

Wind Energ. Sci. Discuss., author comment AC2
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Reply on RC2

Amir R. Nejad et al.

Author comment on "Wind turbine drivetrains: state-of-the-art technologies and future development trends" by Amir R. Nejad et al., Wind Energ. Sci. Discuss.,
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Authors would like to thank reviewers for their constructive comments. All comments have been addressed and the paper is revised accordingly.

Comment 1: The paper gives an interesting and comprehensive overview of technologies and research related to modern wind power drivetrains. It could elaborate a bit more on drivers for technical developments in the introduction, e.g. how are different regions demanding different solutions (US, EU, China, India, offshore, ...)? - how is logistics impacting future designs? - how will increased need for availability (higher capacity factor) impact future designs?

Response 1: Following discussion is now added to introduction: "It is interesting to highlight that the technological drivers for drivetrain are not necessarily the same as other elements of wind turbine. For instance, for towers there are site specific solutions, depending on specific wind conditions or specific site characteristic, which effect the cost considerably. However for drivetrain, the number or size of components are cost drivers, not the site or region specific characteristics.

It is possible to design the drivetrain with respect to the logistic costs meaning modular design which can be handled by crane, reducing transportation or marine operation cost in case of offshore wind turbines, although such technology is yet to be proven. In terms of drivetrain availability for future design, the development is not only on the quality and manufacturing, but also on the service and operational monitoring".

Hereby specific suggestions for the text:

Comment 2: fig 1 => I would recommend to have in the 1st picture of a paper with a state-of-the-art overview a more typical setup of the drive train => for the picture of a wind turbine with a gearbox, I recommend to use a classical 3- or 4-point suspension setup, not an axle-pin design since this is less common; same for the gearbox picture => I would recommend to use a picture from a typical 3-stage high speed gearbox (from a 3- or 4-point suspension)

Response 2: Figure 1 is modified.

Comment 3: 2.2 - 25 - it might be good to reference VDMA 23904 as a method to calculate reliability of wind turbine gearboxes

Response 3: The existing sentence in 2.2 has been modified "...the reliability of the gearbox is the product of the reliability of all the failure modes for which there exists a reliability calculation as described in Verband Deutscher Maschinen- und Anlagenbau 23904 and IEC Technical Specification 61400-4-1."

Comment 4: 2.2 - 34 - "life-limited only by wear" - it is good to add "which means not driven by load dependent fatigue"

Response 4: The existing sentence in 2.2 has been modified "...are only life-limited by wear rather than determined by load-dependent rolling contact fatigue, although...."

Comment 5: 2.5 - quite a lot of details are described on gear modelling - it would be good to indicate that a lot of gear simulation methods are to predict vibration and consequent noise behaviour, whereas the focus in this overview is mainly on calculating stiffness and stresses during wind turbine load conditions (to assess durability of designs)

Response 5: We agree that 2.5 in its current form applies to the gearbox dynamic modelling only. We have expanded this section and included modelling of other components in the revised version.

Comment 6: p 12 - line 27 - it would be good to explain "digital twin" (or put a reference) since this is a quite broad term

Response 6: A reference to section 6.3, where digital twin is defined, is added.

Comment 7: p 13 - line 5 - please explain SCADA (or put a reference)

Response 7: The acronym SCADA is explained at the beginning of Section 3 and what the system entails is explained in Section 3.1.1. The first sentence in 3.1.1 has been extended slightly to make it clear that the SCADA data come from sensors on the wind turbine.

Comment 8: Table 1 - it would be good to add a reference to the relevant IEC61400 chapter

Response 8: Reference to IEC 61400-25-2:2015 has been added.

Comment 9: p 17 - 3.3 - it would be good to distinguish between "consumed lifetime" and "remaining lifetime" since they are both used. I would recommend to use "consumed lifetime" as a metric that can be calculated based on existing rating methods, by using actual loads (whereas design loads are used in the development phase); "remaining lifetime" should be the best estimation of how long a component will still survive => here it is senseful to include statistical methods in combination with conditional parameters (temperature, vibrations, ...)

Response 9: Agreed and included.

Comment 10: p17 - it would be good to refer to industrial use cases (e.g. Boeye-ZF, Nordmark-SKF presented at CWD conference 2021)

Response 10: Agreed and included.