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Comment on wes-2021-19

Anonymous Referee #1

Referee comment on "A reference open-source controller for fixed and floating offshore wind turbines" by Nikhar J. Abbas et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-19-RC1, 2021

Dear Authors,

First of all, I would like to congratulate you on this very nice manuscript! The ROSCO controller and toolbox seems to me very helpful for the wind community. The paper is very nicely written and very well organized.

Please find below some more important issues, some mathematical issues and some minor issues which hopefully help to further improve the manuscript. Due to lack of time, I could not double check my points, so please forgive me, if I missed or misunderstood something.

There are some more important issues:

- Page 6, p. about Region 2.5: You mention that "due to the PI and controllers and the setpoint smoother, there is no specific range for Region 2.5". Since the PI controller and the setpoint smoother as implemented should not change the steady states, it should be always possible to calculate, at which wind speed the steady state of the rotor speed reaches rated rotor speed (depending on k of your k*Omega^2) and at which wind speed the static pitch is larger than the fine pitch. This should also allow to calculate the limits of region 2.5 even with the peak shaving. Please consider this.
- Figure 2 left: TSR seems to continue to be constant at the end of region 2, but rated rotor speed is already reached (which is not possible). For the 5MW, rated rotor speed is also reached before rated power. It would be further helpful to add region 2.5 in the plot (see comment above).
- Section 2.5: The authors write that the integral gains are in general negative for standard horizontal-axis wind turbines. However, this depends on the definition of your speed error (reference – measurement or measurement-reference). From my

perspective, the positive gains are more common (see e.g. Jonkman 2009). Please revise this part.

- Equation (15): Equation (15) is usually obtained setting the rotor motion from Equation (2) to zero and integrating the aerodynamic torque from Equation (3), see e.g. Bossanyi 2000. However, the efficiencies of the generator and gearbox are not part of Equation (2) and (3) of your paper. From my perspective, the efficiency of the gearbox should be part of Equation (2) and thus also (15), but the generator efficiency is only important to calculate the electrical power from the generator torque and thus should not be a part of Equation (2) and thus also not of Equation (15). Please make this part more consistent.
- Equation (21): If "constant power" is used, one can also include the partial derivative of the generator torque with respect to the generator speed in Equation (5). Neglecting this usually causes a large deviation from my experience, also for the 5 MW reference wind turbine. For the ROSCO controller and for the paper it would be nice, if you could include this part or provide some investigation that in your case this is neglectable.
- Section 5.5: Usually (in the Bladed interface), the tower top fore-aft acceleration is a translational degree-of-freedom and thus the integrated signal is the tower top fore-aft speed. This has been used in your reference (van der Veen 2012). However, you use the "tower top pitch angle" (i.e. rotational DOF), which is also possible (but much harder to measure/estimate in reality) and would provide similar results I assume. But since ROSCO is using the Bladed interface and aims to reflect the industrial state-of-the-art, please consider changing to the translational DOF.

Further, the paper can be improved using consistent and accurate mathematical expressions:

- Equation (5) etc.: Please use consider using δ instead of d for β, v etc. and introducing that Δ is the deviation from the steady state. Using simply d might cause confusion with the operator "d".
- Equation (9) etc: Please consider that "d" is an operator and thus using d instead of simply d would be more appropriate.
- Equation (6) etc: the tip speed ration might be good to introduce. And here, using ∂ as in Equation (4) would be more appropriate, since the tip speed ratio depends on both wind speed and generator speed.
- Equation (12): The transfer function $H(s)$ connects the Laplace transform of the input to the one of the output. The Laplace transforms themselves do not depend on s. Thus, the fraction with d\Omega_g(s) is a bit sloppy. Best might be to simply remove this and explain that the transfer function is obtained by using the Laplace transform and Equation (5) and (9).

Minor issues:

- Figure 2 and Figure 5 caption, Appendix A etc.: Units are in non-italic in the rest of the paper (which makes sense, since they are not variables), but here you have kNm, MNm, etc.. Please consider changing them.
- Figure 3: setpoint smoother has more inputs than only the generator speed.
- l 297: "but the power is much more consistent" is not clear to me. Maybe just remove or add something to better explain it. Maybe you mean "more consistent compared to the constant torque case"?
- in Equation (20) you use "rat" as subscript, but in the rest of the paper "rated". Please consider to have this consistent.
- Section 3.1, last sentence: From my perspective, the proportional and integral gains for the torque PI controller are often chosen to be constant for simplicity, since applying Equation (13) usually does not provide significantly differences over the considered operation points. Please check if this could be also helpful here. The reason provided in the paper ("less erratic control actuation…") seems to be a bit vague for a Journal paper.
- l 377: Equation (17) should be included here since Equation (16) is TSR tracking only.