

Reply to Anonymous Referee#1 (RC1)

<https://doi.org/10.5194/wes-2023-52-RC1>

Review Comment

The work presented in this article is interesting. I only have minor comments.

1. The authors have done an extensive review of the literature. However, the purpose of paragraph 2 in the introduction is unclear. This arrangement makes it harder to identify the motivation of the article, which is only mentioned later in the third paragraph (momentum theory – as it is applied to wind turbines – is not suitable for investigating wake induction in AWES). The authors should consider either making the purpose of paragraph 2 clearer, or introducing the motivation of the article earlier.

Authors Answer & Actions

We modified the last sentence of paragraph 1 to briefly mention the main scope of the paper. However we feel that paragraph 2 is needed before going into detail of the scope, as it gives context to this work.

Review Comment

2. The authors does mention that the new power coefficient can identify an optimal aspect ratio that is not infinite. I believe that this advantage over the previous definition (which would result in an infinite aspect ratio) should be highlighted in the abstract and the introduction. Similarly, the ability to compare different AWES using the new power coefficient deserves mentioning.

Authors Answer & Actions

We agree that the two properties:

1. definition of optimal aspect ratio;
2. ability to compare different concepts

are the advantages of this power coefficient definition.

In the abstract, the sentence “The aspect ratio which maximises this power coefficient is finite and its analytical expression for an infinite turning radius is derived.” already addresses property 1 and we added the sentence “allowing to compare concepts for a given wing span” to address property 2.

In the introduction we added 2 sentences in the second last paragraph, when we introduce the objectives of this paper to mention these two properties.

Review Comment

3. In figure 1:

- Are the axes e_1 , e_2 , and e_3 fixed to the aircraft?

- The frame of reference in the figure is unclear to me. The descending trajectory of the AWES would suggest that the viewpoint of figure 1 is fixed to the wind. This should be mentioned if true. And if the viewpoint is indeed fixed to the wind, then the wind vector \mathbf{vw} can be moved closer to the aircraft to highlight that this wind vector is applied locally to the aircraft.

Authors Answer & Actions

The axes are inertial and moving along e_3 with a constant velocity equal to the reel-out velocity $-v_0$. This means that for Fly-Gen the axes are fixed with respect to the ground station. The blue lines represent the rolled up trailed vortices. The circular trajectory happens in the (e_1, e_2) plane. We added an explanation when introducing Fig. 1.

Review Comment

4. Equation 5 and the paragraph below it are very hard to follow. Instead of a long paragraph, I suggest the authors deconstruct equation 5 into smaller equations. For example, eq 5 will be

$$C_D = C_{L,t} / (C_D + C_{T,t})$$

Followed by (along with the accompanying explanation text)

$$C_D = C_{D0} + C_{nD} + C_{fD}$$

$$C_{D0} = C_{D,v} + C_{D,t}$$

Etc

Authors Answer & Actions

We added an equation and the related text to follow this comment.

Review Comment

5. The graphs should be bigger (figures 5, 6, ... ,14). They look small when printed.

Authors Answer & Actions

We will make sure that the fonts are aligned with the text during the copy-editing phase.

Review Comment

6. Finally, the authors are invited to consider the suggested grammatical and editorial changes found in the attached pdf.

Authors Answer & Actions

Please find attached the pdf where we answer all your comments.

Review Comment

I recommend publication of this article once the above queries are addressed.

Authors Answer

Thanks a lot for your valuable review!

Reply to Anonymous Referee#2 (RC2)

<https://doi.org/10.5194/wes-2023-52-RC2>

Review Comment

General comments:

In this manuscript, the authors present improved formulations of the power equations for airborne wind energy systems (AWES). The authors clearly formulate the two objectives of the study: The first objective is to include the aerodynamic effects of the AWES wake in the AWES power predictions, and the second objective is to investigate the sensitivity of the AWES performance to geometric and aerodynamic parameters. Therefore, the authors present new formulations of the power coefficients of AWESs which allows one to compare the performance of different AWES archetypes for given geometric parameters. The derivations are carried out for ground-based and on-board power generation AWESs and the analysis is performed for generic designs as well as for known AWESs from literature. Overall, the new power equations and the related analysis can help guiding some initial AWES design and sizing studies and will hopefully benefit to the airborne wind energy community.

Review Comment

Specific comments:

The present study builds on the work related to AWES wake modeling which was conducted by the authors and was just recently published in *Wind Energy Science* (Trevisi et al, 2023). The manuscript is well organized and self-containing: it contains first a section which summaries the wake model from the aforementioned study, followed by two sections on the derivation of the power equation for the two AWES archetypes separately, and finally two sections which present the results of a parametric study for generic AWESs and the results of an analysis of known AWESs from literature.

Nevertheless, three main remarks were identified, to which the authors are invited to elaborate on.

First, the reasoning behind some assumptions and statements is not always straightforward to understand. Detailed comments have been added for specific statements in the accompanying document.

Authors Answer & Actions

We modified the paper to explain more the assumptions and answer directly to each comment in the attached pdf.

Review Comment

Second, the objectives of the analyses carried out in sections 5 and 6 could be defined more precisely.

Authors Answer & Actions

We added a paragraph giving the overview of the sections at the beginning of Sect 5 and 6. We added an introductory sentence before each analysis of Sect 5 to make the objective clear.

Review Comment

Third, the discussion of the implication of some results falls short at times. It would be beneficial to the reader if some of the conclusions drawn by the authors could be translated into specific examples of recommendations to AWES developers.

Authors Answer & Actions

We summarise the key conclusions and give some recommendations at the end of Sect. 5 and in the conclusions.

We however prefer to avoid recommendations which will require some extra text / analyses. We are working on a paper on the multidisciplinary design and optimization of AWESs, where we will point out how the different disciplines combine in the design. There, we will detail recommendations for developers with holistic arguments. We consider the models developed in this paper as crucial to understand optimal designs and interpret results.

Review Comment

Technical corrections:

Regardless of the clear structure of the manuscript, some parts of the text are somewhat lengthy, which makes the manuscript difficult to read at times. Information is sometimes repeated within a single paragraph which makes it laborious to understand the core message of that paragraph. The manuscript also contains a large amount of equations and mathematical expressions. However, some of them are not further used or referred to in the remainder of the manuscript, which suggests that they could be disregarded or added in an appendix if necessary. I suggest to the authors to try to streamline the manuscript, without loss of content and accuracy. Some suggestions have also been made in this regard in the accompanying document.

Authors Answer & Actions

We removed two equations that were not used and we removed a figure and the related analysis. We tried to streamline the manuscript, following most of the comments in the accompanying document.

Review Comment

In addition, a significant amount of parameters and specific notations are introduced in sections 2, 3 and 4, and later summarized in the nomenclature at the end of the manuscript. Nevertheless, it would be beneficial to the reader if the physical meaning of some of the parameters is systematically repeated in the text. As an example, the definition and physical meaning of the less familiar quantities (λ_0 , κ_0 , ξ_t , γ_t , ...) which are used in the studies of sections 5 and 6 could be recapitulated at the beginning of section 5 along with the objectives of the analysis.

Authors Answer & Actions

We mention the meaning of the new parameters at the beginning of the result section (Sect. 5) and when we felt it was needed in the manuscript.

Review Comment

Further technical corrections are directly included in the accompanying document.

Authors Answer & Actions

We have implemented all the suggested editorial changes and answered directly in the attached pdf. Thank you for your valuable review!