EMS Annual Meeting Abstracts
Vol. 9, EMS2012-251, 2012
12th EMS / 9th ECAC

Optimal spatial distribution of wind farms and CSP plants to reduce power fluctuations: a case study in southern Spain

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We propose a method for analyzing the potential contribution of solar radiation (direct component) and wind energy to baseload power within a region. The method, first, uses the Canonical Correlation Analysis (CCA) for analyzing the spatio-temporal balancing between solar and wind energy resources. Secondly, results of the CCA are used to assess the optimal location of Concentrating Solar Power Plants (CSPP) and wind farms in order to reduce fluctuations in power. The ability to produce stable power of the wind farms and CSPPs alone and interconnected each other are ultimately evaluated at selected locations. The method was tested in the southern Iberian Peninsula, including offshore areas. We used hourly solar and wind energy estimates for 2009 from the WRF mesoscale model at 3 km spatial resolution. Results showed, firstly, the existence of valuable spatial balancing patterns between the wind resources and solar (direct component) resources within the study region, but with a marked seasonality. Most important balancing patterns were found for winter, spring and autumn, being the result of the interaction of the mesoscale circulation and the topographic features of the study region. Secondly, results indicate that optimal allocation and interconnection of wind farms and CSPPs across the study region, by taking advantage of the aforementioned spatial balancing patterns, can substantially reduce power output fluctuations. In some cases, this optimal allocation provides stable (baseload) power.