2nd Periodic Report

Publishable summary

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SWIP – New innovative solutions, components and tools for the integration of wind energy in urban and peri-urban areas

Grant Agreement: 608554

From April 2015 to September 2016

www.swipproject.eu

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Project context

The Wind Energy Roadmap, which was published by the European Commission (EC) on October 7th, 2009, and was presented and discussed at the Strategic Energy Technology Plan (SET-Plan) workshop, will play a key role in fighting climate change and in helping EU Member States to meet the 2020 targets identified by the new RES Directive of December 2008, which sets the following goals for the wind energy sector:

A wind energy penetration level of 20% in 2020.

- Onshore wind power fully competitive in 2020.
- 250.000 new skilled jobs created in the EU by the wind energy sector in the 2010 – 2020 period.

Currently, the major application of wind power is electricity generation from large grid-connected wind farms. However, following the changing trend of the energy sector from a centralized energy system to a distributed one, small wind systems and its hybrid applications are expected to play an increasingly important role in the forthcoming years, meaning a higher share in the energy generation. With the support of the smart grid technology and fostered by the directives and regulation associated to the sector, small wind turbines (SWTs) can now be connected to the electrical grid from the consumer-end and, little by little, contribute to the stabilization of the electrical grid. Due to this fact, small-scale wind energy has now been applied in fields such as mobile communication base stations, offshore aquaculture, agricultural and farming and sea-water desalination, among others, in several countries. Besides this scenario, the integration of small wind energy in urban and peri-urban areas is being a challenge due to the barriers the technology has at this stage of development.

SWIP objectives

The **main objective** of the SWIP project is to develop and validate **innovative solutions for small and medium size wind turbines** to improve their **competitiveness**, enabling and facilitating the **integration** and deployment into **urban and peri-urban areas**.

The new and innovative solutions will address the current barriers (turbulence, noise, vibration, aesthetic aspect, cost of technology, wind resource assessment, wind market, user friendliness, social acceptance and safety) that delay the market uptake of this technology. These solutions will: **reduce the costs** of the electric generator of wind turbines, providing **two new concepts for energy generation**; **increase the Cp ratio of the blades**, so that the number of hours that the SWT is producing increases by 9%, highly **softening or even eliminating the mechanical and acoustic noise** they currently produce; **reduce the maintenance costs of the SWTs up to 40%** by including two innovative elements (SCADA for preventive maintenance and magnetic gearbox) in the SWTs and improving the **integration** of the wind turbines in **buildings and districts with more aesthetic solutions**.

The project will develop **three different prototypes** to be integrated in **three different scenarios** (new energy efficient building, shore-line and industrial area), to validate the solutions and goals aimed, providing scalable solutions for different applications, covering several user needs.

Moreover, the project will **improve the current methodologies for wind resource assessment** into urban and peri-urban areas, reducing the RMS error in wind speed estimation until 8%, minimizing the risk and the opportunity costs of the small and medium size wind turbines when they are integrated in these environments.

Work performed since the beginning of the Project

The work performed in the project covers a period where the core of the works and studies of the project have already been developed. All work has progressed aligned with the requirements from the DOW with some deviations that have delayed the demonstration phase of the project.

All work packages have run simultaneously in this period. A total number of 14 deliverables have been submitted.

Main results achieved so far

With regard to the wind assessment, an improvement of the methodology for wind resource analysis in urban and peri-urban areas by means of the introduction of thermal stability and thermal stratification has been developed and successfully implemented in the software Meteodyn WTv5.3 and Urbawind v2.2. Also the wind resource in the three demo-sites has been characterized and prepared for comparison with the theoretical analysis.

Moreover, and related to the wind turbines prototypes, three generators (2kW, 4kW and 20kW), which will be installed in the demo sites (Choczewo, Zaragoza and Kokoszki, respectively), have been designed, constructed and tested. In addition, a generator prototype has been built with sintered Nd-Fe-B magnets with 3 at.% Dy and tested. Series of actions have been deployed in order to assess a more economic generators for small wind turbine:

- A segmented stator has been designed which would reduce the necessary man-hours in the assembly line and decreasing production cost (in case of mass production).
- New innovative post assembly magnetization technique has been conducted showing a technique technically viable, safer, which enhances production and more economically profitable than the conventional manual assembly technique.
- Modularity concept for permanent magnet generators has been assessed showing a cost reduction in terms of magnet investment.

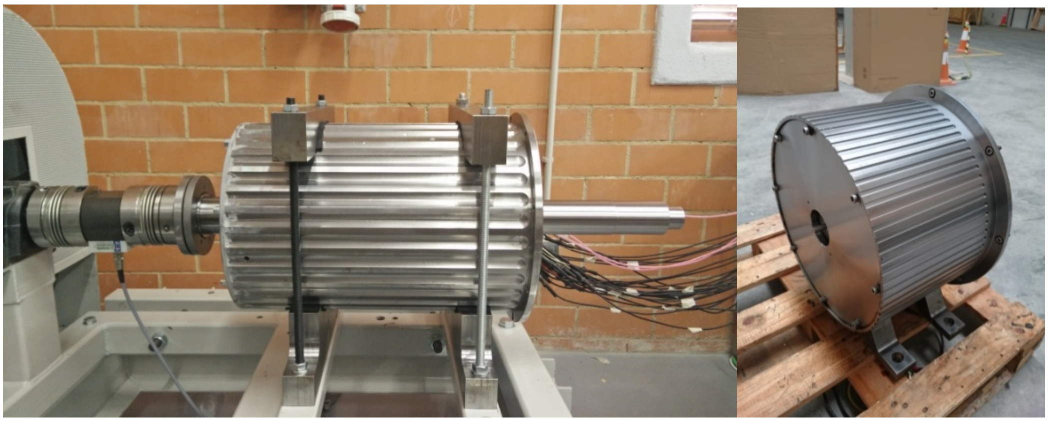

Figure 1. H4 generator prototype (left) and H20 generator prototype (right)

Blades' structures have been designed considering performance and noise generation. The blade design has been optimized by means of CFD analysis. Furthermore, the prediction of the effect of potential contaminants to the blade has been reported. Blades behavior has been tested in the wind tunnel and also passive pitch systems and yaws have been designed for H4 and H20 wind turbines.

Regarding the electrical part of the wind turbines, a full set of converters have been designed, manufactured and tested for the three wind turbines. In addition, a SCADA system has been designed and manufactured for H4 and H20 wind turbine which will allow checking meteorological variables and wind turbine features through a web based application.

Masts and anchorages for the wind turbines have been designed taking into account the characteristics of the demo sites as well as the wind turbines. In order to provide an overview of the possible Small Wind Turbine (SWT) integration solutions, a comprehensive atlas of typical building and models SWT integration solutions has been created.

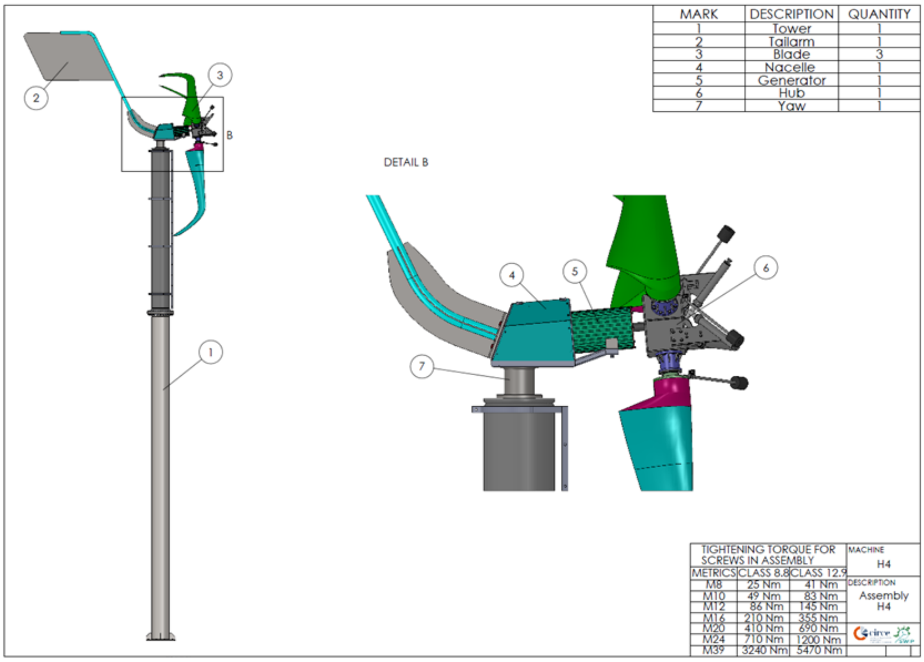

Figure 2.H4 prototype

Other outcomes related to the project development:

- Two separate state-of-art sound propagation codes for urban and peri-urban scenarios respectively were developed.
- Deployment plans for each of the three demos-sites

Expected final results

SWIP project sets up a comprehensive **benchmark** that includes the most significant European legal and technical frameworks regarding small wind energy turbines regulations, the generation technologies and the energy plans for cities.

The project will deliver a **methodology for wind resource assessment in urban and peri-urban areas**, able to predict wind speed in urban location, without the need of performing a measuring campaign, and to implement such methodology in software. By means of that software the consortium will be able to assess and validate the accuracy of the model in the three locations in the project.

SWIP project has a clear orientation to small and medium wind power which involves:

- The design of **an innovative and low cost wind generator** (between 1 and 100 kW) which could be adapted to different types of wind turbines deployments depending on its final emplacement. Two configurations of permanent magnet generator will be developed, one for direct drive connection and a second one for a gearbox connection.
- The design and development of **cutting-edge technology wind blades**, which maximize the wind energy conversion in each type of final model, addressing small and medium size wind turbines and considering both vertical and horizontal axis for different use. The new blades will also contribute to the objectives of reducing vibration and noise coming from those elements, addressing the overall operation goals established in SWIP.
- The implementation of a **Supervisory Control And Data Acquisition (SCADA)** system that will allow a better performance of the wind generator, through improved operation and maintenance. This system will be used for operation mode selection and reliability improvement through preventive maintenance. Converters will be able to work connected to the network. Furthermore, their control will satisfy "The Network Code on Requirements for Generators" which will be certified once they are installed in their final locations.

The SWIP project will also analyze the **structure and anchorage elements** of small and medium size wind turbines for their installation into districts and buildings and it will develop best practices guidelines, for the aesthetic integration of these systems into urban and peri-urban settings. The project will also develop and implement solutions in order to mitigate and to absorb the noise and vibration produced by the wind turbine and to study the existing regulations regarding the safety issues in small wind turbine operation.

SWIP website

The Project website is www.swipproject.eu. The web page is regularly updated with information of the Project.