Analysis of Solar Radiation Data from Satellite and Ground Station for PV System Applications in Al-Diwaniyah Location

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Abstract. Solar radiation power is the fuel for all solar energy production purposes. All sets of activities such as chemical, physical and biological revolving near the ground or in the atmosphere layer. The solar radiation data at ground level and in the atmosphere are an important characteristic in solar energy applications such as photovoltaic (PV) systems. Various meteorological databases are accessible with data acquired from ground measurements, satellite data, or unification of both. In this paper, the comparison between satellite data derived from ground station installed at Al-Diwaniyah location and PVGIS website so as to design the PV system for maximum competence under different climatic conditions. The monthly data for one year (2015) was analyzed and assessed at zero and tilt planes. The results showed that the difference and bias between acquired satellite and ground station data. The annual rate value of solar radiation for selected location is 1423.5 (Kwh/m²/year) for ground data and 1825 (Kwh/m²/year) for PVGIS data, so, this rate is suitable for PV solar system applications.

Keywords: Solar radiation, PV system, PV generation

1. Introduction

The sun is a primary energy source, and energy that is getting from the sun is called solar energy. Every day the sun's energy travels through space in the form of solar radiation. Solar radiation energy is employed directly to generate electricity for photovoltaic (PV) systems and solar thermal systems [Error! Reference source not found.]. Global solar radiation is commonly measured on a horizontal plane, and all major sources for meteorological data provided horizontal plane measurements too, eliminating confusion and facilitating easier adaptation [Error! Reference source not found.]. Analysis of solar radiation data is essential for assessment of solar energy systems because it is used directly to produce electricity for PV and solar thermal systems [Error! Reference source not found.]. The performance of any solar energy system required the adequate information of actual global solar radiation at a place of study [Error! Reference source not found.]. Global radiation is the whole shortwave radiation from the sky coming onto a horizontal surface on the ground. It incorporates both the direct solar radiation and the diffuse radiation emerging from reflected or disbanded sunlight. It is measured in either irradiation (kWh /m² .day) which is the power over a period of time [Error! Reference source not found.], hence the sunlight hitting the earth, or irradiance (W/ m²) which is the power from the sun hitting the earth which is used a pyranometer to estimate the solar radiation flux.
density from the hemisphere above within a wavelength range 0.3 m to 3 m typically [Error! Reference source not found.]. The detector of pyranometer used for climatologically purposes is normally made of thermopiles. Other types of detectors used as photosensors, pyroelectric or bimetallic sensors [Error! Reference source not found.]. The objective of solar radiation analysis is to approve the quality of ground measured series. The accuracy of global horizontal irradiance is required for the solar resource assessment by electing a proper place which represents an important sector of promoting a viable solar PV project. In deciding a site, the object is to maximize yield and reduce cost [Error! Reference source not found.]. Precise measurements of the incoming irradiance are crucial to solar power plant project plan and implementation because irradiance data are comparatively complex and consequently expensive related to other meteorological measurements.

The solar electricity generation in each area given by kW generated from each kW peak of a typical PV System. In this approach, a sensitivity inquiry is taken out to appraise the impact of the spatial distributions of the PV-modules at country and regional levels. Thus, the quality of the assumptions is also gauged to estimate the locations of the PV farms for each region.

2. Meteorological and processing data

Solar radiation data was recorded from a ground station, which is installed by the ministry of science and Technology-renewable energy directorate. The coordinates of the ground station are (44 46.611 E, 31 57.249 N). The type of the pyranometer sensor is (LI-200). This instrument used silicon detector to measure global solar radiation. The 12 months are concatenated to provide data expressing a 1-year period (the Conventional Meteorological Year), a time interval for data is 10 min. PVGIS (The Photovoltaic Geographic Information System (PVGIS) website is another source of solar radiation data was used to assess the location for PV system installation and compared with the ground data for the same period to quantify the similarities or the differences between the two types of data. PVGIS is a model developed at the Joint Research Centre since 2001 providing values of solar irradiance and the potential power production from PV modules for different choices of technologies, panel orientations and other parameters.

The data was measured at zero planes and calculated in optimum tilt angle for PV system applications about (28 degrees) for Al-Diwaniyah location. The principal scope of establishing a solar resource measurement station is to assemble data that allow an interpreter to precisely describe the solar irradiance and relevant meteorological parameters at a particular location. Data processing is the first step to assess solar radiation rates. The second step is the meteorological data treatment; in this case, it is necessary to calculate solar radiation data into radiation on inclined planes. The last step is to estimate the PV generation for fixed PV solar systems.

3. Results and discussion

Fig 1 shows the daily solar radiation rate for the ground station, it is clear that most days in the year have high solar radiation rates. It is an incentive for investment in solar energy applications.
Figure 1. The daily solar radiation rate for ground station.

It is noticed that some of the days have a low value of solar radiation values due to the attenuation of cloudy and dusty days. To compare the ground station data and accurate source data for the same location, PVGIS data were selected and analyzed. The figure 2 illustrates the daily solar radiation rate PVGIS data.

Figure 2. The daily solar radiation rate for PVGIS.

Fig 3 shows the annual solar radiation data for the ground station in horizontal (zero angles) and optimization tilt angle (28º) for Al-Diwaniyah location.
Figure 3. The monthly solar radiation rate for the ground station at horizontal and tilt angle.

Figure 4 shows PVGIS data for monthly totals combining the data available for horizontal (zero angles) and optimization tilt angle (28) for Al-Diwaniyah location.

To estimate the potential of 1 KW monocrystalline silicon system, the area was assumed 6.5 m$^2$ and efficiency is 0.18.

Fig 5 shows the monthly PV generation comparison between the ground station and PVGIS data.
It is clear, there are some differences in the amount of PV generation. PVGIS data produce a high amount of generation due to its high rates as compared with the ground station data. This difference due to PVGIS data was modelled to be agreed with the general behaviour of annual solar radiation for this location. This year witnessed a cloudy and dusty day, so, its lead to attenuation of solar radiation rates and this climatic condition affected on the annual solar radiation rates.

4. Conclusions
Briefly, it can be deduced that Al-Diwaniyah location has adequate and acceptable potential for solar radiation rates. This rate helps the interesting investigators to plan to install many PV system applications such as residential sectors, agricultural and large scale PV systems plants.

5. References

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