The Funnel Effect and its Practical Benefits in Wind Applications

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Abstract: **Although wind technology has been greatly improved during recent times, the available technical know-how is not yet adequate to develop reliable wind energy systems functioning at low wind speeds. The developments of wind energy converting systems working at low wind speeds of 3–5 m/s, which are available for a considerable period of the year in the major part of the continental locations, remain unfulfilled. This issue continues to be a matter of great concern for wind research. This paper analyzes some profiles derived from hill effect and tunnel effect – a funnel concept of amplifying the wind speed before it comes in contact with the rotor blades. Furthermore we analyze the amount of practical benefits derived from using a funnel to increase wind speed.**

I. Introduction

Wind power energy obtained in urban areas was a developing research field in the last years. Two major study directions regarding urban wind energy can be highlighted: placement of small turbines on the roofs of existing buildings and the construction of new buildings having a wind optimized shape and distribution (see [5], [7]). To enhance the wind speed artificial structures are used in order to obtain the funnel and hill effects, see [4]. Rigid or flexible funnel like structures can be used to increase the wind power in low wind speed areas, see [3], [6].

Considering, the funnel in figure 1, where v_{in} is the wind speed at the funnel entrance (area **A**, diameter **D**) and v_{es} is the wind speed at the exiting end of the funnel (area **a** , diameter **d**); then after the continuity equation where it is assumed that the flux rate Q is constant we have:

$$Q = A \cdot v_{in} = a \cdot v_{es} . \quad (1)$$

From here:

$$v_{es} = v_{in} \cdot \frac{A}{a} = v_{in} \cdot \left(\frac{D}{d}\right)^2 . \quad (2)$$

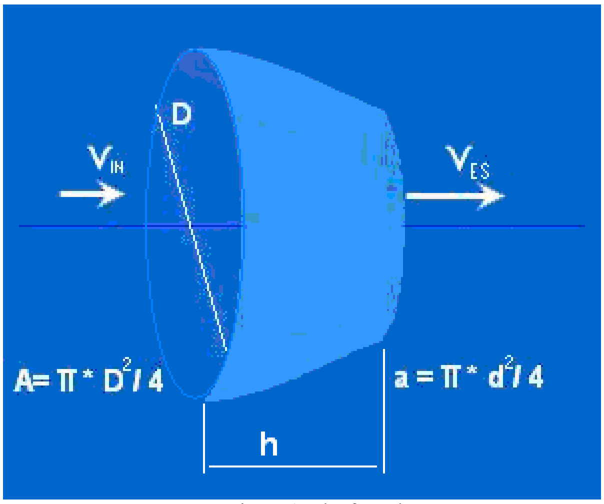

Figure 1. The funnel

Given that power P of a wind turbine is proportional to the cube of wind speed:

$$P_T = c_p \cdot \frac{\rho a v_{in}^3}{2} , \quad (3)$$

Where:
Cp is a factor that depends on wind turbine efficiency,
ρ is the air density (Kg/m3).

Now, theoretically, with a funnel in the front of the wind turbine, WT, it is possible to produce a power P':

$$P' = c_p \cdot \frac{\rho a v_{es}^3}{2} = c_p \cdot \frac{\rho a}{2} \cdot \left(v_{in}\left(\tfrac{D}{d}\right)^2\right)^3 = P_T \cdot \left(\frac{D}{d}\right)^6 . \quad (4)$$

From the diagram of variation (figure 2) of the power of wind at the exit of the funnel, according to the funnel diameter ratio (D / d), the wind power grows by 3 times if the diameter of the entry of the funnel is 20% larger than the diameter of the exit.

The complet paper could be consulting on AQTR2010 IEEE Procedings volume