

Responses to the interactive comment on “Proposal for Generic Characterization of Electrical Test Benches for AC- and HVDC-Connected Wind Power Plants” by Behnam Nouri et al.

Responses to the referee: Prof. Ola Carlson

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Comments reply by authors:

We are pleased to get your precious comments and elaborate on our paper by considering them. We are thankful for your considerations and time regarding the paper. The following revision have been done according to the comments:

1. Referee’s comment: “May I also suggest that the author make a suggestion of which work is most important for the future operation of the power system and why.”

Authors revision:

This Comment is very close to the first comment from BJÖRN ANDRESEN as well which is “1. Add a little bit more explanation on “Why” you mean the proposed new tests are necessary from the system perspective - system impact. (Black start, Grid forming, etc.)”. Regarding to the referees comments, we have revised a paragraph in the Introduction and a paragraph in the Conclusion as follows:

- The paragraph revised in the Introduction:

“Primarily, power quality and transient performance during faults have been essential aspects, which needed to be tested and verified. However, by increasing trends towards 100% VRG-based grids, the VRGs are required to be developed and featured by advanced capabilities to ensure the robustness and reliability of such grids. In this way, the state-of-the-art wind turbines (WTs) are under development to be upgraded to more advanced features such as grid-forming, black start, and frequency support capabilities. These new features would necessitate test and assessment standards in the near future (Langstadtler et al.45 (2015); Asmine et al. (2017) and Gevorgian et al. (2016)). Besides, by increasing wind power installations, the requirements and appropriate test methods are required to study increasing challenges such as harmonic interactions and control performance of WPPs in connection to different types of AC and HVDC

transmission systems according to (Hertem et al., 2016), (Zeni et al., 2016) and (Buchhagen et al., 2015). Thus, it is essential to adapt or define new regulations, standards, and compliance test methods to analyse the developments and issues regarding wind energy.”

- The paragraph added to the Conclusion:

“Primarily, the focus of IEC standard tests had been on the compliance test of WT capabilities. Nowadays, the new features of modern WTs, such as Grid-forming, system restoration, black start, harmonic rejection, and frequency support capabilities, have been introduced by manufacturers to support renewable energy dominated power grids. These new features necessitate new or reformed test standards in the near future.”

2. Referee’s comment: “The references are well covering the subject, the author may consider including the work by Mebtu Beza and Massimo Bongiorno, “Identification of resonance interactions in offshore-wind farms connected to the main grid by MMC-based HVDC system” International Journal of Electrical Power and Energy Systems, p. 101-113, <https://doi.org/10.1016/j.ijepes.2019.04.004>, in line 230 of the paper.”

Authors revision:

Done

3. Referee’s comment: “And paper: Selam Chernet, Mebtu Bihonegn Beza, Massimo Bongiorno, “Investigation of subsynchronous control interaction in DFIG-based wind farms connected to a series compensated transmission line” International Journal of Electrical Power and Energy Systems, p. 765-774 <https://doi.org/10.1016/j.ijepes.2018.09.005>, in line 255 of the paper.”

Authors revision:

This paper is a very good example regarding the influences of the grid characteristics on wind turbines. We decided to review and use this paper in the sub-section “4.1.1 Grid Impedance” by adding new sentences as follows:

“In a synchronous generator-based grid, large electrical loads help the grid stability during dynamics and resonances. However, even in such grids, the sub-synchronous control interactions between WTs and series compensated transmission lines, which is investigated in Chernet and et al. (2019), are still a serious concern. The impedance of the test bench would be arranged as such to study the sub-synchronous control interaction as well.”

4. Referee's comment: "The abbreviations in formula 4 is not clearly written in the text, see line 261-2."

Authors revision:

We changed the abbreviation from "TSI" to " E_{Ti} " which makes more sense for the total rotational inertia of the system in MW-s, which is the energy metrics.

5. Referee's comment: "In line 487 PV should be PEV."

Authors revision:

Done

Finally, we would like to appreciate the precious comments from the referee again. We hope to succeed in understanding the comments and revising the paper on a satisfactory level.