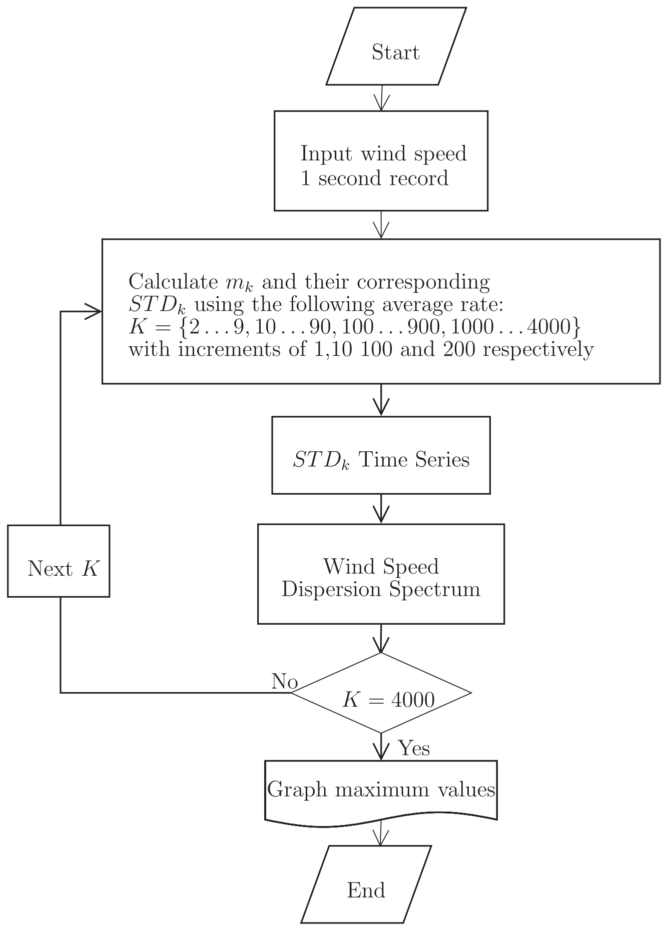

Fig. 2. Flow diagram of Matlab's code written to study wind speed dispersion spectrum.

the symbol □. Each point presents the 1 minute arithmetic mean of the original time series and their corresponding standard deviation STD_{1min}. This latter time series is used to develop the spectrum analysis. It is important to notice that the size of the error bars do not have the same magnitude, which confirms the variability of the wind speed.

The time series corresponding to m_K and STD_K power spectra for each STD_K has been presented. Now the power spectrum is calculated; as a result, we present Fig. 4, which contains the power spectra maxima of each STD_K time series computed, as well as the corresponding spectra for STD_{1min} and STD_{10min} represented by the symbol □ linked with a solid line and Δ symbol linked with a dash line, respectively.

In Fig. 4, we observe that STD_{1min} and STD_{10min} present power spectrum contributions in two frequencies; however, there is a considerable difference between maxima equivalent to 250 m^2/s^2. This confirms that spectral peak dispersion is near 1 minute average time which according to van der Hoven's work (van der Hoven, 1957) represents the micro-meteorological conditions of the site where the interactions at this scale contribute to power production in *SWT* applications.

In Fig. 4, the maximum corresponding to m_{1hr} is plotted at the left inferior region of the figure represented with the symbol ○. According to van der Hoven's spectrum, there is a zone of stable wind conditions between the 0.1 and 2 hours where the dispersion is minimum (see Fig. 1). This zone of stable wind conditions cannot be observed in Fig. 4. Instead, there is a significant difference between the STD_{10min} and STD_{1hr}. This behavior means that there is no region of the spectra with minimum dispersion conditions; therefore, for the site where the data were recorded, 10 minutes as mean time mean ensemble does not represent a reliable measure for stable wind conditions. This may be caused by the geographical characteristics of the site where the data were recorded; in the intertropical region, fast wind speed changes are common.

In the following section, we present an analysis to determine if these fast wind speed changes nondetectable by an mean time of 10 minutes has influence over power resource assessment.

Wind resource assessment

Different average times and dispersion wind speed spectrum have been studied for a common data sample; in this section, we quantify the possible changes of using different mean times to wind resource assessments. In the first place, Eq. (4) represents the energy per square meter available, where ρ is the air density and $f(U)$ is the probability density function that represents wind site regime (Manwell et al., 2010).

$$P_w = \frac{1}{2}\rho A \int_0^\infty U^3 f(U) dU \tag{4}$$

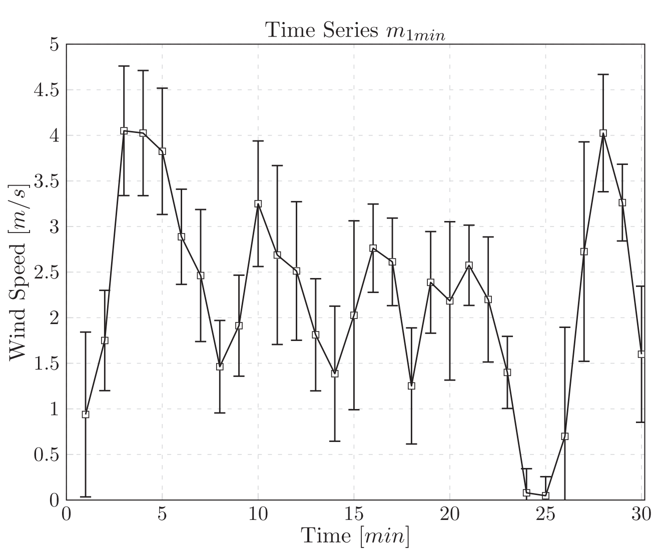

Fig. 3. m_{1min} time series with the corresponding standard deviation STD_{1min} of the first 30 minutes of the 50 day total sample.

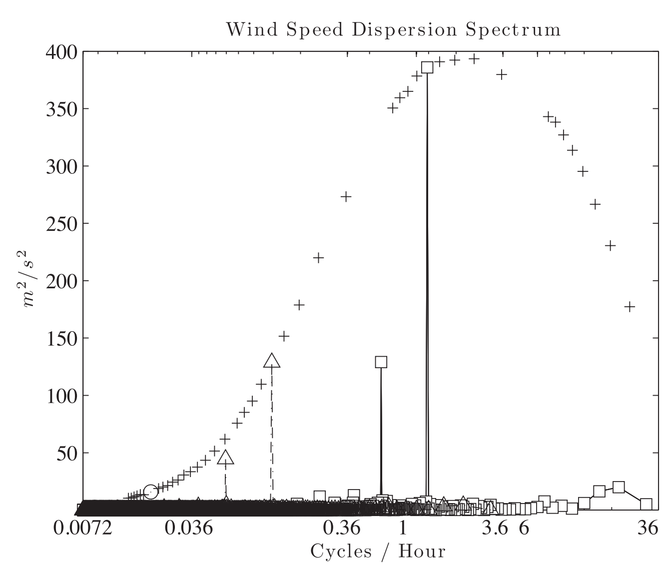

Fig. 4. Maxima of the wind speed dispersion spectrum with +. Besides is plotted the power spectra corresponding to STD_{1min}, STD_{10min}, and STD_{1hr} represented by □, Δ, and ○ symbols, respectively.

For a given wind speed regime represented by a probability distribution, $f(U)$, and the wind turbine power curve $P_w(U)$, the average wind turbine power, $\overline{P}_w$, is given by the expression (5). This methodology is common in *SWT* power output estimation (Walker, 2011).

$$\overline{P}_w = \int_0^\infty P_w(U) f(U) dU \tag{5}$$

Taking into account the specific needs of a *SWT* project where it is important to produce energy at the lowest wind speed and using the mean time proposed in the last section, three resource assessments are computed using three commercial *SWT*, which were selected in order to match wind speed conditions and optimize resource exploitation. Their main and common technical characteristics are their lowest cut in speed and similar swept area as reported in Table 1.

The wind turbines selected were a) Bergey BWCXL1 (Bergey-Wind-Power, 2012) with a rotor diameter of 2.5 m and nominal power of 1 kW, b) Earth Tech ET500 (Earth Tech-Energy-Systems, 2012) with a rotor diameter of 2.5 m and a nominal power of 500 W, and finally, a c) True North Power (True-North-Power, 2012) *SWT* model "Arrow" with a rotor diameter of 2 m and nominal power of 1 kW.

To establish a clear idea of the calculation process, we present the resource evaluation for $P_{1\min}$ and North Power *SWT*. In Fig. 5, the Weibull probability distribution as $f(U)$ and the power curve of the *SWT* selected as P_w in Eq. (5), times the hours of operation during the 49.9 days are presented. The result is $P_{1\min} = 10.49$ kWh, as shown in Table 2.

Table 2 was computed to analyze the influence of mean time over wind power resource assessment; this table presents the available energy and energy production for each *SWT*. Using Eq. (4) and the corresponding operating time, the second column is calculated, which corresponds to available power $P_{\text{Available}}$; the third, fourth, and fifth columns present the results of resource power assessment using 1, 5, and 10 minutes as sampling times; they were computed through Eq. (5) and are represented by $P_{1\min}$, $P_{5\min}$, and $P_{10\min}$, respectively.

In Table 2, we observe that the fact of selecting a *SWT* is an extra element that determines power production assessment; therefore, it is important to establish a methodology focused on this concern (Simic et al., 2011). Furthermore, it is important to notice that although two *SWT* posses the same nominal power, their power production under the same wind conditions is not equal.

The next stage of the analysis consists on presenting the percentage difference between power resource estimations P_i and P_j with $i < j$, using Eq. (6). It is observed in Table 3 that it is a common fact among *SWT* that while sampling time is larger, a lower power is computed, which confirms the resource underestimation (Rodriguez-Hernandez et al., 2013); therefore, the highest difference is presented between 1 and 10 minute sampling time.

$$\text{Percentage Difference} = \frac{P_i - P_j}{P_j}, i < j \tag{6}$$

This underestimation is, in first place, caused by the assumption that using the arithmetic mean, implicit in mean ensemble technique, as a reliable representation of the original time series is valid. This implies that the recorded sample comes from a normal random distribution which is not necessarily true at shots periods of time (Boettcher et al., 2007). As an example of our statement, the probability density function commonly used on wind energy assessment is a Weibull function (Carta et al., 2009). In addition, there are regions in the world where bimodal distributions represent wind speed conditions (Jaramillo and Borja, 2004). Second, assuming wind speed as a normal random variable generates a significant lost of information of the original data set, e.g., its left assymetry; this is an important parameter since the highest speed produces highest power production (Rodriguez-Hernandez et al., 2013).

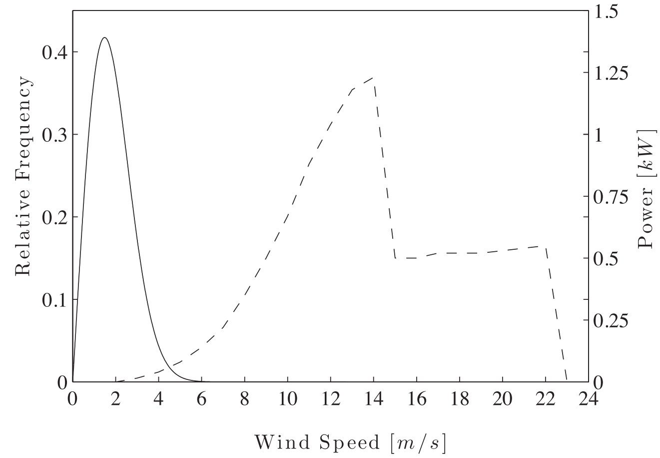

Fig. 5. Weibull fitted with scale and shape parameters $\alpha = 2.08$ and $\beta = 2.03$ and North Power *SWT* power curve in solid and dash lines, respectively.

It is important to mention that although the amount of data used in this study is not enough to detect seasonal or annual meteorological phenomena, which are outside the scope of this paper, it is useful instead to establish a clear analysis methodology concerning the wind speed data treatment in resource assessment. Resource underestimation and consequent analysis developed in this work are a consequence of the sampling technique, not of the evaluation time, since for the same period of evaluation the variable of interest is the sampling time used for the mean ensemble construction.

Thus, the sampling time proposed in this work responds to the need to take into account the sudden wind speed changes which contribute in power production given the dynamic response of the *SWT*. This range is located in the second peak of Fig. 1, which is near the 1 minute sampling time. In addition, projects that involve *SWT* interact mainly to micro-meteorological site conditions; second peak is associated to this phenomenon.

In fact, the use of a shorter mean time preserves important information useful in wind resource assessment. It takes into consideration a physical characteristic as the dynamic response of the wind turbine; it is clear that large commercial wind turbines do not present significant reaction to small gusts; however, an *SWT* does. In this paper, we propose an appropriate sampling time that is coherent with *SWT* technical characteristics and environmental interactions; this sampling time is around 1 minute, but it could be more precisely determined by the time response of the specific turbine used.

Although these results are somewhat expected, it is important to emphasize that the difference above mentioned is an important fact

Table 1
Basic specifications of SWT selected.

SWT	Rotor Diameter [m]	Nominal Power [kW]	Cut in speed [m/s]
Bergey	2.5	1	3
Earth Tech	2.5	.5	3
North Power	2	1	3

Table 2
The second column presents the available energy for each wind turbine model. The third, fourth, and fifth columns correspond to the energy produced using different data sets calculated for 1, 5, and 10 mean ensemble, respectively.

Wind turbine Model	$P_{\text{Available}}$ [kWh]	$P_{1\min}$	$P_{5\min}$	$P_{10\min}$
Bergey	43.05	16.02	14.28	13.34
Earth Tech	43.05	17.78	16.03	15.00
North Power	27.68	10.49	9.37	8.75

Table 3
Here, the percentage difference between the energy estimated for 1, 5, and 10 mean ensemble data sets and the corresponding wind turbine are presented.

Win turbine	Percentage difference [%]		
Model	P_{1min} and P_{5min}	P_{1min} and P_{10min}	P_{5min} and P_{10min}
Bergey	10.8	16.7	6.6
Earth Tech	9.8	15.6	6.4
North Power	10.7	16.6	6.6

that must be taken into account to develop reliable wind resource assessments. Therefore, to establish the correct sampling, mean time in function of wind turbine dimensions is important.

A reliable resource assessment in a specific wind project will be that where the dynamic time response of the wind turbine selected is taken into account. This dynamic response time will be used as the mean time under mean ensemble technique in the wind speed time series used in the resource assessment. In such a way that the most important aspect of the wind turbine: the behavior along time is taken into consideration; otherwise, this information is lost by the way the power assessment is computed. Therefore, the inclusion of the turbine dynamic response to the resource assessment will be the reliable way to get closest assessments near to real power production.

Conclusions

We study the mean ensemble as sampling technique, calculated several mean ensembles using different mean times to analyze the behavior of the dispersion and therefore determine an adequate mean time for *SWT* applications; in addition, we analyze the influence of the selection of mean time over resource assessment.

From dispersion analysis, we found a maximum around 1 minute mean time. In *SWT* resource assessment, we propose using this time to detect the largest amount of changes in the time series, changes that may contribute to power production. From spectrum analysis, the amount of information contained in the time series is around two orders of magnitude bigger than that described by van der Hoven. Furthermore, the stable wind conditions region is not presented in the spectra analysis presented here; therefore, 10 minutes as sampling time does not necessarily represent the wind turbine operation conditions. Resource assessments calculated show that using 1 and 10 minutes as mean times generates power resource assessments with a difference around 17%, which may be a factor that prevents *SWT* penetration. Also from resource assessment, we found that similar *SWT* generates different power resource assessments; therefore, there exist at least two factors that must be taken into account to obtain reliable results in power resource assessment, the *SWT* selection, and mean ensemble mean time.

In comparison with large wind turbines, *SWT* application responses to different necessities, design, technical characteristics, and energy demand are the main elements that establish a clear line between these applications; therefore, the use of the same paradigm for resource evaluation will lead to unreliable results. In this work, we present a new element that contributes to generate an adequate paradigm according to *SWT*'s applications.

We stress that the selection of the mean time has to correspond to the *SWT* dynamic time response; therefore, we suggest that this important parameter for *SWT* should appear in devices' technical specifications.

It is a common task to find in the literature related to wind resource assessment based on data from existing meteorological stations that uses 1 hour mean ensemble, the common conclusion is the rejection of the site as a large power supplier. As discussed in this paper, it is recommended to take into consideration the adequate mean time for mean ensemble technique and the wind turbine dynamic response time.

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