Review: esd-2017-48 - More Homogeneous Wind Conditions Under Strong Climate Change Decrease the Potential for Inter-State Balancing of Electricity in Europe

Jan Wohland, Mark Reyers, Juliane Weber, and Dirk Witthaut

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Comments to the Authors

The manuscript under review presents a study of the impacts of strong climate change on the operation of a fully renewable European power system using future projections from the EURO-CORDEX dynamically downscaled regional climate ensemble. To assess the impact the authors compare historical and future backup energy needs, allowing for trans-national transmission. The authors consider this 'network expansion' as the cost-optimal adaptation strategy, rather than exploring the incorporation of storage capacity.

Major Points

I consider that this manuscript should be subject to minor revision due to the fact that the analysis of the results if often unclear given their definitions and use for expressions such as 'backup energy' and 'backup needs'. Given that the article has been submitted to a journal where authors and readers come from a diverse range of backgrounds, I believe that a clear nomenclature is fundamental.

Instances of these conflicts, along with an extended set of minor points is included next, with suggestions on how to improve the manuscript.

Minor Points

1. Page 3, lines 60-61: extra parenthesis in citation

2. Page 3, line 32: high resolution future projections but coarse representation of the power system? This might require a better description of the implications and assumptions. Are you considering the effect of changes in the national grids negligible?

3. Page 5, lines 92-94: This paragraph looks out of place in the Methods section and is redundant to the Introduction

4. Page 5, line 102: should be 'sensitivity analyses' or 'a sensitivity analysis'

5. Page 6, eqs 1-2: You don't include any representation of existing storage capacity in the system? How would results change if you did?

6. Page 6, line 51: a 20yr time slice only allows to account for a portion of natural variability: interannual rather than decadal, and you mention in your introduction that larger time-scales also have an impact on the power system operation

7. Figure 1 and Table 1 captions: These are very long. Consider including more of this information (which even includes multiple references!) in the Methods section.

8. Figure 2: one really can't tell much from panel a on this figure. Consider removing it and using only the changes, or just show it for fewer expansion coefficients (or just no expansion) to be able to 'zoom in'. On the caption, there is a typo and should read 'later on'. And you are also discussing a lot of the results on the caption!

9. Page 10, lines 75-77: The assessment is not clear. An increase in backup energy needs implies under your definition that there is more of the local energy mismatch (difference between demand and volatile RE) that could not be met by transmissions. So, how can this be due to more excess energy? Is the problem on the assessment of line 74, since the increase is not on backup NEEDS but rather on energy available for transmission? If what you show on the plot (panel a) is back up energy, that is decreasing with network expansion. You can see how your descriptions are leaving big gaps in the interpretation of results.

10. Page 10, lines 183-184: this is not true for all ensemble members. Cahnges in CNRM and MOHC are not that 'pronounced'.

11. Figure 8b, Supplementary Information: How can the backup energy increase by incorporating PV? You can see it in the two larger α values for the CNRM model in the *midc* period.

12. Page 10, line 194: should be 'reveal'

13. Page 11, lines 199-201: how is this a lower bound to 'back up needs' if this is this represents the worst case scenario for mismatch. I can see how it is a lower bound for the mismatch M_i, since it is negative.

14. Page 12, line 232: should be 'importing'

15. Page 13, lines 257-259: this clarification should have been made in the Methods section, since it was also an assumption of the previous analysis.

16. Figure 7: check language of labels in x axis. To mix the directions and rotations in the same plot makes it impossible to see any changes in the first. Consider adding two panels!

17. Page 20, lines 345-6: It seems like you are making assumptions about more spatially homogeneous condition from an analysis that is based on a single point. How can you draw those conclusions from CWT?

18. Page 23, lines 372-2: Comment starting in 'Moreover...' need revision