Long-term variability of solar irradiance and its implications for photovoltaic power in West Africa

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West Africa is one of the least developed regions in the world regarding the energy availability and energy security. Located close to the equator West Africa receives high amounts of global horizontal irradiance (GHI). Thus, solar power and especially photovoltaic (PV) systems seem to be a promising solution to provide electricity with low environmental impact. To plan and to dimension a PV power system climatological data for global horizontal irradiance (GHI) and its variability need to be taken into account. However, ground based measurements of irradiances are not available continuously and cover only a few discrete locations.

Data records of surface irradiance based on satellite measurements have the advantage of covering wide spatial regions and being available over long time periods. The European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Satellite Application Facility on Climate Monitoring (CM SAF) provides the Surface Solar Radiation Data Set-Heliosat, Edition 2.1 (SARAH-2.1), a 35 year long climate data record in an half hourly resolution, covering the whole of Africa and Europe.

In this study, the SARAH-2.1 data record (1983-2017) is used to analyze the impact of 35 years atmospheric variability and trend on GHI and PV yields over West Africa (defined as the region from 3°N to 20°N and 20°W to 16°E). The trend and the variability of solar irradiance is analyzed separately for the wet and dry season as well as for annual data. Furthermore, a simplified model provides high-resolution potential PV yields.

According to the SARAH-2.1 data record, solar irradiance is largest (with up to 300 W/m 2 daily average) in the Sahara and the Sahel zone with a positive trend (up to 5 W/m²/decade). Whereas, the solar irradiance is lower in southern West Africa with a negative trend (up to -5 W/m²/decade). The positive trend is mostly connected to the dry season, while the negative trend occurs during the wet season. PV yields show a strong meridional gradient with lowest values around 4 kWh/kWp in southern West Africa and reach more than 5 kWh/kWp in the Sahara and Sahel zone.

This poster will discuss the long-term trend and variability analysis of solar irradiance and highlight
the implications for photovoltaic-based power systems in West Africa.