Data request for solar power data shortfalls due to topography

Requested location

Latitude: --.---º
Longitude: ----.---º

Estimated annual losses: ~3%

The main goal of this analysis is to account for the effect of topography on the solar resource of a PV site located at coordinates --.---º North and --.---º West. The main tools utilized have been the irradiation from the enhanced Solar Anywhere database, developed and provided by Clean Power Research. It contains GHI and DNI data for the year 2011, with 30 minute temporal resolution, and a 36 arc-seconds (~1 km) spatial resolution. This data allow quantifying the solar potential in absence of topographic shading. In addition, a Digital Elevation Model (DEM) of the area have been used, which allows calculating the horizon of the studied point. Both sources are utilized to quantify the effect of topographic shading on the daily irradiation and also an estimation of the power production losses due to topography.

---

1. Site horizon

The calculated horizon shows a mountain South of the site, which also affects the West and East directions, but no elevations are found North of the site. Figure 1 represents the horizon (blue) together with the obstructed (green) and unobstructed (yellow) sun paths. It can be observed how the mornings (left) are slightly more affected than the evenings (right).

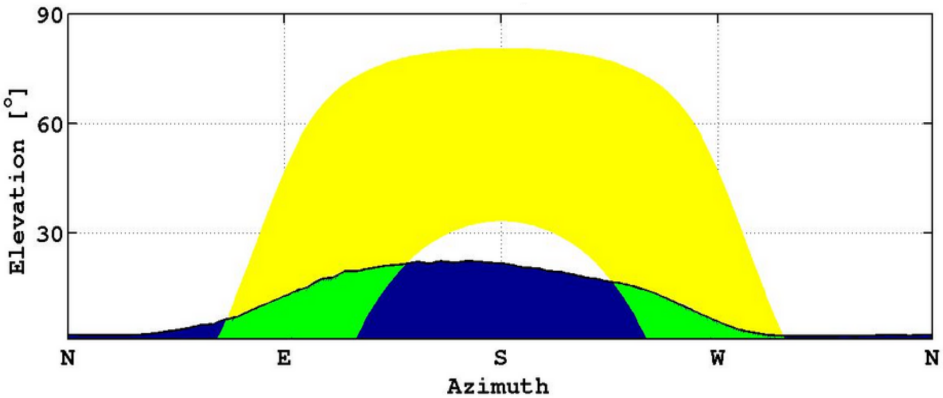

Figure 1. Horizon (blue) and sun trajectories along the year (yellow). The portions where the elevation is shading the direct sunlight are painted in green.

The main effect of the obstructions is the reduction of direct sunlight hours reaching the site for a given clear day. For example, if a house on top of the mountain (i.e. with no obstructions around) receives 10 hours of sun for a given winter day, the one with the obstructed horizon would receive just a reduced number of hours of direct sunlight (for example 6 hours). This example would result in a ratio of 0.6=6/10, which is defined here as the day fraction d_f. Figure 2 shows the evolution of the day fraction along the year. d_f ranges from 0.6 during the winter to almost 1 during the summer.

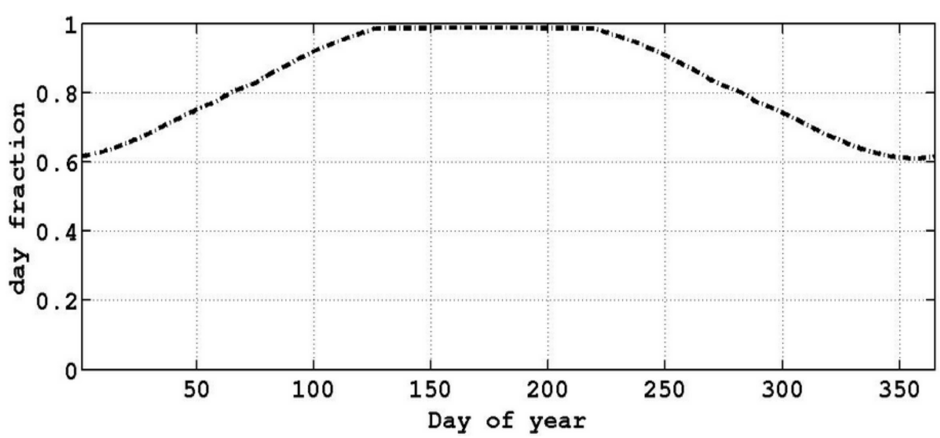

Figure 2. Day fraction evolution along a year time period.

However, the values obtained for d_f cannot be taken as the reduction in power production because the most number of shading hours occur during the early morning and late evening, when the sun is low in the sky and the produced power is also lower. Section 2 shows the estimation of the power production losses.

2. PV power losses estimation

The amount of power production lost for a given day due to the nearby mountain will depend on the season considered, but also on the cloudy/clear conditions observed for that day. Specifications of the installation will also affect this number, in this analysis south oriented PV panels with a tilt angle of 20º have been utilized. Finally, obstruction due to other objects not included in the Digital Elevation Model (trees, other buildings, etc...) would add to this losses calculation which has to be considered as a first order approximation.

Figure 3 shows the daily percentage losses estimated from satellite data from the year 2011. Losses are almost negligible for April to August, and can reach up to ~15% for winter months. The average percentage daily losses are ~4%, and the total yearly losses due to horizon are estimated to be ~3% of the produced power.

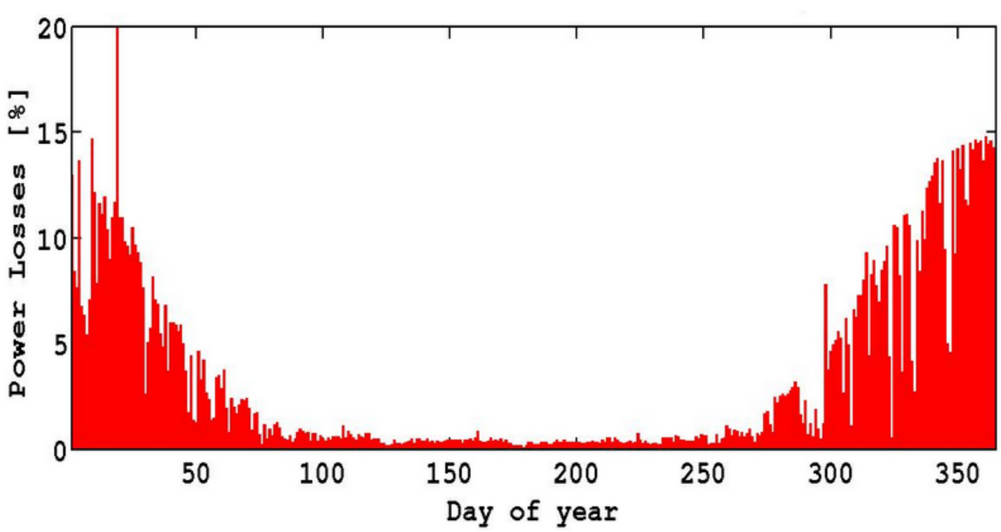

Figure 3. Estimated losses due to horizon obstruction of the sun for the year 2011. They are calculated as a percentage of the daily power production that would be lost if compared to a obstructions free horizon.