Wind Energ. Sci. Discuss.,
https://doi.org/10.5194/wes-2019-21-RC2, 2019

WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Multi-element ducts for ducted wind turbines: A numerical study" *by* Vinit V. Dighe et al.

Anonymous Referee #2

Received and published: 4 July 2019

The ducted wind turbine concept may be applied to increase the power production of small wind turbines, especially in urban environment where turbine size, rotor protection and noise generation may become crucial constraints. The paper is interesting and provides information on the application of multi ducted elements, focusing on a parametrical analysis related to two geometrical features, with the aim of optimizing the turbine power coefficient. The main issue of the ducted turbine is the definition of the optimized shape of the diffuser acting downstream of the machine, easily prone to separation leading to a dramatic reduction of the effectiveness of the whole design. The numerical methods applied in the paper are suitable to reproduce the actual behavior of the diffuser, but the analysis of the turbine behavior is definitively too simplified and the results may not be really considered as representative of the actual fluid dynamic performance of the whole system. The presence of a non uniform flow field together with the presence of an unsteady wake shed by the turbine, may dramatically influence the outcome of the paper: readers should be advised and the influence of the mentioned limits should be reported and discussed in the paper. Generally speaking, the machine is always simplified by a uniformly loaded actuator disc: in the reviewer's opinion this approach limits the results validity when applied to an actual case. Moreover, the theoretical 1D analysis performed in chapter 2 defines the dependency of the power augmentation parameter "r" to the change in the thrust coefficient CT (which is probably required and related to the turbine simulation methodology applied in the numerical schemes) but does not relate it to the area ratio of the duct outlet to turbine sections., which is the most important parameter influencing the performance of the diffusing duct and thus the flow rate interesting the turbine and the extra power production.

1)The application of the inviscid method (panel) provides the expected results: quite accurate up to the onset of separation, unable to capture separation for more aggressive diffuser geometries. Which is the contribution to the paper of the panel method? The conclusion was already known at very beginning. 2)The application of a steady CFD scheme does not count for the effects produced by the passing wakes shed by the rotor and by the flow radial non uniformity, both on the flow field inside of the duct and, in particular, on the inner wall. When operating in aggressive geometry, passing wakes can induce unsteady separation (like dynamic stall) on the duct inner wall. Author should advise and comment on this effect in the paper. 3)It is not clear why authors prefer to refer to a 2D symmetrical scheme rather than to an axis symmetrical one, which is definitively the most suitable one to represent a rotating machine as a turbine, even in a simplified and steady simplification. 4) very short description of the "FAN condition" should be reported in the paper for clarity reasons and reader's convenience. 5)The reference Re number is not reported in the paper, not for the validation cases, nor for the application ones. Please provide. 6)With reference to 5.1: a)information about the value of the duct and flap outlet area (possibly rated to the inlet one) should be reported in this paper for reader's convenience. b)A comparison of the obtained results to the 1D momentum theory applied to ducted wind turbines, at least in terms of maximum expected power augmentation coefficient, should be included in the paper. The basic 1D momentum analysis shows that the optimal (maximum, under Betz hypothesis) power coefficient Cp of a ducted turbine can be calculated as C_(p,max)= 2/3 K/$\sqrt{}$3 where K is the area ratio of duct outlet area to turbine area (actually, the square of the A/AAD value reported in the paper) At the same time the induction coefficient "a" at the optimum power production condition can be calculated as a_opt=1-K/$\sqrt{}$3. By referring to these two simple relations, authors may provide to readers interested to the topic, useful information about the deviation of the reported results with respect to the theoretically expected ones. The optimal case presented in the paper seems to exhibit an area ratio of 1.5ˆ2=2.25 and the optimal ideal power coefficient results 0.87, approximately 1.5 the Betz one of the not-ducted turbine. The velocity at the disc is in average 1.3 V0; the optimal Vd for the area ratio of 2,25 is 1.3 * V0. . .. . .not really far from theory. Author's should comment about that and report part of this discussion in the paper, if they find it useful. > Pag 1, line 16/19 : "The best aerodynamic performance. . .. . .i.e. by generating a strong reduction of the static pressure at duct's exit" : the static pressure at the duct exit is expected to increase to the external value. The pressure reduction is expected at the nozzle throat, downstream of the disc.> > PAG 5 line 2: tau in eq. 11 should be >0 to guarantee r>0, not tau>1 as reported. > Some typos can also be found in the paper (th for the): please check.

Interactive comment on Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2019-21, 2019.