Editorial

Special Issue on "Micro Wind-Power Applications"

Antonino Marvuglia*

Public Research Centre Henri Tudor (CRPHT), Resource Centre for Environmental Technologies (CRTE), 66, rue de Luxembourg, L-4002 Esch-sur-Alzette - Luxembourg

The achievement of technologically efficient solutions for energy generation, distribution and usage represents a crucial need of modern society, both for environmental and economic reasons. An important role in tackling future energy challenges is played on one hand by the replacement of the electrical energy production from conventional fossil based (coal, natural gas, and oil) sources to renewable energy sources (among which wind power still plays a key role) and on the other hand by the usage of highly efficient and reliable power electronic converters to optimize production, distribution and final use systems. Furthermore, the process of energy market deregulation has nowadays opened new perspectives based on a distributed green energy generation.

In the modern world energy landscape, wind power has indubitably become an economically attractive option for commercial electricity generation and can count installations in more than 70 countries all over the world. But if large wind farms have become a common sight in many locations worldwide and public attitudes towards the visual impact of wind turbines are changing, the penetration of small-scale wind generators has been characterized by a much slower development. Besides technical factors, their acceptance and integration in the urban landscape has not at all reached a full level of maturity. As observed by A. Ross [1], "satellite dishes on the sides of houses were once viewed as an eyesore. Now, they are so common we hardly notice them. Will micro wind turbines be viewed in the same way?".

It is worth nothing that in the common practice there is not a clear definition neither of what is classifiable as *small scale wind energy*, nor of the concept of *micro wind turbine*. As an example, RenewableUK (formerly named British Wind Energy Association – BWEA), the UK's leading renewable energy business organization, uses the term "*micro wind*" to describe a wind turbine whose size is under 1.5 kW (with a total height between 10 and 18 meters), the term "*small wind*" to refer to wind turbines whose size is between 1.5 and 15 kW (with a total height between 12 and 25 meters), and the term "*small-medium wind*" to refer to wind turbines whose size is between 15 and 100 kW (with a total height between 15 and 50 meters). The standards 61400 of the International Electrotechnical Commission (IEC) define *small wind turbines* those with a size under 50 kW, 16 meters diameter and 200 square meters swept rotor area approximately. However, according to Spera [2] and Gipe [3] *micro wind turbines* have a rated power between 50 W and 2 kW and a rotor diameter smaller than 3 m; whereas *small wind turbines* have a rated power between 2 kW and 40 kW and a rotor diameter between 3 m and 12 m. In James *et al.* [4] *micro-wind turbines* are instead classified in terms of their swept areas, which has to be <25 m^2 (with a rated power up to 6 kW).

Leaving aside their exact categorization, small-scale wind power generation systems have the advantages of low visual impact, very few moving parts and possibility of deployment in remote, isolated and sometimes off-grid locations (stand-alone configuration). However they also pose some problems since speed or torque regulation and maximum power control become difficult tasks. Fortunately, in order to handle this task, scientists have developed emulators that can be used to reproduce the static and dynamic behavior of a wind turbine without costly construction of the actual turbine blades. Furthermore, this offers a controllable test environment that allows the evaluation and improvement of control schemes for electric generators, which would be hard to accomplish with an actual wind turbine, due to the highly random variability of the wind speed.

The paper by Arifujjaman *et al*., presents a Wind Turbine Emulator (WTE) to investigate the power electronics performance and Maximum Power Controller (MPC) of a small wind turbine in a laboratory environment. The emulator models the nonlinearities and dynamics of a realistic wind turbine, including the furling action. It could be used for further research on small wind energy conversion systems and provides a test-bed to investigate and develop control strategies.

Other examples of investigation in the field of system control for small wind power generators are presented in the second paper by Arifujjaman and in the paper by Luna *et al*. The former describes a control strategy for a Permanent Magnet Generator (PMG)-based Small Wind Energy Conversion Systems, proving its operational stability for different wind speeds; the latter presents a thorough analysis and simulation of a grid-connected micro-wind energy conversion system based on a permanent-magnet synchronous machine (PMSM). The authors sought a trade-off solution taking into account cost minimization and simplicity of deployment and analyzed the system under two very different

*Address correspondence to this author at Public Research Centre Henri Tudor (CRPHT), Resource Centre for Environmental Technologies (CRTE), 66, rue de Luxembourg, L-4002 Esch-sur-Alzette – Luxembourg; Tel: +39 091 236 139; Email: marvuglia@dream.unipa.it

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time scales (0.6 sec and 24 hours). Through different series of numerical simulations they show that the system architecture and control strategy devised assure competitive performance with respect to a conventional turbine of the same peak power level, operating at the same average wind speed.

The paper by Messineo *et al.* shows an application of a micro wind turbine for powering telecommunications equipments in a transmission station located at the top of a mountain. Generally speaking, the advantage of employing this kind of system in remote locations is twofold: on one hand it guarantees the mobile network coverage in an area that otherwise would have probably remained disconnected; on the other hand it allows emissions savings, considering that very often off-grid mobile towers are powered by diesel generators with low efficiency and high greenhouse gases (GHG) emissions. Based upon technical considerations the authors chose a wind power system rather than a photovoltaic system to power the transmission station and after an anemometric characterization of the site at hand they selected the most suitable commercial small-scale wind turbine among various possibilities.

The last short paper by Franzitta *et al.*, presents an approach to the conversion of the power generated by a sea wave Permanent Magnet Generator (PMG) integrated in an offshore wind power farm. In order to compare two different technical solutions (called *decentralized* and *partially centralized* in the paper) the authors performed numerical simulations to investigate the behavior of a sea wave power farm composed by 10 generators integrated in a wind farm composed by 5 micro turbines. The performances of the two approaches are compared in terms of ripple of the d.c. link voltage, time of use of each inverter and continuity of generation. The authors show that the partially centralized approach is more efficient and reliable than the decentralized one.

The papers comprised in this Special Issue thus cover some of the main aspects related to micro wind power technologies and applications. However, the use of small turbines, especially in urban areas, is still a relatively under investigated domain. Further research efforts should be carried out by the scientific community to address crucial points which have not been investigated enough, such as: quantification of energy and carbon payback times of this kind of technology; problems and solutions for urban buildings integration of small-size wind turbines. In this research area I would like to mention two recent meaningful contributions: the PhD thesis of S.R. Allen [5] (and related papers) and the International Workshop on "Small scale wind energy for developing countries", held in Nairobi (Kenya) in September 2009. In 2010, only a few papers on building-integrated wind energy conversion systems appeared in the journals *Renewable Energy*, *Energy and Buildings*, and *Energy Policy*.

To conclude, I would like to express my appreciation to the authors of this Special Issue for their efforts in the realization of the papers submitted and for the cooperation showed during the review process. Additionally, I would like to express my acknowledgement to all the reviewers for their comments and feedbacks which provided a valuable support to the authors and helped them to improve the quality of their manuscripts. Finally I would like to address a special thank to Dr. Ting He, Editor-in-Chief of TOREJ, for giving me opportunity to organize this Special Issue, and Qurrat-ul-Ain Khan and Ghazal Ahsanullah, who have followed one another in the position of Assistant Manager Publications of TOREJ, for their assistance during the whole organizational process.

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