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Monitoring the performance of solar energy plants from satellite remote sensing of air temperature and ground solar irradiance through an accurate modelling of the effects of aerosol optical properties

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We present a new method for the performance analysis of solar energy plants based on satellite remote sensing and on an accurate modelling of the optical properties of atmospheric aerosols. This method stems from the results obtained in the frame of the FP7-ENDORSE (ENergy DOwnstReam Services) project (2011-2013).

The original methodology, developed in FP7-ENDORSE by Flyby S.r.l. and by the Image Processing and Pattern Recognition for Remote Sensing (IPRS) Laboratory of the University of Genova, starts from the near real-time elaboration of both Global Horizontal Irradiance (GHI) data provided by the MACC-Copernicus Atmosphere Service (based on Meteosat Second Generation - MSG satellite optical imagery) and of air temperature data calculated through an automatic parameter optimization for vector regression applied to MSG infrared imagery. Then the GHI in clear-sky conditions (provided by MACC-Copernicus too) and the near real-time GHI are used to calculate the solar irradiance incident on a fixed tilted plane (GTI) or the beam component of the solar irradiance on the normal plane (BNI) thanks to a dedicated model. Remotely sensed GHI and air temperature data are the inputs to a detailed opto-electronic model of the solar energy plant (PV, CSP or CPV) that finally calculates the expected behaviour of AC power yield and allows a near real-time service for the monitoring of the actual AC power production. This service, called “PV/CSP/CPV Controller” and currently available on-the-market, is capable to readily detect any possible malfunctions and to evaluate the performances of the plant, but its reliability is critically connected to the accuracy of the remotely sensed GHI.

In order to increase its accuracy, the original method has been further developed including an accurate modelling of the contribution to the radiative transfer due to aerosols in clear-sky conditions, particularly thanks to the research activities performed by the University of Milano. This upgrade is based on a novel method for characterizing nano- and micro-particles, which is capable of assessing the optical properties in a completely new way and allows a more detailed modelling of the spectral radiative transfer in clear-sky conditions and of GHI.

These new scientific results, obtained thanks to the partnership among University of Milano, Flyby and University of Genova, led to a sensible improvement of the original remote monitoring service. The first tests on some well-functioning solar energy plants in Sicily (Italy) show an overall increase of accuracy of about 2-5% in the AC power calculation with respect to the results of the original method.