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# *Interactive comment on* "Power Fluctuations In High Installation Density Offshore Wind Fleets" *by* Juan Pablo Murcia Leon et al.

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PART I - General comments

A revised manuscript is under preparation in which the following comments will be addressed:

I.1. A detailed explanation of time series simulations for wind speed and turbine/plants simulations.

I.2. The description of CorRES has been improved.

I.3. Improved description of high wind speed technologies.

I.4. An overall review of grammar, wording, and consistency has been carried out.



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Discussion paper

I.5. The referencing style has been aligned.

I.6. More detailed explanation in the results, discussion, and conclusion sections to illustrate the significance of the work for the industry.

PART II - Specific comments (scientific)

A revised manuscript is under preparation in which the following comments will be addressed:

II.1. Improved description of the problem and motivation. The hypothesis of the research is stated. A clear connection between power fluctuations and turbine curtailment technology is stated.

II.2. The research gap is further explained and the novelty of the presented work is rephrased.

II.3. Description of the scenarios has been enhanced.

II.4. The wake modelling approach used is explained in more details.

II.5. Abstract has been rephrased to include quantified results.

II.6. A discussion of the impact of curtailment technology in terms of capacity factors is added. Note that because the probability of observing high wind speeds (ws > 20) is low, there is no significant difference in terms of energy production for the two high wind speed operation types; this can be seen in Table 3.

II.7. Results and conclusion sections have been expanded. Emphasis is put into the relevance of this article for the scientific community and the industry. There objective of this article is not to study what is the optimal density of offshore installations to minimise power fluctuations, as the optimal spacing would be to spread the offshore fleet as far away from a possible. In the context of an offshore wind energy fleet that has clear delimitation of location and area, we concluded that high wind speed operation is necessary to limit the extremes in the aggregated fleet power fluctuations, but this

technology is not sufficient since the extreme fluctuations are still present in the ramping up after storms, the authors propose mitigation measures that can be implemented in plant or fleet level.

PART III - Technical corrections

A revised manuscript is under preparation that addresses most of the technical corrections suggested by the referees except for the following:

Introduction - page 34: "smoothing effect" is a term that is used in the large scale energy system modelling of wind energy that refers to the fact that fleet-level wind generation time series is smoother (fewer fluctuations) for fleets in which the plants are spaced further apart. The geographical smoothing effect is a consequence of the spatial correlation trends (decrease correlation as a function of the distance between locations) in both wind speeds and wind power.

Literature synthesis - page 117: Agora Energiwende's study reports the impact of installation density and wakes in the capacity factor of large offshore fleets in the North Sea; the motivation for our article is not that, but to study the impact of installation density, turbine technologies and wakes in terms of fleet-level power fluctuations.

Methods - page 133: High wind speed operation is commercially available on most wind turbine manufacturers. Each manufacturer implements the high wind operation with different control strategies, therefore the actual reduction in power at high wind speeds results in a different curve for each manufacturer.

Final Comments

The authors would like to thank the referees for their detailed review, comments and their work.

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