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The benefits of distributed grid production: An insight on the role of spatial scale on solar PV energy

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The hydrometeorological processes associated with renewables are characterized by substantial spatiotemporal variability, and thus uncertainty, which is addressed through decentralized planning, thus taking advantage of scaling effects. The objective of this work is to provide a comprehensive investigation of the role of scale regarding solar photovoltaic production in Greece, which is one of the predominant renewables. By implementing macroscopic criteria in terms of solar potential (e.g., topography-adjusted radiation indices), we select a sufficient sample of well-distributed locations in Greece. For these points, hourly radiation and temperature data, derived from satellite products, are retrieved and validated against ground observations. Following this, we formulate a detailed simulation procedure that accounts for the two physical drivers and the panel characteristics (i.e., efficiency and temperature impacts due to heating), and we configure the baseline scenario by computing the individual production of each site. Next, to highlight the added value of distributed production and quantify the scaling effects in PV power production, we follow a Monte Carlo approach by randomly distributing PVs across the selected locations, to eventually provide a statistical analysis on the spatial and temporal domain and over different PV technologies.