Assessment of the Inter-Annual Variability of the Global Horizontal Irradiance in the Atacama Desert of Chile

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SUMMARY

The inter-annual variability (IAV) of the solar resource is an important uncertainty component in annual energy production (AEP) estimates of photovoltaic (PV) plants. Based on studies [1] in the Mediterranean and Black Sea region, a figure of 4 to 6% is commonly used by consultants. For the extremely arid climates in the Atacama Desert in the North of Chile such generic values are expected to unnecessarily penalise developers seeking project financing. In the absence of reliable and consistent long-term ground measurements for this region, and based on previous in-house validation work and industry experience, long-term mesoscale satellite-derived datasets from the SolarGIS® database were considered to be the best available data source to estimate the IAV of the global horizontal irradiance (GHI). It was found that out of 14 sample sites investigated in this study, none displayed an IAV exceeding 2%. While this result is subject to limitations, the observed performance of the model relative to measured data suggests that the uncertainty in the IAV estimate is small compared to the systematic error that otherwise arises from using a 4 to 6% generic figure for sites in the Atacama.

PURPOSE OF THE WORK - RELEVANCE

The AEP of a PV plant is subject to a number of uncertainties. These can be grouped into three main categories:

i) variability of the solar resource (depending on the time period considered),

ii) uncertainty in relation to the measurement of the solar resource, and

iii) uncertainty associated with the simulation.

The IAV of the solar radiation, which is the main driver of category i), is therefore a key input into the financial assessment and valuation of a PV project. It quantifies how much a yearly value can vary from the long-term average, and ultimately influences the debt-ratio and return on investment as it directly intervenes in the Pxx calculation (Banks and investment firms working on solar PV projects often require P90, P95 or P99 values). Considering the geographic and climatic characteristics present within the Atacama Desert of Chile, the aforementioned generic 4 to 6% figure obtained from [1] and used to quantify the IAV was hypothesised to be excessively conservative. An attempt was made to estimate a more realistic value within this study.

APPROACH

Long-term mesoscale satellite-derived datasets from the SolarGIS® database of the global horizontal irradiance (GHI), spanning a historic time period of up to 14 years, in hourly resolution, were sourced and used to calculate the year-to-year variability of the GHI at 14 locations, which were reasonably representatively spread across the studied area. In parallel, the accuracy of the long-term mesoscale satellite-derived datasets was quantified by calculating biases and root-mean-square-errors on available concurrent period with ground measured data.

RESULTS AND CONCLUSION

The density of measurement locations available to validate the modelled data is higher than in previously acknowledged study and bias and RMSE are within the same range or lower. This suggests that the methodology adopted for the Mediterranean and Black Sea region is also suitable for the North of Chile.

None of the sites considered in this study showed an IAV of the GHI near the generic 4% to 6% IAV figure used for PV projects in the North of Chile which proves this assumption is overly conservative, and a smaller figure would be more realistic.

While satellite-derived irradiance datasets can be a useful tool for estimating a project IAV value, they may underestimate the variability of solar radiation in mountainous regions, and it is difficult to verify that they capture low frequency climatic phenomenon such as the “El Niño Southern Oscillation”. Ground-measured long-term datasets for the last 20+ years (which are currently not available for Chile) would be required to further validate the findings of this study.

REFERENCE

[1]. Šúri M. *et al*., "Uncertainties in photovoltaic electricity yield prediction from fluctuation of solar radiation" in 22nd European Photovoltaic Solar Energy Conference, Milano, Italy, 2007.

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