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Complementarity between Solar and Hydropower: Sensitivity study to climate characteristics in Northern-Italy

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Climate related energy sources such as wind, solar and runoff sources are variable in time and space, following their driving weather variables. High penetration of such energy sources into the energy network might be facilitated by using the complementarity of different energy sources. Complementary resources lead to reduce the balance between the energy load and production from the energy mix. This study presents the analysis of the effect of a 100 % renewable energy mix composed by solar and run-of-the-river energy in three administrative units in Northern Italy. These two energy sources are the main ones in this area. Solar power is generated in the flat Veneto plains and run-of-the-river power is generated at the two opposite location of a climate transect going from the Alpine crest (snow melt dominated area) to the Veneto plains (rainfall dominated area). The manageability of each energy source is first discussed thanks to the analysis of the standardized auto-correlation of the energy balance obtain using each energy source alone. Covering the all possible energy mix among these energy sources, we then analyze their complementarity across different time scale using two different indicators. The first one is the standard deviation of the energy balance. The second one is the theoretical storage required for balancing. Results show that at small time scale (hourly), a high share of run-of-the-river power allows minimizing the energy balance variability. The opposite is obtained at larger time scale (daily and monthly) essentially because of lower variability of solar power generation at those time scale, which also implies a lower storage requirement.