

Review of the manuscript “Mitigation of offshore wind farm cluster wake effects by low-specific-rating, low-induction turbines” by Paulsen et al.

The study is interesting and timely. Discussions on the envisioned increase of wind energy production in the North Sea have been focusing on risks and uncertainties due to inter- and intra-farm wake effects for wind farms with turbine sizes of the order of the 15MW or 22MW IEA reference wind turbines and specific power ratings similar to commercial wind turbines.

The authors propose an alternative route for achieving a similar annual energy production (AEP) with an arguably better grid integration potential. To this end, they simulate and compare wind farms with IEA 15MW reference wind turbines to those with the same rating but employing the so-called hybrid-lambda design philosophy. The latter design features a considerably larger rotor and, hence, a lower specific power but also a lower thrust coefficient at higher wind speeds and hence, presumably, less wake losses.

The study is novel, relevant and of good quality. Some challenges that could still be discussed in the manuscript are given in the following.

It is reasonable to look at AEP as a first key metric for success. Nevertheless, if feasibility of the hybrid lambda rotor were to be established, then it seems to this reviewer that metrics covering the economic viability could become decisive. Some of the benefits of the novel concept may be lost due to changes in cut-in and cut-out speeds or higher installation and maintenance costs. It would be good to discuss this in the conclusions.

The study is motivated by an improved grid integration potential. Why, in this context, full load hours (or capacity factor) matter is not clear to this reviewer and may need to be better motivated or put into context. On the other hand, the ability to help with demand matching, e.g. during doldrums, is of relevance. So is a possibly lower AEP loss due to cluster wakes. An assessment of the grid integration potential, ideally with a suitable metric, would be great to see in the conclusions.

The larger and even more slender rotor of the hybrid-lambda concept invites for challenges regarding installation and maintenance but also on validity of design tools and operability of the novel rotor concept with respect to physical phenomena related to aeroelasticity, erosion, dynamic stall, high Reynolds number or possibly even transonic flow effects. It may be appropriate to point out these risks in the manuscript, preferably together.

In addition, below are a few smaller suggestions given, mainly for improved readability:

- Page 2, line 37: Note that also the demand is usually intermittent! Maybe rephrase as the current sentence may be misunderstood as if intermittent renewable sources by themselves are a problem rather than a demand and supply mismatch.

- Page 2, line 52, unclear sentence: Are the wake losses reduced by 18% or the energy production? How does this value relate to the 30% stated in the sentence before?
- Page 4, line 117: Introduce the acronym WFP at first use.
- Page 7, line 176: Isn't it "Collaborative Research Centre"?
- Page 8, line 224: by the IEA ... (missing article)
- Page 9, figure 2: Maybe add inserts for the power and thrust curves to better discern deviations or plot a difference between concepts. The figure is described in the text but not self-contained as information is missing. For example, please add the specific ratings.
- Page 9, line 242: brackets misplaced in citation.
- Page 10, figure 3, maybe switch plots for better orientation (Netherlands on the left).
- Page 10, first paragraph: Why was the option for layout optimization chosen?
- Page 10, last paragraph: Maybe also look at AEP gain per wind bin?
- Page 13, line 300: introduce t_{tot} as hours in a year.
- Page 13, line 320, unclear sentence: "causing the integration of wind speeds at higher altitudes"
- Page 14, figure 4: difficult to discern differences. Maybe also add a plot with the difference
- Page 17, table 4: How do these values compare to other studies, e.g. full load hours of an IEA-type wind farm at the same or a similar location?
- Page 18, line 378-380: What is the role of the wake model?
- Page 19, line 394: Why is the median of interest and not the mean?
- Page 21, figure 10: Maybe add the unity line for reference?
- Page 24, table 6: Can you say something about the order of uncertainties expected and consider the corresponding relevant digits? -2.13% vs -1.73% is only a 0.4 percentage point difference!
- Page 28, line 573: Can you comment on the uncertainty of the wake modelling with respect to the expected benefit due to reduced wake losses?