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## A century of European wind and solar power generation variability

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To reach its goal of net greenhouse gas neutrality by 2050, the European Union seeks to massively expand wind and solar power. Relying on weather-dependent power generation, however, poses substantial risks if climate variability is not adequately understood and accounted for in energy system design. Through informed combination of centennial reanalyses that have been tested for agreement with large scale climate phenomena, we here quantify European wind and solar generation variability over the last century. We report that wind and solar generation vary on a multidecadal scale, but wind more strongly. We identify hotspots and study dominant patterns of (co-)variability, finding that solar generation varies mostly uniformly across Europe while the leading wind variability modes reveal cross-border balancing potential. Continental scale transmission thus proves useful in balancing wind power variability also on multidecadal timescales. Evaluating local solutions to balance generation variability, we find that combined wind and solar systems optimized for minimal seasonal variability exhibit multidecadal variability of around 10% in many European countries. This amplitude can be reduced three-fold through wind shares optimised for minimal multidecadal variability. Thus, with improved spatial planning only, multiple options to mitigate long-term renewable generation variability exist.