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# Proposal of roadmaps for gradual integration of new solar PV and wind capacity in the Spanish power system based on Mean-Variance Portfolio optimization techniques

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In this study, different roadmaps for the gradual integration of new PV and wind capacity in Spain have been designed and analysed based on the Mean-Variance Portfolio optimization. These energy scenarios aim, firstly, to allocate 18 GW of new renewable capacity in Spain – the main target for 2030, and secondly, to reach 40% of the national electricity generated by solar and wind energy. The roadmaps are designed according to two different objectives: 1) to minimize the level of power fluctuations and 2) to maximize the average level of power supply preserving the current level of fluctuation. Data used in the study consists of hourly PV and wind generating capacity time series for the Spanish continental regions (47 in total). Costs of the different roadmaps are evaluated. Overall, the two proposed roadmaps improved the performance of the current distribution of PV and wind capacity, although the strategy that seeks to maximize the mean generating capacity clearly showed the best compromise between the optimization target and the resulting electricity costs. The new wind and solar capacity spatial distribution also vary depending on the strategy adopted. For instance, for the roadmap that aims to maximize the average level of power supply, the PV capacity is mainly located in the River Ebro valley and the Strait of Gibraltar area. On the contrary, for the roadmap that aims to minimize the fluctuations, the PV capacity is mainly located in the northern Spain, whereas the wind capacity is mainly allocated in the Strait of Gibraltar area.