Review of ”Evaluation of the impact of wind farm control techniques on fatigue and ultimate loads for a 10 MW wind turbine” by Alessandro Croce, Stefano Cacciola, Luca Sartori, and Paride De Fidelibus.

This paper falls in two parts. The first part presents considerations of the impact of farm control on an individual wind turbine quantified in term of fatigue and ultimate loads as well dynamic blade response under extreme conditions using a simplistic showcase. Two examples of active wind farm wake control are in focus - wake re-direction and dynamic induction control. The second part uses the results obtained in the first part to perform a wind turbine blade re-design with the purpose of ensure structural integrity under increased loading of the solitary wind turbine investigated in the first part.

The topic is interesting and relevant to the community, but the approach - in its present form - is too simplistic to give meaningful/useful results. Roughly speaking the paper is composed of two ‘half papers’ (cf. more detailed comments below), and would benefit from selecting a more focused topic (e.g. first part) and then work this trough in more details, however, still using a simple showcase. In its present form, the paper is not ready for publication in the Wind Energy Science journal. Detailed comments/suggestions are given below.

General comments

- ***Heading***: Due to the simplicity of the selected showcase - where only loading of a single wind turbine in a *non-waked* inflow condition is considered - the wording ‘wind farm’ should be toned down, and the heading modified to e.g.: Aspects of the impact of active wake control on fatigue and ultimate loads for a 10 MW wind turbine.
- ***Scope***: Following the comments in the introduction, the paper could benefit from narrowing down the scope to e.g. consider only the first part (i.e. impact of active wake control on wind turbine loading and dynamics), and then treat this topic more elaborate. This can e.g. be done simplistically by considering the smallest possible wind farm - a two-turbine setup - allowing for analyses of important wind farm load and production characteristics such as wind turbine *spacing* and wind turbine *offset* relative to the mean wind direction (i.e. full wake, partial wake cases).

  The premise for the wake re-direction case in the first part of the paper is that wake effects of downstream wind turbines can be completely mitigated. This is usually not the case. The premise is established based on a stationary flow model (cf. Fig. 1). Stationary modeling of the inflow field makes sense for *production* prediction. However, for *load simulations* wake dynamics is important, and un-steady modeling of wind farm flow fields is needed. This stochastic dynamics comes on top of the static flow illustrated in Fig. 1, and the consequence is that, even in the case of considerable reduced wake production losses, non-neglectable wake loading of downstream turbines may occur. The ‘efficiency’ of wake re-direction is usually of the order of 0.5D at approximately 10D downstream - somewhat less for densely spaced wind farms. Therefore analyses of different wind farm spacings should be performed.

  The second part of the paper (Section 5), which is which is anyway limited to the PCM control strategy with parameters apparently somewhat arbitrary - or at least not motivated in terms of cost efficiency - could be the topic for another paper based on more detailed findings from a focused first part of this paper.

- **Wind speed limitation**: In the present study, the wind farm controller (i.e. the wake steering) is only active for wind speeds lower than 15m/s. This makes perfect sense for production optimization, but for *load mitigation* of e.g. a system consisting of two wind turbines, where one is operating in the wake of the other, this is less obvious and should be motivated. It is a weakness of the paper that only possible increased loading of the wake generating wind turbine is considered without considering the possible load reduction of a downstream wind turbine.
- **Dynamic induction control**: In dynamic induction control, the magnitude of the thrust force of an upstream turbine is varied, which leads to increased power and thrust variations. This in turn negatively impacts power quality and fatigue loading of the wind turbine subjected to this type of active wake control. Therefore, maybe a comparable approach - the helix approach - could be considered. Investigations (https://onlinelibrary.wiley.com/doi/full/10.1002/we.2513) show that this approach leads to enhanced wake mixing (like dynamic induction control) with minimal power and thrust variations.
- **Ultimate loading**: The paper claims to deal with wind farm ultimate loading but in reality only deals with ultimate loading of a solitary wind turbine under various (wind farm related) operational conditions. Addressing wind farm ultimate loading requires in addition extreme loading of a wind turbine operating in a waked flow field to be considered.
- Choose wind farm or WF throughout.
- Choose wind farm control or WF control or WFC throughout.

Editorial, semantics and minor comments

- P.1: "…production, possibly weighted with the wind Weibull": Inclusion of wind direction and wind speed pdf's are a minimum for a trustworthy estimate wind farm production.
- P.2: A number of studies dealing with the impact of WF control on WT fatigue loading (Cardaun et al., 2019; Ennis et al., 2018; White et al., 2018; Boorsma, 2012; Damiani et al., 2018; Zalkind and Pao, 2016) is mentioned, but the results of these studies are not shared with the reader.
- P.2: … the possible increase in machine loading induced by wind farm control: I would actually expect that wind farm control aiming at increased production in most cases will lead also to load mitigation due to less severe wake effects.
- P.3: To the best Authors → To the best of the authors
- P.3: All analyses are performed in this work → In this work, all analyses are performed
- P.3: organized according to the following plan → organized as follows
- P.3: … wind farm controller (WFC) has on the single wind turbine (WT). Why not introduce these acronyms in the introductory section, where 'wind farm control' and 'wind turbine' are also mentioned.
- P.3: WFC is highly site specific. YES, INDEED!!
- P.4: in those conditions which → in conditions which
- P.4: certainly involved in wake interaction → certainly influenced by wake interaction
- P.4: Figure 1 on left → Figure 1, left panel,
- P.5: has to yaw of significant yaw angles → has to yaw significant yaw angles

- P.5: … in order to provide an analysis of general validity: I'm not convinced this is possible for a case study consisting of very few WTs. This statement needs at justification/motivation.
- P.5: if only because a machine → because a machine
- P.5: In this work we assume → In this work we use
- P.7: For example, it may happens that, → For example, it may happen that,
- P.8: … simplify the analysis and make it of general validity, the farm control is considered active only in a range of wind speeds: This intuitively a good idea for power optimization - less intuitive for load mitigation.
- P.8: speed (i.e. up to a → speeds (i.e. up to a
- P.9: inverse SN-curve slope → inverse SN-curve slope (i.e. Wöhler exponent)
- P.9: only for wind speed lower than 15m/s the wind farm controller (i.e. the wake steering) is active: Justify that this is a sensible choice for WFC when also WT loading of downstream WTs is taken into control - see e.g. IOP Conf. Series: Journal of Physics: Conf. Series 1102 (2018) 012019 doi :10.1088/1742-6596/1102/1/012019 in which optimal yaw strategies are defined for above rated wind regimes, where no power loss occurs.
- P.9: regardless to the yaw → regardless of the yaw
- P.9: lacks in generality → lacks in generality and will be highly dependent on the site wind rose
- P.9: … rotated of an angle → … rotated an angle
- P. 12: ((Munters and Meyers, 2017, 2018)) and → (Munters and Meyers, 2017, 2018) and
- P.12: via a wind tunnel experimentation → in a scaled wind tunnel experimental campaign
- P.13: … larger pitch amplitude and Strouhal number → larger pitch amplitudes and Strouhal numbers
- P.14: may arrive to 20% and 30% → may amount to 20% and 30%
- P. 15: PCM: … impact of such a pulsating flow with downstream machines can be significant in terms of turbine loads and aero-servo-elasticity. This particular study, out of the scope of the present paper. BUT IT SHOULDN'T - same comment as for the wake re-direction!
- P.15: nodding ant the → nodding and the
- P.17: no matter of the wind direction an TI → no matter of the wind direction and TI
- P.18: How does the increased PCM induced loading balance with the potential increase in power production in a COE context? This is the crucial question every wind farm owner will address - why should they otherwise accept the increased loading shown in Table 2? It makes no sense to include the detailed analyses presented in Section 5 as long as this basic question isn't addressed. As an illustration, it is stated that "on the other hand, only the PCM with amplitude of 2 deg., the impact of PCM and WR becomes comparable" - yes correct, but what is then the sensibly choice in a WF control context … and why?
- P.18: different wind farm controls have → different wind farm control strategies have
- P.18: skip Sec. 5 (which is anyway limited to the PCM control strategy with parameters apparently highly arbitrary - or at least not motivated in terms of cost efficiency) and

elaborate more on Sec.4 to approach more complete picture of WF loads associated with active wake control.

- P.19: For what concerns → Concerning
- P.19: curve which → curve, which
- P.19: (left)) which → (left)), which
- P.20: Baseline → baseline
- P.20: Then, an important → Thus, an important
- P.21: Baseline → baseline
- P.21: Redesign PCM → re-designed PCM
- P.22: Baseline → baseline
- P.22: Redesign PCM → re-designed PCM
- P.23: Standards and are not site-specific → Standards, and which are not site-specific