HyDesign

General:
This study:
1) integrates battery degradation into a hybrid plant sizing optimization problem (through both penalty and integration in the objective function via replacement costs)
2) compares a traditional LCOE objective with an NPV/CAPEX objective to observe the impact on hybrid plant sizing (also includes a penalty for not meeting peak power)
3) applies a novel "efficient global optimization" algorithm with an outer loop of surrogate modeling and inner loop of gradient-based optimization
4) includes optimal EMS integration in hybrid simulation and battery dispatch

Overall, the contributions of this study are noteable and the methods seem thorough. However, the methods are incomplete and, at times, not understandable. The results are barely and poorly presented, and the conclusions section is almost non-existent. I would strongly suggest a major revision of this paper, focusing on:
• clarifying methods and presenting them completely
• presenting results so that major scenarios and findings are compared and impact is detailed, and
• rewriting the conclusion to include major findings and impacts, as well as limitations and future work.
There are also grammatical errors, which should be corrected before the draft is returned to reviewers.

Content:

• Wind and solar both have degradation based on resource, environmental conditions, control, etc. You're right that wind degradation is hard to track given the influence of control, operations, and maintenance on the degradation of the turbine (along with the turbine characteristics, like steel quality). Wind and PV, however, do have open data about efficiency losses, capacity factor decreases, and sometimes degradation rates. You might want to pivot just a little bit from inclusion of PV degradation as a novelty (on line 60) (since the linear degradation is common in solar and hybrid plant modeling) to just dynamic battery degradation with use. I would like to see 1) inclusion of wind degradation, even if it is linear, 2) PV degradation value justification after Line 46 (you state 0.5%, but it isn't cited or justified), and 3) tease out the interaction and further explore the impact of penalizing the ramping of the battery on dynamic battery degradation. The capability that you do have about battery degradation is interesting and worth highlighting more! Can you also speak to the difference in depth of discharge (how you defined the penalty) versus the rate of discharge? Have you limited the rate?
• Could you elaborate on this?: "Note that the EMS optimization is solved using linear programming and therefore does not compute the battery degradation, instead, it assumes new battery and PV panels (without degradation)." Do you mean the EMS assumes a non-degraded battery, even though you are running the battery down to replacement-level degradation? If this is true, it should be noted as a limitation and should detail how it impacts results (potentially assumes more charging capacity than capable, up to 15% capacity (if you replace at 85% max SOC). If it is non-negligible, it should be worth noting why you didn't
• Line 165 talks about this threshold during which the SEI forms, which differentiates two regimes of degradation in LoC. The value of that threshold needs to be given, cited, and justified. So does the linear degradation rate. Any value that is being used should be noted throughout the equations, just as you mention alpha and beta values in line 167.
• Up until page 10, the authors discuss 3 Indian locations to demonstrate their methods. Then, on page 10, 9 new locations are suddenly introduced (in France, the U.K., and Germany) with no justification or background, never to be mentioned again. I would suggest sticking to a smaller set of locations to demonstrate the methods, and to provide justification for why those locations are chosen (like the Indian locations, which compare good solar, good wind, and bad solar/wind conditions). If there is no justification, I suggest leaving the locations out. For the selected locations, it is important to say where those locations are in the respective country, as well. The readers should be able to tell easily where the locations are and why they were chosen.

- On Line 189: there is mention of an EMS comparison, but up to this point, it isn't clear that is one of your objectives (EMS comparison). I see Section 2.7 contains an "EMS Optimization Model" and Section 2.9 contains a "EMS Long-term" model, but I'm unsure of how they fit together. If you are comparing two models, I suggest you combine 2.7 and 2.9 into a single section (move Battery Degradation to 2.7, so that EMS would be Section 2.8), include an intro that describes you are comparing the two EMS methods and why you are doing so, highlighting the major differences. Then, you can have two subsections that describe the models, "EMS optimization model and long-term model". To me, it seems as if section 2.7 already includes battery degradation, so there needs to be some clarification for the reader to follow. Section 2.9 says that the rule-based EMS is implemented to include battery degradation, PV degradation, and forecast errors for wind and solar generation without rerunning the EMS optimizations, which makes me think that the two sections work together to describe a single method, rather than two separate methods for comparison.
- Section 2.9 is difficult to read as written, especially the second paragraph starting at Line 182, and I cannot infer what the authors are trying to say. Figure 7 (Cross-validation errors on rule.) also is difficult to understand. What is the relative error comparing the EMS results against? I understand you are validating the EMS-LT method, but I'm not sure what you are using as your baseline. You should make it clear that you are validating its performance.
- Line 189: By "500 different sizing capacities" do you mean optimization evaluations?
- The scaling relationship you used for the wind turbine cost on Line 201 should be given, even though it is from another paper. All parameter values for the costs models need to be reported.
- When discussing the cost models, the term "user" starts to creep in. It is fine if you are referring to an open-source software model, but up to this point, you've been describing the methods without referencing users and user-defined inputs. For the demonstration of your methods in this paper and the accompanying analysis, you need to provide YOUR inputs. In code documentation, defining user inputs and potential default values is completely appropriate.
- For the cost models, could you elaborate on what goes into the fixed versus variable cost components for CAPEX and OPEX? The reason I ask is that the way you've presented your equations, it hides whether or not you've included replacement costs. Because degradation is a central part of your paper's stated novelty, it is worthwhile to include how replacement was integrated. I see you have called it out with the N_b variable in Section 2.12 for Battery costs, so that is great. How you calculate N_b needs to be detailed (read: at what point is replacement triggered? What is that threshold?).
- Might want to reiterate on line 235 that you are comparing two different objectives, your novel use of NPV/CAPEX to the traditional LCoE to see differences in performance regarding resulting technology capacities.
- What does "outer" mean in Line 242? When you define the "efficient global optimization" algorithm in the abstract, you say, "This new algorithm is a surrogate-based optimization method." There is no mention of a nested approach. I think it would be good to clearly outline to the reader earlier in the paper when it is mentioned (both abstract and intro) that it is a nested optimization approach that uses an outer surrogate-based optimization loop, followed by a gradient-based optimization inner loop.
- Table 1 finally defines parameters used in the methods, but is incomplete (doesn't define all variables), uses parameter names that are inconsistent with how they were defined, and doesn't use the same styling (for instance, using the Euro symbol or spelling out Euro). It also introduces a comparison not ever mentioned in the rest of the paper, and that is "expensive batteries" versus "cheap batteries." This comparison of scenarios NEEDS to be introduced and justified earlier when the scope of the paper is being presented in the introduction. Why is this comparison included? Now we are back to the 3 Indian sites as well, and we've ignored the 9 other sites? How does the cost of more expensive batteries compare to the savings in replacement costs due to degradation?
- Line 267: "Over-planting the generation or by introducing storage" maybe should be "over-building generation and storage capacity"? "Over-planting" is not a common term and comes off as odd. Used again on L269, L270, etc. Please check throughout paper.
- Line 269: What is meant by "business case is negative"? Can you elaborate, using specific results, what is makes it a negative business case? Used again on L274.

- Line 271: What is meant by, "The final size is a combination of reductions of land costs and wake losses, as it can be seen in the selection of larger spacing (ρ_W) for the LCoE-based design."? Final size of which case and location?
- Line 277: Grid utilization factor needs to be defined so that we understand the result and its impact.
- Tables and figures should appear in the order they are mentioned, which would put Figure 8 below the tables that are mentioned before it in text.
- In general, the results and conclusions are lacking and require significant revisions. There are so many aspects of this paper that are completely ignored in the results section. The link between the methods and the impact of the results are not fully explored in presented results nor in text. For each "novelty" claimed in the abstract and each "scenario" defined in the methods section, the results need to support each of those aspects of the paper. What was the impact of including degradation in battery modeling? What was the impact of including more or less expensive batteries? What was the impact of building a site for NPV/CAPEX rather than LCOE (this is barely touched on)? What do all these findings mean for developers and the wider research community? How should we be designing plants, based on your findings? Each finding should have supporting text describing what is driving the finding. For example, if cheap batteries are more advantageous, why? Does the CAPEX of the batteries outweigh the replacement costs for cheaper batteries? At what price does that change?
- The conclusion section seems incomplete. It needs to outline the contributions of the paper, both from a methodological and from a results standpoint, describe limitations, and propose future work to overcome those limitation and continue to advance the field.

Grammar: Note that many of these corrections include an example but should be applied throughout the paper
- Consistent italisizing/capitalization of names (ex: Line 75 has pywake and Line 81 has *pyWake)*
- Equations should have all variables defined, and then the figures should consistently use those variables (rather than units). For instance, Equation 1 has some variables defined, but others not (like N_WT), and then in Figure 3, MW/km^2 is used rather than the variable defined rho_W. Ideally, similar subscripts would be awesome, but I know Matplotlib is limited.
- Consistently capitalize "Figure" and "Equation" rather than "figure" and "equation" (ex: Line 71 has "figure 1" but Line 90 has "Figure 4".
- Consistently use undercase in captions. For instance, "Figure 2. Generic Wind Turbine surrogate" should be "Generic wind turbine surrogate"
- Define acronyms before use (examples include CAPEX, which is used on Line 47 and defined on line 196 and WPP, which is first used in Figure 1 and Line 85 and is defined on Line 111, SEI on Line 165, WT on line 201)
- L 127 Spot to spot
- L 129 Has to have
- Spacing around equations is a bit odd (particularly, there seems to be extra space above, maybe?)
- Line 72 potential spelling error: constrain > constraint
- Line 44 potential grammar error: "while *the* wind turbine" rather than "while wind turbine"
- Line 121, need a comma between the two subscripts "S" and "inverter" so that it is "C_S, inverter
- Line 119, missing an article and comma at "grid-connected": "Sandia performance model for *a* grid-connected*,* PV-inverter model"
- Figure 6 caption: "two…factor*s"* rather than "factor"
- You use "solar PV" and "PV", so I suggest you pick one for consistency
- Line 132: Once you define an abbreviation, use it consistently (ex: EMS is defined early in the doc, but then spelled out throughout). Definition of abbreviations only need to happen once (ex: OPEX, CAPEX, EMS, and others are defined multiple times). Also, "The energy management system optimization model consists in" should be "The energy management system optimization model consists of"
- Line 156: "a rainflow counting" should be "Rainflow Counting…is implemented" or "A Rainflow Counting algorithm/method…is implemented"
- Line 177: "A ruled based EMS is implemented" should be "A rule-based EMS is implemented"
- Line 180: "*the* reduction"…missing article 'the'

- Line 191: "Spot electricity price" > "spot market price", "single year operations" > "single-year operations"
- Throughout paper: "Consist in" should be "consists of"
- Line 199: "fix costs" > "fixed costs"
- Line 208: ", solar AC to DC ratio" > "and solar AC to DC ratio"
- Line 209: "inverter costs is" > "inverter costs are"
- Line 247: "near optimal initial conditions" > "near-optimal, initial conditions"…this grammar issue is throughout and should be thoroughly checked.
- Line 261: "A summary of assumptions costs and general specifications of HPP" > "A summary of assumptions, costs, and general specifications used for this analysis"
- Line 267: Wind is capitalized when "w" should be undercased
- Line 274: missing comma after PV. You can decide to use the Oxford comma or not, but just do it consistently.
- Line 278: "This is in general an expected result" > clauses need commas for separtation > "This is, in general, and expected result"
- Figure 8 caption: "10 days *of* operation" and "NPV-optimized"