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Estimation of Energy Losses of Photovoltaic Systems in France Using Real Monitoring Data

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Abstract : Photovoltaic (PV) systems have risen as one of the modern renewable energy sources that are used in wide ranges to produce electricity and deliver it to the electrical grid. In parallel, monitoring systems have been deployed as a key element to track the energy production and to forecast the total production for the next days. The reliability of the PV energy production has become a crucial point in the analysis of PV systems. A deeper understanding of each phenomenon that causes a gain or a loss of energy is needed to better design, operate and maintain the PV systems. This work analyzes the current losses distribution in PV systems starting from the available solar energy, going through the DC side and AC side, to the delivery point. Most of the phenomena linked to energy losses and gains are considered and modeled, based on real time monitoring data and datasheets of the PV system components. An analysis of the order of magnitude of each loss is compared to the current literature and commercial software. To date, the analysis of PV systems performance based on a breakdown structure of energy losses and gains is not covered enough in the literature, except in some software where the concept is very common. The cutting-edge of the current analysis is the implementation of software tools for energy losses estimation in PV systems based on several energy losses definitions and estimation technics. The developed tools have been validated and tested on some PV plants in France, which are operating for years. Among the major findings of the current study: First, PV plants in France show very low rates of soiling and aging. Second, the distribution of other losses is comparable to the literature. Third, all losses reported are correlated to operational and environmental conditions. For future work, an extended analysis on further PV plants in France and abroad will be performed.

Keywords : energy gains, energy losses, losses distribution, monitoring, photovoltaic, photovoltaic systems
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