

Roda-de-Vento, a Proposal for an *Ex-libris*

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ABSTRACT

The idea described herein is a proposal for an artistic-technological installation on the coastline of Porto, Portugal. The aim is to install in a seaside esplanade a giant bicycle wheel (*Roda-de-Vento*) which will turn with the wind. This element will be both an architectural construction praising those who often use the esplanade for riding bicycles, roller-skating, wind-cars, etc., as well as a wind electrical generator, aimed to directly promote to citizens the potential hidden in renewable energies¹.

1. Introduction

During these last years, the coast of Porto and of its neighbouring towns has observed significant transformations due to general works. These have started in the wake of the event “*Porto2001-European Capital of Culture*”, and were prolonged for some years till nowadays with an intensive change of the town’s view. Despite the long time passed in works, and the negative effects that such a situation had brought to the population, some of the spaces have definitely changed for the better and have even stimulated people to change their own habits. The most important was a surge in the outside door practice of walking and sports. The two works deserving special mention, in our point of view, since they had effectively contributed positively to a better life in the town, were the

creation of the “*Parque da Cidade*” (City Park), an extensive and natural place where people started to engage with nature, as well as walking, running, etc., finally fulfilling the urgent need for a natural place to compensate for the saturated ambience of the inner city, and the “*Passeio Alegre*” (seaside esplanade), where a way of several kilometres for walking, cycling, roller-skating, etc., was also built along the seaside.

The interventions in these places were diverse and of various types, including architectural and artistic, but time has shown that the most important aspects achieved with those works were the dynamics created in the population by simply opening and making available places of such importance. In effect, each of them represents nowadays a place of choice for many people, where life runs in its most natural and healthy form.

The subject of this article is related to the preservation of such a spirit and to a trial of including in it the interesting approach of renewable energies (in this case, from the wind). The running wheels of the bicycles and roller-skates that can usually be observed moving along the seaside esplanade, as well as the wind cars and wind-boards, kiteboards, etc. which may also be found there, represent most of the inspiration for the present proposal. The remaining contribution was due to some giant bicycle wheels installed in some places around the world for diversion purposes, as the one presently installed in London, next to the *Thames*, or the one installed in a place for skating in Japan, represented respectively in figures 1 and 2.



Fig. 1 Giant bicycle wheel installed near the Thames, London, for diversion



Fig. 2 A similar type of wheel installed in some place for skating in Japan

2. The present situation

Bordering one of the sides of “*Parque da Cidade*” (City Park), and extending along several kilometres north-south next to the Atlantic Ocean, the seaside esplanade is at present, as mentioned before, a way for people to enjoy the pleasures of breathing the sea air, walking, the beach, and the practice of sports. Nevertheless, the presence of tourists in such areas is rare, perhaps because it is a futuristic place and in effect with no special motifs for the photographic cameras. Besides the little castle which stands in a corner (“*Castelo do Queijo*”), nothing there seems yet to contain history or any interesting conceptual idea deserving the attention of a tourist. So, the space is simply noticed as being good for racing bicycles and to enjoy the pleasures of the seaside and, moving a bit upwards, for the nature of “*Parque da Cidade*”. The next figures aim to give a better view of this site, more precisely of the place where we propose

the *Roda-de-Vento* (wind wheel) to be installed.



Fig. 3 Bicycling and roller-skating in the seaside esplanade, a view to the north, to the town of Matosinhos



Fig. 4 View to the south, in the direction of Porto, with the little castle (*Castelo do Queijo*) visible, at the right

Although the practices of sports observed in this place already associate a certain movement with it, our proposal is that the installation of a wind wheel will operate as an architectural element of synchronization of such a movement, better integrating people’s activity in the windy and wavy scenery, by means of a human construction. This may be the intention behind the artistic nature of the proposal.

In addition to this, however, and considering that the places around are already too crowded of divertive offers, our proposal has the strong objective of also inducing the fascination of renewable energies in people, as we said. For that reason, the wheel will also be used to transform the wind energy in electrical energy, we believe in sufficient quantity for satisfying the energy demand of several houses in that space (perhaps the bars operating in the beach). The next figure is another view of the site.



Fig. 5 Another view to the south, in the direction of Porto

3. The Roda-de-Vento

We defend that the *Roda-deVento* must be developed in the dimensions of a giant wheel, at least 10 metres in radius, so that the construction emerges from the ambience and naturally transforms in a sort of signal, an *ex-libris*, being seen from far, and, that way, imposes itself to the ambience as the main synchronizer of the movements between the sea waves and the people's activities. During those hours that the activities are reduced or the site is empty, this wheel will be seen as a solitary and beautiful producer of electrical energy, exhibiting perhaps the maximum of its fascination. We have in mind to paint it in certain places with fluorescent ink, which will be best visible during the night.

The wheel presented in this article is not, of course, in its final design and dimensions, but solely represents a first approach to the idea. Nevertheless, the usage of a giant bicycle wheel, perhaps made of aluminium, as the basis for the wind turbine, is definitely the proposal, since it fits perfectly the two primer objectives of the project.

At the same time, we expect to enrich this system with a level of automation which will be principally used for security reasons in the case of very strong winds, which will make the wheel turn around by itself and face the wind direction with the minimum area, therefore reducing the impact and the probability of breaking the structure. This feature may, of course, be also appreciated as another interesting concept for those who visit the location. The basis for this system can, therefore, be something like that represented in the next figure (Fig. 6).

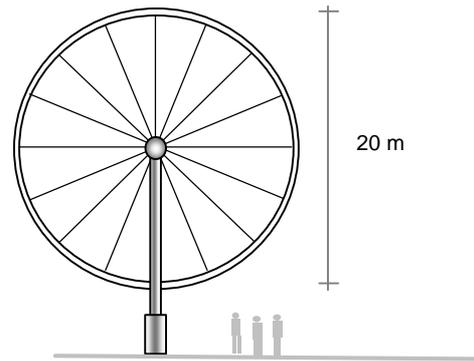


Fig. 6 The basis for the *Roda-de-Vento*

The transformation of this bicycle wheel into an efficient wind turbine will be easy; also simple will be the incorporation of the electrical generators (in number of two) into this structure.

4. Energy retrieved from the wind

Considering such an apparatus and such wheel dimensions, calculations show that the wind energy captured by this system may well be enough to power the bars presently installed at the same beach. Such calculations were made taking in account the following mathematical relations:

$$\begin{aligned} \rho &= 1,2 \text{ Kg/m}^3 - \text{density of the air} \\ E &= \frac{1}{2} m V^2 - \text{wind kinetic energy} \\ S &= \pi \cdot r^2 - \text{Area of the wheel} \\ P &= 1,9 r^2 V^3 - \text{Wind power received (Watt)} \end{aligned}$$

For a radius of the wheel of 10 meters, these equations lead to the following data:

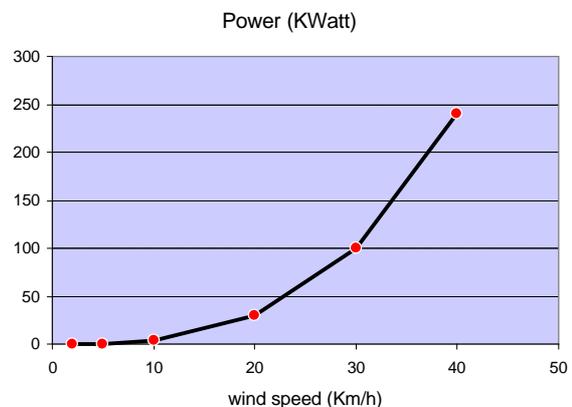


Fig. 7 Wind power received by the wheel in the case of low and medium wind speeds

Considering that: (1) the wheel would have a

power coefficient of 30%; (2) each bar in the beach would continuously demand 5KWatt for operation; (3) the wind in that place will normally have speeds between 20 and 30 Km/h (power received by the wheel would be around 30 to 100 KWatt); then the number of bars that could be served would be between 2 and 6. Of course, if the wind speed goes to 40 Km/h this number automatically jumps to more than 14. So, it seems perfectly possible to generate the necessary energy to supply the bars presently installed in the beach, since during the night they close while the generator continues to produce energy.

Notice that as the wind speed increases the power is increased by a cubic law (see figure 8), and, for instance, winds of 80 Km/h, which sometimes occur in the place, would represent a power of 2000 KWatt, enough to feed 120 bars!

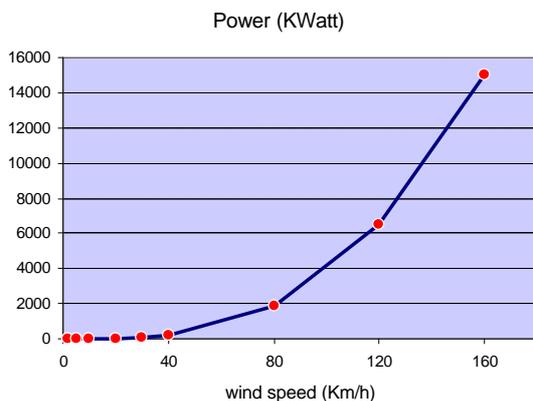


Fig. 8 Wind power received by the wheel for the case of high and very high wind speeds (danger of break)

Wind speeds superior to this will probably make the structure instable, so the wheel must rotate in order to minimize the area exposed to the wind. This will dramatically decrease the wind pressure on the structure and adjust the power generated to a reasonable lower level, protecting also the electrical generators.

The simplicity of this system is leading us to believe that the project may entirely be developed with national technology.

5. A simulated view on the future

The next figures intend to give a brief idea of how *Roda-de-Vento* will look when installed in the place we propose. These views, representing the future, are taken precisely at the same site as those of figures 3, 4 and 5, which represent the present.

So, the two situations can be compared. Through figure 9, for example, one can already get the idea of a synchronizing wheel, an environment synchronizer, while figure 10 shows the apparent simplicity of the construction and the way it lands in the scenery. It is interesting to bear in mind that the sea next to the wheel is usually used by people practicing surfing. Figure 11, shows the wheel in a turned position, as when avoiding strong winds.



Fig. 9 The wheel as an environment synchronizer

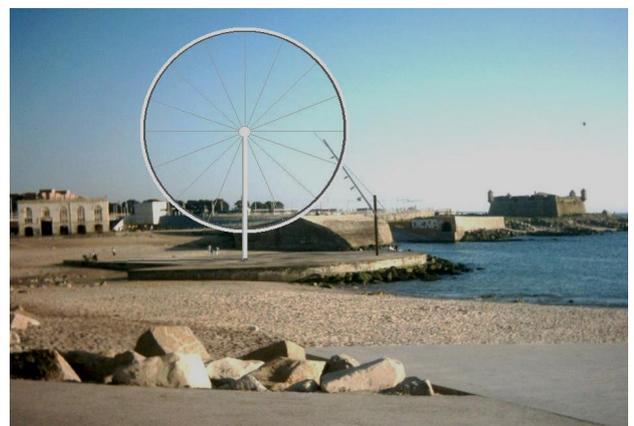


Fig. 10 The basic *Roda-de-Vento*



Fig. 11 Wheel rotated, to protect from strong winds

It is important to mention that the simplicity presented here will not correspond to the final design of the wheel, since it is still necessary to include certain blades to collect the wind and impulse the system, even if those blades are in principal to be almost transparent, in the present conception of the work. We have in mind, in effect, to maintain the fascination of the wheel by the simplicity of the wheel in itself, which also will be made as silent as possible, at least compared with the sea sound, to create even more the sensation of being suspended in people's imagination. This is intended not only to be an artistic effect, but also a work where an interesting concept will be exposed and alive. Therefore we expect to make of this building an *ex-libris* for people in general and, who knows, even for Japanese tourists who for sure will enjoy photographing it.

6. Conclusions

As was stated in this article, the proposal of a giant bicycle wheel as an artistic-technological installation in the seaside esplanade of Porto is expected to help improving both the charm of the place and the promotion for the usage of renewable energies. In effect, this wheel, which we named *Roda-de-Vento*, will be seen not only as an architectural dynamic construction honouring those who practice sports at the place, but also as an electrical generator directly retrieving energy from the wind. Its capacity for generating energy is, of course, dependent on the final dimensions of the wheel, but based on calculations considering a wheel of 10 metres of radius, it is expected that enough energy will be generated to fulfil the needs of the bars operating in the zone. The proposal will, for both reason, add value to citizens' life and probably even to tourism. The construction may therefore be seen as a kind of *ex-libris*, and a curious attraction.

Author Biography:

J. Manuel Feliz-Teixeira graduated in Physics in the Faculty of Sciences of University of Porto, Portugal, and MSc and PhD from the Faculty of Engineering of the same university. His work has been related to various matters, from optical communications, solar energy and seismology to, more recently, the simulation of complex systems in the management science, like warehouse and supply chain. His PhD thesis is on "Flexible Supply Chain Simulation".

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