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Interactive comment on "Combined preliminary-detailed design of wind turbines" *by* Pietro Bortolotti et al.

Anonymous Referee #1

Received and published: 25 February 2016

Subject: Review of manuscript submitted to Wind Energy Sci. Title of the paper: Combined preliminary-detailed design of wind turbines Authors: P. Bortolotti, C. Bottasso, A. Croce

The manuscript under review presents a combined preliminary-detailed optimization method to do the sizing of structural and aerodynamic design of wind turbines using sequential optimization. Rotor and tower of the wind turbine are designed simultaneously with stresses, buckling, blade-tower tip clearance, modal frequencies and fatigue as the design constraints. The objective function is to minimize the cost of energy. The method is applied to a 2.2 MW onshore, and a 10 MW offshore wind turbine. Results show some improvements in the COE with respect to the initial design.

The manuscript is well written in English, but its structure and level of details are not

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Discussion paper

well defined. Also the value proposition of the paper is not clearly defined. My recommendation is to accept the paper but with major revision. Below are some comments for the authors to fully revise their paper:

Major comments: Abstract section: “A new procedure is introduced that marries ...”. This is a strong statement to say. First of all, it is nowadays a common industrial practice to do this type of analysis, though the wind turbine manufacturers do not talk about it publicly. Second, earlier papers have up to some extent the same methodology as presented here. For instance: - Kenway GKW, Martins JRRA. Aerostructural Shape Optimization of Wind Turbine Blades Considering Site-Specific Winds. In: Proceedings of the 12th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference. Proceedings of the 12th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference. Victoria, BC; 2008. AIAA 2008-6025

Finally, there are several wind turbine computational codes that have the same capability as presented in this paper. PHATAS-FOCUS from ECN and the S4WT are among codes that can do this type of analysis and optimization. My suggestion is to revise this statement. The merit of this paper will not be judged by this claim that may or may not be true.

Why the authors believe that the combined preliminary-detailed design is important? What is the advantage of this approach compared to other design techniques? Please show how this technique can solve an actual problem. For that, the authors need to find a knowledge gap in the existing design procedure that the proposed approach can solve. You need to explain to the reader clearly why is this a good approach in terms of its value proposition.

Nothing is said in the paper on how the 3D turbulent wind is generated and used? What about sheer and veer in the wind? Any coherent directional change in the wind? What about other aspects of the flow field modeling like the dynamic stall, dynamic inflow and 3D effects? Some of these issues are particularly important when the optimization happens. As an example, the 3D effects have dependency on the blade aspect ratio that changes in every optimization iteration. Please clarify.

Nothing is said on how the controller works in this approach? Please explain how the authors did the optimization of the rotor, while in every optimization iteration the same controller may not be representative? If it changes, then how?

While changing the rotor diameter, the rated rotor speed and wind speed also change. This influences the controller design switching algorithm. How is this seen in the existing setup?

It is not clear what the safety factors are for the initial design and the optimized design of the two wind turbines. One can always do an optimization and provide a better optimal by reducing the safety factors. Please comment on this, since this is important.

What happened to the hydrodynamic loads of the 10 MW offshore wind turbine? Is there any hydro loading considered? Is the optimization of this design without considering and hydroelasticity in place?

Page 11, line 31: Doing an optimization with only one seed is not realistic. What if the seed that you used gives much smaller loads on the design than the original design. In this case you can always claim to optimize the design which is not necessarily fair to claim. Please do a multi-seed analysis and average, max, etc the outcomes.

How do the thickness of the composite layups change? Do they change continuously (which is not realistic) or they are introduced as discrete variables? Is the number of laminates fixed? What about the angels? Please explain.

So no transportation, logistics and installation in the cost models, but what if the 10 MW turbine has optimized the design considering these issues, and you not? You can make a design better than what they made since you are relaxing the design space allowing to search for a better optimum and claim that the 10 MW is not optimal. Please explain.

First line of conclusion: “This paper presents an integrated ...”. This is integrated but a sequential design. Also only the structural design is high-fidelity and not the aerodynamic design. Please be more precise.

Page 16, line 25: The design is far from the industrial practice. A single seed, limited DLCs, no soil-structure interaction, a frozen controller parameters, etc. I think it is better not to have such statements in the paper, since the authors do not know what industry is exactly doing, and this leads to confusion for the readers.

I was not able to understand how the authors considered ground-blade clearance? Is there any limit on how close it can gets to the ground? Additionally, it seems that there is a strong wind shear present since the optimizer is trying to increase the hub-height beyond what the optimal is. Please explain.

Minor comments: Section 2.2.1: How is the AEP computed? Is the Weibull distribution function considered? If so, what are the scale and shape factors?

Equation 2: This type of presentation is difficult to read from a readers point of view. My suggestion is to replace it with a figure where the data and process flow can be presented visually.

Page 10, line 2: What is the approach for computing the gradients for the optimization? Finite difference? Forward, backward, central?

Please provide a table with all the DLCs and their corresponding parameters in details.

Please provide a figure to allow comparing both the flapwise and edgewise stiffnesses of the two designs? It is not clear how globally these important design properties change with blade length for the original and the optimal designs? The same thing with mass distribution.

Please provide a comparative table to show the cost and mass of the optimal and original designs, as well as the AEP and COE. In this way, once can see what happens to the wind turbine during the optimization, and what changes and what not.

Page 13, last line: “higher than 1.1 drives ...”. I did not understand what the authors want to say.

How many discrete stations are used along the blade and tower to do the optimization for both the design variables and design constraints?

I do not understand. Why the authors want to say something in the middle of the paper on low induction concept. This is a side activity and distracts the reader from focusing on the framework. Please consider removing that and focusing more on the details of the method.

Page 16, line 11: Nothing is said about the controller, and controller parameters.

Please provide the modal frequencies of the original and optimized design for the purpose of comparison. Additionally, how are these constraints defined and what is their lower and upper limits?

Please provide the details on how the fatigue damage calculation is done? What are the parameters, properties, and lower and upper limits defined as a design constraints?

Similar to fatigue damage and frequencies, the details of other constraints, the way they are calculated and the upper and lower limits of each of them and how they are satisfied in the design are missing. Please provide these details.

Overall, the paper misses lots of technical details and some of the claims made by the authors is not on a fair basis to compare with the original design in terms of the improvements. Also no supporting arguments is provided to believe that these claims are correct. This particularly applies to the 10 MW offshore design. The paper needs a major revision before it can go to the next step in the publication process.

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