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Simulation of long term solar power feed-in and solar balancing potential in European countries

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In future, solar energy sources will play a remarkable role in European energy market. The nature of solar energy is
determined by the deterministic pattern resulting from the earth-sun geometry and by highly fluctuating meteorological
factors, especially by the presence and the optical properties of clouds. Due to this weather-dependent nature, solar energy has highly fluctuating feed-in profiles. In order to overcome the mismatch between energy demand and power
production, it is important to study and understand these generation patterns and the spatial balancing potentials.
The current work is carried out in the framework of the project RESTORE-2050, which aims to address the major questions regarding the transition from a demand-driven electrical energy system to a highly variable grid-integrated
renewable power production system. This paper will primarily focus on the solar energy component of the project and
investigate how the feed-in profiles from photovoltaics (PV) and concentrated solar power plants (CSP) behave in the
context of a sustainable power supply system.
For this work, irradiance has been retrieved from Meteosat first and second generation satellites on a 7km $\times$ 7km grid for all European countries. Since an effective solar power production strongly depends on the module configuration
and efficiency, special attention has been given in finding optimal module configurations in terms of reduced power fluctuations. Solar power has been aggregated on the country level and the production patterns have been investigated
for the period 2003-2012. In a first step, the quality of the simulated feed-in time-series has been investigated by comparison to real estimations of observations for solar power generation. Furthermore, some sensitivity studies with
respect to underlying assumptions like spatial distribution of installed capacities, have been done and will be presented.
Finally, we studied the potential how smart configuration and combination of PV and CSP systems can be used for peak shaving in single countries and in entire Europe.