Wind Energ. Sci. Discuss.,
doi:10.5194/wes-2016-15-AC1, 2016

eawe european academy of wind energy
Open Access WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Wind-farm layout optimisation using a hybrid Jensen–LES approach" *by* V. S. Bokharaie et al.

V. S. Bokharaie et al.

johan.meyers@kuleuven.be

Received and published: 4 August 2016

We thank the reviewer for his/her time, and the comments that were provided on our work. These are further discussed point by point, indicating in what way we intend to address them in a revised version of the manuscript (to be approved first by the editor).

1. **Reviewer:** *This paper presents a new approach for the optimal micro-sitting of wind turbines problem. The main contribution of this work lays on the calibration (by running Large-Eddy Simulations) of the decay constant, Kw, used in Jensen's model to assess the wake effect. This approach is interesting but in my opinion it does not allow to overcome the main limitations of the Jensen's model, especially when assessing the multiple wake effect in large arrays. The decay constant is*

usually determined by empirical observations. Therefore, running simulations to recalculate this constant doesn't seem to be a significant improvement on the wake model.

Response: We thank the reviewer for this comment. We realize that we may not have sufficiently explained our main objectives. As indicated by the reviewer, the Jensen model with a constant k_w may not work well, e.g., in case of large arrays. However, this can be remedied by using a wake expansion coefficient that is not constant, but depends on streamwise distance into the farm, or on local turbulence intensity. An example is found in the work of Stevens, Gayme, & Meneveau (J. Renewable and Sustainable Energy 7, 023115, 2015), in which a top-down model is used to tune a streamwise dependent expansion coefficient, providing good results for extended farms with various alignment patterns. More generally, such a relation for k_w may also depend on wind direction, and certainly atmospheric stability.

However, the problem then is how to fit k_w a priori, in particular since the parameter will most certainly also depend on the wind-farm layout, which is not known before optimization. To this end, LES can be used in the approach proposed in our work. The main aim of our paper, is in showing how to do this, i.e. the main challenge is in making this computationally feasible, given the very high costs of performing LES. Our demonstration case itself is a moderate farm (in size), i.e. 30 turbines. In our particular case it turns out that is suffices to use a constant k_w (something we didn't expect when we started our study), but our method does not preclude more complicated parametrizations for k_w. Indeed this may be relevant for larger farms, or farm areas that are much more irregular in shape.

We propose to better discuss this in our revised manuscript, in particular we will add one or two paragraphs making these points following the one but last paragraph of the current introduction.

2. **Reviewer:** *The problem description section needs to be improved. Also, it would be helpful to include a flowchart of the proposed methods.*

   Response: This is a good suggestion – we will add a flowchart with the different models and how they are linked, as suggested by the reviewer. See also next point for further discussion on problem description

3. **Reviewer:** *When defining the optimisation problem in (2), the averaged Pi seems to be the same as the averaged Pi defined in (1), which according to the statement "T is a time averaging window that is sufficiently long to average out the turbulence effects." corresponds to a short-term average. However, when dealing with a planning problem the objective should be either maximise energy or long-term averaged power.*

   Response: We agree with the reviewer. The power needs to be optimized for a much longer time horizon, i.e. over a period of years, and covering multiple wind directions and atmospheric conditions. Thus equation (2) essentially needs to be updated to include a summation (or integral) over all atmospheric conditions occurring (wind directions, stability classes, etc.). In the paper, we then basically first elaborate a case for one condition only, and later for a wind rose (but given one stability class only). In a revised version of the manuscript, we propose to address these issues both in the problem description section, as well as in the discussion and conclusion afterwards.

We hope that the approach suggested above for improving our manuscript is acceptable, so that we are allowed to proceed with a revision.

Interactive comment on Wind Energ. Sci. Discuss., doi:10.5194/wes-2016-15, 2016.