Utilization of synthetically generated hourly wind speed data in the optimization of Wind-Batteries stand-alone systems.

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Abstract. This paper shows a study of the influence of the type of wind data in the optimization of Wind-Batteries stand-alone systems. We have considered two types of input data for the wind speed: 1) measured wind speed hourly data for a whole year and 2) monthly average wind speed data. When using the second type of data, we generate synthetically the hourly wind speed data of the year, and we force a certain number of consecutive days of "calmness" (in this case wind speed lower than 3 m/s) in the month of most time of calmness (generally December or January in Zaragoza). The results show that, using monthly average wind speed data, if the number of consecutive days of forced calmness is adequate, the optimal system found by the optimization tool is the same as the one obtained using the measured wind speed hourly data. Thus, the method of generating wind speed hourly data synthetically is validated to be used in the optimization of Wind-Hybrid systems.

Key words

Stand-alone Wind-Batteries systems, generation of hourly wind speed, optimization software.

1. Introduction

Stand-alone Wind-Batteries systems are not very usual, as hybrid systems including Photovoltaic or Diesel are more reliable and usually lest costly than the systems that use a single source of energy [1].

The main problem in Wind-Batteries systems is the variability of wind speed. In stand-alone systems this aspect is even more important than in grid-connected systems, as wind resource is the only primary source of energy to supply the load. From one year to another the performance of a stand-alone Wind-Batteries system can change drastically, as the wind speed can be different in average values and in distribution during the year. If the electrical load to be supplied is critical, another source of energy must be added, generally Photovoltaic panels or Diesel genset, or both. Even for non-critical load, the use of hybrid systems is encouraged by many manufacturers of wind turbines.

In this work we have considered only Wind-Batteries systems (Fig. 1) to study the influence of the wind speed data in the optimization of the system. However, the conclusions obtained can be extrapolated to wind-hybrid systems, and should be taken into account in the optimization of wind-hybrid systems.

The optimization of the system is done by HOGA (Hybrid Optimization by Genetic Algorithms) software, developed by the authors [2,3].

We have considered two types of input data for the wind speed:

- Measured wind speed hourly data for a whole year.

- Monthly average wind speed data for a whole year.

Comparing the results of using one type of data or the another one, we conclude that the use of monthly average wind speed data can be correct, taking into account some considerations.

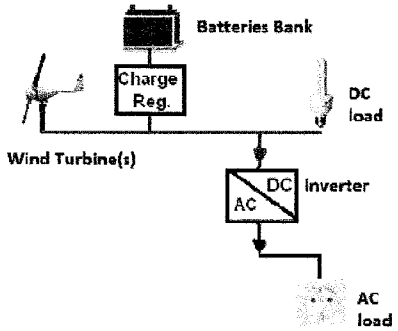

Fig 1. Wind-Batteries system.

2. Model to generate wind speed hourly data

If we use as input data the monthly average wind speed, we must generate hourly wind speed data so that HOGA can simulate the systems in steps of 1 hour. Different methods to generate hourly wind speed series are in the literature, some of them use ARMA models [4]. The model used by HOGA to generate synthetically wind speed hourly data is a simple model, shown in [5].

Wind speed hourly data $v(t)$ is calculated by equation (1):

$$v(t) = v_p(t) + \alpha_v(t) \quad (1)$$

Where $v_p(t)$ is the part of wind speed which indicates the dependency of wind speeds upon the time of the day: