Reply to the Reviewer #1

The topic addressed by the authors is relevant to the journal in terms of wind turbines and noise reduction strategies, but the work and the methodology has several strong short comings and lack of information which prevent me from accepting this manuscript in its current form and requires several major revisions. Please find attached the main general comments of concern, followed by specific comments.

Reply: The authors would like to thank the reviewer for the time to review our paper. The comments that the reviewer provided have contributed to the enhancement of our paper. We have taken the opportunity to make several improvements in the text, in order to strengthen the paper. A list of point-by-point replies to the reviewer's comments is reported in the following.

Specific comments

1. Line 32: 95 dB sound pressure level (SPL). Which kind of turbine (horizontal axis or vertical axis) does it correspond to?
   Reply: HAWT can produce about 95 sound pressure level (dB) of noise. But we deleted the content since HAWT is irrelevant to the present study.

2. Line 35: Rephrase, ”noise by air”
   Reply: We changed the sentence based on reviewer's suggestion.

3. Line 39: ”acoustic analogy theory” : This statement does not seem completely correct. There is the direct noise prediction (by performing a direct numerical simulation or large eddy simulation) or indirect noise approach by separating the noise source calculation, and noise propagation. And the acoustic analogy is one of the ways for noise propagation (eg. other approaches such as finite element, boundary element, or low order approaches).
   Reply: Thanks for pointing out. We have deleted the content.

4. Line 40: Inconsistent use of sound pressure / sound pressure level (SPL), I suggest to define and use the abbreviation
   Reply: We defined the abbreviation of SPL.

5. Line 43: ANSYS CFX version ? Which method (RANS or LES) ?
   Reply: We deleted the content since NREL Phase VI HAWT is irrelevant to the present study.

6. Line 44: Relevance of NREL Phase VI blade ? Is it a VAWT ?
   Reply: We deleted the content since NREL Phase VI HAWT blade is irrelevant to the present study.

7. Line 49: Tip noise is the dominant source ? Is it true for VAWTs ? Justification/citation to relevant literature required
   Reply: We deleted the content in the paper.

8. Line 51: Maizi.et al (2018) used a 2D or 3D approach ?
   Reply: They conducted a 3D numerical analysis with unsteady CFD simulations. We have added the text in the paper.

9. Line 57: The term ”velocity ratio’ is not defined
   Reply: We changed the sentence velocity ratio into tip speed ratio.

10. Line 61: What is meant by spacing ? Does it refer to blade solidity ? Any justification given in the paper for ”excessively small or large spacing increasing noise emissions ?
    Reply: Spacing meant between the airfoils in every blade. We added in the discussion. We also deleted the sentence excessively small or large spacing increasing noise emissions.

11. Line 62: The review of Botha (2017) is vague regarding the analytical model falling short ? Which noise generation mechanism was modelled ?
    Reply: We have extensively revised the content of this literature review.

12. Line 69: Naccache et. al (2018) , appears to be irrelevant to the present study, since it is a D-VAWT and not a standard VAWT that has been investigated in the present study.
    Reply: We deleted the content since Dual VAWT is irrelevant to the present study.

13. Line 77: Ideally always method the methodology used in a flow solver (RANS/LES/DNS etc) and if the simulation is 2D or 3D.
    Reply: We added more information in the paper review.

14. Line 79: Nyborg et. al (2018) the use of higher -fidelity sound propagation model is vague. Is it a empirical model ? Is it relevant to the present study on VAWTs ?
    Reply: We deleted the content since this paper review is irrelevant to the present

study.

15. Line 92: Not true, there have been several studies which are missing from the literature review such as for example: https://www.mdpi.com/1996-1073/13/16/4148, https://journals.sagepub.com/doi/10.1260/1475-472X.14.5-6.883, https://arc.aiaa.org/doi/10.2514/6.2022-3058
Reply: We added the three papers in the literature review based on reviewer's suggestion.

16. Line 102: ANSYS FLUENT has to be mentioned unsteady RANS (uRANS) approach is being used, incompressible flow can capture only tonal components (unsteady blade loading). For turbulence interaction noise, no propagation of sound waves since the density is constant, the numerical schemes and methodology is too dissipative.
Reply: We deleted the dissipative text based on reviewer's suggestion.

17. Line 116: The relevant research related to the 2 turbulence models that have been extensively used for VAWTs has not been cited.
Reply: The relevant research (Venkatraman et al. (2021); Mohamed (2016)) related to the 2 turbulence models have been added in the paper.

18. Line 120: The constants have not been defined. Please define all the constants and the values for the constants in a Table for both the turbulence models.
Reply: We define all the constants and the values for the constants in Table.1 based on reviewer's suggestion.

19. Line 138: ϵ has not been defined
Reply: ϵ has been defined.

20. Line 145: Relevance of the used methodology/formulation for rotating machines ? Has it been used in published literature for rotating machines and also specifically for VAWTs ? The variation of noise sources over the revolution of the blade is not accounted for.
Reply: Dinulovic et al. presents the aeroacoustic calculation methodology for the

H-Darrieus wind turbine. The CFD analysis, for different wind turbine blades' angles of attack, coupled with the noise analysis is calculated. In this paper, sound propagation equation is solved by Lighthill and Curle. We added the text in the paper.

(Dinulovic M, Trninic M, Rasuo B and Kozovic D (2023) Methodology for aeroacoustic noise analysis of 3-bladed h-Darrieus wind turbine, Thermal Science, 10.2298/TSCI2301061D, 27:1 Part A, (61-69).)

Nukala et al. described that FW-H and Curle's analogies are the most widely used integral methods for predicting acoustic field and considered as formal solutions of Lighthill's equation applied for rigid and moving wall boundaries relative to flow field.

(Vasishta Bhargava Nukala & Chinmaya Prasad Padhy (2023) Concise review: aerodynamic noise prediction methods and mechanisms for wind turbines, International Journal of Sustainable Energy, 42:1, 128-151, DOI: 10.1080/14786451.2023.2168000)

21. Line 151: What is the correlation area ? How is it defined ? A diagram could be useful.
    Reply: Based on reviewer's comment, we have defined the correlation area.

22. Line 157: No end plates or supporting structures have been included in the model. They could alter in the predicted blade loading and noise characteristics, in case a practical noise reduction methodologies are required. https://doi.org/10.1108/HFF-09-2022-0562
    Reply: In the past, many studies only considered the wind turbine blades when simulating blade noise. This method not only allowed for a more accurate assessment of the blades' torque and noise, but also contributed to understanding the aerodynamic characteristics. However, the reviewer's comment is also reasonable. Comprehensive simulation of the entire wind turbine noise characteristics and the turbine performance, considering the end plates and supporting structures might be necessary. This could be incorporated into the future works.
    (Viqueira-Moreira M, Ferrer E. Insights into the Aeroacoustic Noise Generation for Vertical Axis Turbines in Close Proximity. Energies. 2020; 13(16):4148. https://doi.org/10.3390/en13164148)

23. Line 183: How accurate are first-order schemes ? The turbulent kinetic energy could be too dissipative to have any meaningful prediction for the computed noise (the methodology which itself is questionable for use for VAWT noise prediction).
Reply: The equations coupling velocity and pressure are derived from the continuity equation, basically the continuity equation is not easy to converge, so the 2nd order scheme is adopted. However, the turbulent convergence of the cases in this paper, there aren't significant problem with turbulent flow convergence, so 1st order can be used.

24. Line 184: Influence of time step size has not been reported ? How is this time step choice justified ? Is it based on a CFL number / any relevant flow physics ?
Reply: In this study, an implicit scheme is employed to calculate the transient terms, so the acoustic cases were less sensitive to the CFL number. CFL number is acceptable around 1 based on the FLUENT manual. Therefore, the CFL number 0.12 to 2 and a time step of 0.01 s were used in the paper. We added this information in section 2.5 in the revised paper.

25. Line 210: Refer main general comment 1, also the number of points across the blade and the maximum wall y+ could be reported in the table. The mesh sizes yhave not been changed in a consistent way.
Reply: SST k–ω model has a higher tolerance for y+, therefore y+ has no impact on the results. To ensure the computational validity of realizable k–ε, maximum y+ value less than 80 in this paper. We added the information in section 2.4.

26. Line 221: The methodology used to compute the torque is not reported. Are the forces on the blades summed up, and multiplied with radius and the rotational speed ?
Reply: We added the methodology used to compute the torque in the paper.

27. Line 224: Mesh independence study has not been performed in consistent way, by changing the mesh size over the entire domain, refer main general comment 1.
Reply:
Based on the recommendations in the ASME V&V 20-2009 report regarding establishing the mesh independence study, ASME suggests changing the mesh size by approximately 1.3 times based on their experience to ensure a significant difference. In this study, we also performed the mesh independence study based on this report.

28. Line 230: Time-averaged torque of 227.7 , unit undefined.

    Reply: We added the units in the sentence.

29. Line 240: Figure 8 : unit undefined for Torque , unit for acoustic power shown in W, but the differences reported in dB in text.

    Reply: We added the units in the figure, and changed db to W in the text.

30. Line 245: Figure 3, how many revolutions of the turbine have been simulated ? Has convergence been achieved in time. How long does it take for the initial transient ?

    Reply:

    60 rpm

    Yes

    About 1 min

31. Line 256: How were the angles of attack calculated ? Was the flow velocity sampled at a point ?

    Reply: The attack angle is the angle at which the chord of a blade meets the wind velocity. The wind velocity was sampled at a point. We added this information in the revised paper.

32. Line 296: Deflectors could be similar to trailing edge serrations used for noise reductions. Agree that they help energize vortices close to the trailing edge and reduce extent of separation.

    Reply: Thanks for the reviewer's agreement.

33. Line 320: No units on legends for Pressure, also the azimuthal angle (positions of the blades over the revolution) needs to be added.

    Reply: We added the units on legends in Fig. 4 and 8 in the revised paper. Different t/T values correspond to blade positions. For instance, t/T=0.5 means a rotation of 180 degrees. We also added this information in section 3.1.

34. Line 336: $u*$ is not defined

    Reply: We defined it in the sentence.

35. Line 351: The higher wall roughness could increase the wall pressure fluctuations

which increase the noise. But here the increase/change has not been reported in dB.
Reply: We added the noise 15 db in the text.

36. Line 355: ”visualization effect of the distribution” - unclear, please rephrase.
Reply: We changed the phrase in the sentence.

37. Line 358: Refer main general comment 6
Reply: The authors made several modifications in the conclusion based on reviewer’s comment.

Thanks for the valuable comments.