

Prof. Michael Muskulus  
Associate Editor of the Journal,  
Editorial Board,  
Reviewers

## RESPONSE TO THE EDITOR AND REVIEWERS

Dear Editor and Reviewers,

We would like to thank you all for your effort on reviewing our article entitled “*A Neighborhood Search Integer Programming Approach for Wind Farm Layout Optimization*” (submission wes-2022-82). It is very satisfying to us that you consider that the manuscript is almost ready to be published.

To finally fulfill the last requirements, we have addressed point by point the comments from the reviewers after revision 1. We would like to emphasize our appreciation to the reviewers for the very high quality of their comments, resulting in a considerable improvement of the manuscript. See below the responses.

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**- Comment:** *p2/33, p5/124: the Bastankhah's Gaussian → Bastankhah's Gaussian*

**- Response:** Thanks for the suggestion. We have taken it into account.

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**- Comment:** *p2/46-47: try to find and add a reference that supports your claim of poor scalability or at least make it more nuanced; there are also gradient free algorithms that scale well (as mentioned in my original report)*

**- Response:** We agree with the reviewer about the need to be more specific in this statement. One could classify gradient-free methods in two subcategories: heuristic and metaheuristics. Heuristics usually scale well (polynomially), while metaheuristics (such as population-based) usually exhibit exponential complexity. We have added the reference (Stanley and Ning, 2019) where there is available a quantitative analysis of gradient-based and gradient-free methods scalability, justifying our claim. The sentence now reads as follows:  
“*In general, metaheuristic algorithms, although highly flexible for modelling aspects, have considerably poorer scalability for larger problem sizes than gradient-based approaches (Stanley and Ning, 2019).*”

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**- Comment:** *p3/70: try to find and add a reference that supports your claim of continuous-location algorithms not supporting NPV optimization*

**- Response:** We have added reference (Pollini, 2022) where the point of number of wind turbines as variable is discussed along with an extensive literature review.

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- Comment: p3184: try to find and add a reference that supports your claim of heuristic routines not being compatible with continuous-location optimization; wake width expansion can be seen as such a heuristic, but also your NSH could in principle be compatible with an inner continuous-location optimization

- Response: We refer in this sentence to heuristics following a strict definition of these algorithms in the context of integer programming theory, widely applied in routing problems, for example. Meaning that integer variables are restricted to a smaller subdomain to prove local optimality. This claim is also backed by references (Fischetti et al., 2016; Shaw, 1998).

- Comment: p4193: 'previous works' → cite (some of) them

- Response: In subsection 1.5 this point is discussed. To avoid redundancy, the sentence has been modified to

*"For example, as discussed before, previous works have considered aggregation of power deficits instead of velocities, gaining a simplification on the mathematical formulation in detriment of the physics modelling fidelity."*

- Comment: p4196 and in many other instances: avoid citations that break the flow when reading out loud, but make citations part of the sentence; here 'In contrast to (LoCascio et al. 2022)' → 'In contrast to LoCascio et al. (2022)'

- Response: Thanks for the suggestion. We have taken it into account throughout the whole manuscript.

- Comment: p51145: collects → collect

- Response: Done.

- Comment: p61147: the → The

- Response: Done.

- Comment: p71182: scrap first  $u_{ijk}$ ?

- Response: We do not understand what is meant by this comment.

- Comment: p71185: why not use 0 instead of some  $u^{ini}$

- Response: We feel comfortable with this explicit notation, and we do not think it affects the formality of the model deployment.

- Comment: p71189-196: join equations in one nice align or gather, as the current display has too much whitespace in between, interrupting the reading flow

- Response: Thanks for the suggestion. We have taken it into account.

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- Comment: p8l202: Let  $\rightarrow$  Let us

- Response: Since we chose to use impersonal language in the manuscript, we have edited this sentence as:

“Let binary state variables  $\eta_{lijk} \in \{0, 1\}$  for  $l = 1, \dots, m + 2$  be defined with the interpretation”

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- Comment: p9l228: Eq. (18f)  $\rightarrow$  Eq. (18g)?

- Response: Done.

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- Comment: p9l232-233: neglects power curve  $\rightarrow$  neglects the power curve

- Response: Done.

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- Comment: p9l234: ‘The model’  $\rightarrow$  Which?

- Response: Clarified.

“The power-curve-free model introduces...”

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- Comment: p10l252:  $z_{ij} - \xi_i, z_{ij} - \xi_j \rightarrow$  I am a bit confused by these math fragments

- Response: Thanks for noticing this typo. The correct fragments are  $z_{ij} \leq \xi_i, z_{ij} \leq \xi_j, z_{ij} \geq 0$ .

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- Comment: p10l254,p11(23b): explain the big-M trick a bit

- Response: We consider the explanation suffices in this case.

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- Comment: p11l274: points  $\rightarrow$  solutions(?)

- Response: We consider points as elements forming the domain, while solution being the optimum or incumbent evolution. Hence, we keep this use throughout the manuscript.

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- Comment: straight forward  $\rightarrow$  straightforward

- Response: Done.

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- Comment: p11l281-282: what is meant by ‘determined’ (clarify/reformulate)

- Response: Done.

“...for the power-curve-based model, the value of continuous state variables  $u$  can be found through classical wake analysis...”

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- Comment: p12Alg1112: on first mention of 'true objective function', be sure to be explicit what is meant by this

- Response: Done. This is explained in the algorithm description p111289 to 1293.

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- Comment: p141328: Wind resource → The wind resource

- Response: Done.

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- Comment: p151357-358: Describe the generation procedure more explicitly; I disagree that the general trend is representative, as you nicely explain in your replies to reviewer comments (I had hoped some of that explanation would have found its way into the paper)

- Response: To nuance this statement, the sentence has been modified to "...Although the random way of generating the layouts is biased against high-quality points, the interest is in the general trend in order to assess whether it makes sense to implement the linear proxy objective  $\sum_{i=1}^N \tau_i$  when optimizing AEP..."  
This is aligned with the discussions during the reviewing process. We decided to not extend the content of the manuscript with new results obtained after replying to the reviewers' comments, since we consider that the presented findings in the article are enough to support the main results while avoiding excessive length. We think that by making open access to the response letter, we are explicitly being transparent about detailed information of the methods' performance.

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- Comment: p171391 and further subsections: repeat the case being discussed in-text for better text flow

- Response: Done.

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- Comment: p19Table2 and further such tables: put into an appendix, as it doesn't add much beyond what is in the figures and does take up space/interrupts the text

- Response: Done.

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- Comment: p191435-438: try to find and add a reference that supports your claims of 'generally faster' and 'cannot support', or be more nuanced

- Response: The expression is modified as per "...which is usually a competitive time compared to these kinds of population-based algorithms."

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- Comment: p211442: we present → present

- Response: Done.

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- Comment: p261490: in the following → below

- Response: Done.

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- Comment: p261508: as target → as the target

- Response: Done.

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- Comment: \* p281544-549: use of a much finer wind rose is another important aspect (cf. Thomas 2022c)

- Response: True. Although the power-curve-free model in principle should not be directly affected by it in terms of model scalability.

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- Comment: p281550: very enthralling → strange formulation

- Response: We removed the “very”.

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- Comment: 281553: very challenging → I find this claim to be insufficiently justified (e.g., by references or argumentation)

- Response: We consider that we provide key references and raise challenges not addressed in the literature (Sect. 1.4). Regarding the complexity of having the number of wind turbines as variable in the context of continuous gradient-based optimization, we cite the reference (Pollini, 2022). For the integrated optimization of wind turbines and cable layout, we have added references (Pérez-Rúa and Cutululis, 2022; Cazzaro et al., 2023), where this challenge is discussed. For the ease of modelling terrain/local costs, reference (Cazzaro and Pisinger, 2022) is incorporated. On the ease of modelling different project areas and several discretized wind turbine types, we consider that these advantages are intuitively understandable.

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- Comment: p291570: is inherently studied → strange formulation

- Response: We removed “inherently”.

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- Comment: p291571: I would say that the AEP is actually comparable even

- Response: We agree.

Best wishes,  
Juan-Andrés Pérez-Rúa  
Mathias Stolpe  
Nicolaos A. Cutululis