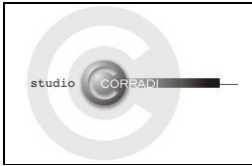




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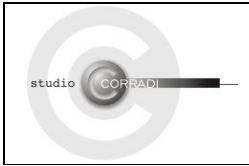
## A micro wind turbine developed for low environmental impact

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## 1. Definitions

- A micro wind turbine is defined as a wind system of max 20 KW, normally represented by a tower of max 20 m and a rotor with a max diameter of 8-10 m;
- A mini wind turbine is defined as a wind system of max 200 KW, normally represented by a tower of max 35-40 m and a rotor of max 30 m;
- Powers over 200 KW refer to large wind turbines.

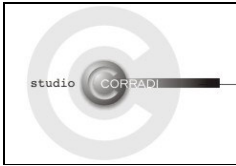
So far, in Italy, but also abroad, not much attention has been paid to micro wind systems. Only lately enormous advantages have been discovered with respect to traditional large wind systems.

## 2. Micro wind system advantages

Usually micro wind turbines characterized by a rated power range from 5 to 20 KW, a tower height range from 12 to 20 meters and a rotor diameter range from 6 to 10 meters, represent the best solution for the realisation of either stand-alone power systems for small activities (just like farms or isolated houses) or wind parks for the energy supply of small municipalities, communities and industrial areas.

The main reasons and advantages favouring the installation of micro wind turbines are:

1. In spite of the large wind systems, micro wind turbines show an almost no-environmental impact. As a matter of fact, if we consider the small size of tower height (< 20 m), the low tip speed of rotor blades (up to 90 m/s in spite of 200 m/s of large wind turbines) and the resulting noiseless of micro wind rotors, we can define the micro wind turbines as very high environmentally friendly power systems.
2. For the mentioned reasons, any kind of authorization is not requested to the authorities in order to proceed with the installation of micro wind turbines.
3. Since micro wind systems don't need great electric transformation cabins but just simple tri-phase connections working at low tension, it's not necessary to carry out great infrastructural works to execute the installation of micro wind turbines;
4. Micro wind systems are well suited for different energy demands just like those of small centres and municipalities up to 4-5000 citizens, which are willing to cut their electricity charges for public utilities;



5. Micro wind systems surely represent one of the best answer to the new world-wide energetic tendencies which are favouring the creation of small energy production nodes, spread over the territory and interconnected between themselves (*diffuse energy propagation*).

The system here presented adds some further advantages as follows.

### **3. A new micro system designed and manufactured by Studio Corradi**

In order to well understand the advantages due to the micro wind generators completely designed and realized by Studio Corradi, a Research and Engineering Firm, is convenient to describe briefly some technical-constructive characteristics of this kinds of energy generator machines.

These kind of wind generators are especially suited and optimized to work with low and medium wind speeds (up to 10 m/s), they present no complex and expensive electronic systems to realize the power control, and their rotor blades are manufactured with composite materials reinforced with natural fibers.

This latest peculiarity represents the more important innovation in the field of the materials used to realize rotor blades of wind turbines. At the present time, no attempts have been made to use bio-composite materials for this purpose except for a research centre of Oxford University which is trying to use natural fibers in order to realize the blades of large wind turbines.

Studio Corradi, in collaboration with the University of Perugia and Rome "La Sapienza", has been making a three years study and laboratory tests in order to achieve the first prototype of a wind micro turbine blade made of biocomposite material reinforced with bamboo natural fibers.

The term "biocomposite" indicates a composite material in which at least one of the constituents (fibres reinforcement of matrix) is derived from renewable resources whose peculiarity is to be easily restored without causing a lack of the raw materials and energy available in nature.

By means of standardized international procedures is possible to quantify and estimate the environmental damages deriving from the realization of a product or the supply of a service.

Applying this scientific method to both a traditional composite material (glass fibers in epoxy resin) and to a bio-composite material (bamboo fibers in epoxy resin), it has been possible to analyze and compare environmental loads related to both materials during all their life cycle.

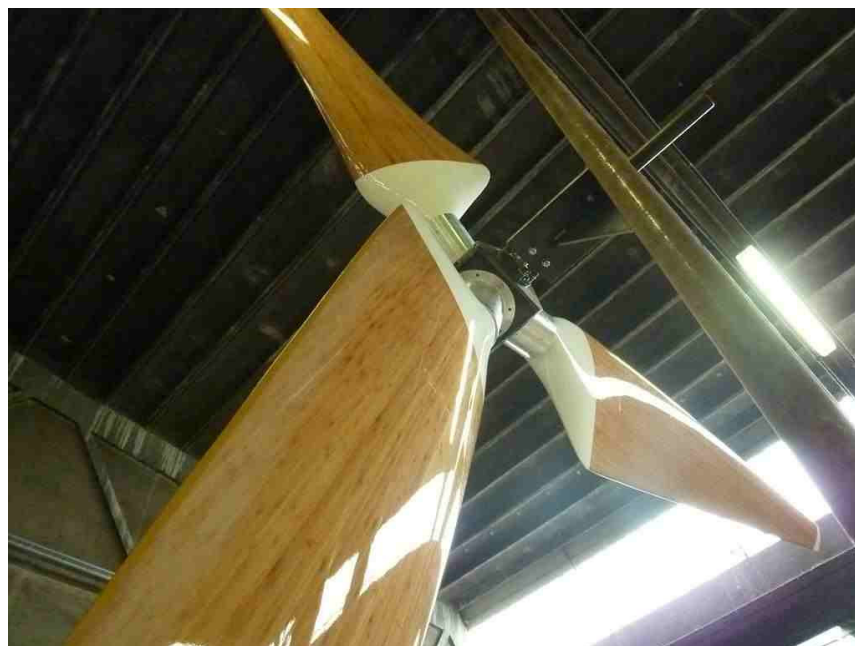


Figure 1: Micro wind turbine rotor made with bio-composite material

This approach has been helpful to verify a reduction of the environmental impact relative to the use of the biocomposite material, especially with regard to the carbon dioxide emission in atmosphere.

Besides this ecological advantage, the biocomposite materials introduce other favourable characteristics like the lightness in terms of weight and the mechanical properties comparable to those of the traditional composite materials that allows the employment of biocomposites also in structural applications just like in the realization of wind turbine blades.

It's worth underlying that peculiar law dispositions and certifications already exist to promote the employment of eco compatible materials in different kinds of applications, just like the nautical one or the bio furniture.

As the matter of facts if we consider the "pay back time" of the most common alternative energy systems (like photovoltaic panels or wind turbine generators), that is defined as the time necessary to the system to give back a quantitative of energy equal to that one consumed for its realization, it can be easily understood the great advantage deriving from the employment of a biocomposite material.

In fact both the synthetic fibers usually used for the realization of rotor blades or the modules of photovoltaic panels result to be highly energy-expensive because their realization request a very large amount of energy.

Using a bio-composite material reinforced with natural fibers like those of the bamboo plant, means to drastically reduce the "pay back time", passing from an order of magnitude of some years, by means of the employment of traditional materials, to some months with the employment of bio-composite materials.

Actually, no other system in the market has a low pay back time as the one here presented.

This is just an advantage of ethics kind (the return in energetic terms of the proposed system is much more reduced with respect to other wind systems already on the market) but not less important.

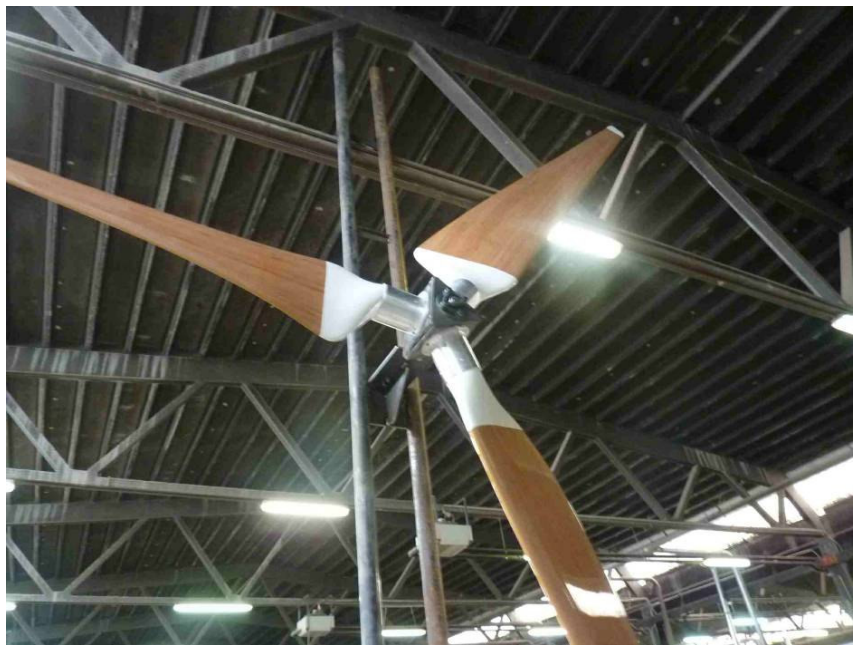


Figure 2: The biocomposite wind rotor

The use of the bamboo fibers, not only brings certain advantages under the ecological profile, but gives a significant contribute to reduce the environmental impact under the profile of the visual impact.

Wind energy systems determine an environmental impact mainly due to the occupation of the territory and the variation to the landscape. The location of the wind systems are always characterized by a great visibility and evidence to the naked eye.

For the exposed reason the visual impact constitutes a real problem and it is increased from the aesthetic characteristics of the materials usually used in such systems (metals and composites for the tower and the rotor blades).

The use of bamboo fibers makes possible the reduction of the visual impact thanks to a more harmonious integration on the territory and to the possibility to introduce an appearance completely similar to the wood with colours easily assimilated to those of the natural landscape.

#### **4. Maintenance**

Maintenance in wind turbines is really important. For this reason, Studio Corradi designed an automated system which allows a simply nacelle and blades maintenance.



Figure 3: Lowering automated system for nacelle maintenance



## 5. Technical data

Rated power:	6 kW @ 9.5 m/s wind speed
Max Power:	8 KW @ or > 12m/s wind speed
Start wind speed:	2.5 m/s
Maximum wind speed:	30 m/s
Rotor diameter:	6 m / 28.2 m <sup>2</sup>
Blades:	3 blades in biocomposite reinforced with natural fibers
Tower height:	13 m, provided with an hydraulic system to ease the maintenance
Speed rotation range:	40-260 rpm
Over speed control system:	Tail rotation electro mechanically controlled
Emergency break:	Electro mechanical break (Warner Electric ERS VAR99)
Maximum tip speed:	88 m/s
Alternator:	Three phase permanent magnets
Nacelle weight:	350 kg
Rotor Thrust:	3960 Newton at 15 m/s wind speed
Maintenance:	2 years
Guarantee:	2 years

