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Laboratory Test System for Small Wind Energy Generators

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Abstract. This research work is devoted to the development of a set-up facility for testing Permanet-Magnet Synchronous-Machines (PMSM) used in small wind energy generators. The developed test system can be used not only for PMSM parameters characterization but also for the study of the performance of the power electronic associated to the electrical machine.

1. INTRODUCTION

Small Wind energy is a hot topic. A study of the American Wind Energy Association (AWEA) [1] shows that even considering the economic downturn, the U.S. market for small wind generators grew a 15% in 2009 with an added capacity of 20.3 MW. Fig. 1 summarizes the 2009 global sales considering both off-grid and on-grid applications. The aggregated data shows over 10,000 new generators and pushes the total installed capacity in the U.S. to more than 100 MW. AWEA defines Small wind turbines (SWT) as having a generating capacity up to 100 kilowatts (kW) (18 m or 60 ft rotor diameter).

Spain can be considered a reference model regarding wind energy generation. However, the total installed power of small wind generator is below 7 MW. It is expected that the installed power will increase in the nearest future with the development of the smart grids and the distributed generation paradigm. At the moment there are more than 526 small wind turbines from 190 different manufacturers around the world [2]. The turbines can be included in two different sets:

- 426 Horizontal Axis Wind Turbines (HAWT)
- 100 Vertical Axis Wind Turbines (VAWT)

Acording to Fig. 1 it is expected that set-up facilities like the system it is presented in this paper will be necessary in the next future in order to test the performance of the electrical machine and the power converter.

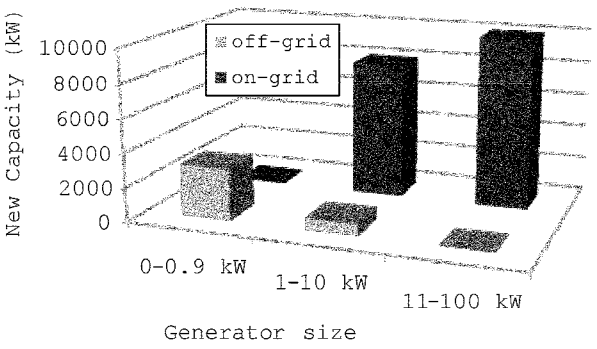

Figure 1. 2009 global sales of the U.S. small wind generator market [1].

2. SET-UP ARCHITECTURE

The architecture of the set-up facility is summarized in Fig. 3 and 2. The generator is a three-phase PMSM whose output is rectified by a full-wave rectifier. The dc component is adapted to a suitable value which can be inverted in order to inject the power to the grid.

Fig. 4 shows the set-up with all the components. An electronically regulated dc motor is used as a primary motor. In [3] the rotor blade performance can be evaluated by means of an axial flow fan which provides the wind source. Both torque and speed are measured in order to compute the mechanical power converted by the generator. The electrical magnitudes voltage, current and power are measured at all the stages of the conversion