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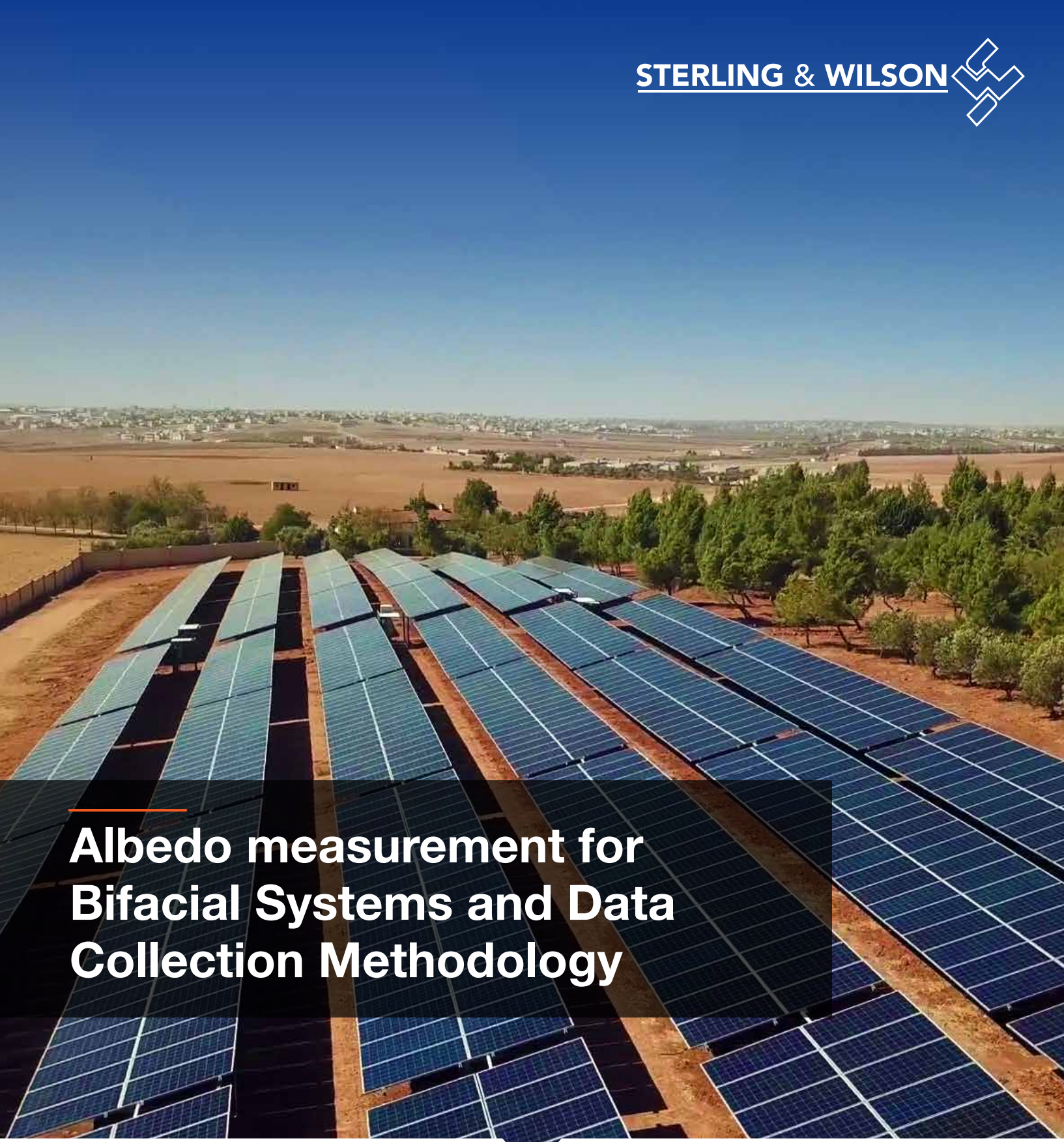

Albedo measurement for Bifacial Systems and Data Collection Methodology

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Abstract:

Importance of albedo on the solar PV panel performance is relatively understood, some investigations points that higher the value of Albedo better will be the performance of solar PV modules in terms of its power output. However, selecting an optimum value of Albedo is always been a challenge for a project company. Although, value of Albedo can be calculated by the available data of irradiation (direct and diffused) from various meteorological websites i.e., PGVIS, Meteonorm for the location where PV project is proposed. However, it'll give more confidence to the project company if measurement is taken by installing Albedometer at various locations of the ground where PV project is proposed. This paper gives information about the methodology proposed for the Albedo measurement, basis of location selection for the equipment to be placed for reading and then analysis of the data to consider the final value of Albedo in simulation.

1. Introduction:

Among various resources of renewable energy available at earth, 23000 TWy/yr is received from solar itself which is highest among any other resources (1). World energy demand is 18.5TWy/yr which is the fraction of what we receive at earth by solar (1). Looking at the current research and development in the field of solar PV system it is seen that solar PV technology is now competing with the other conventional energy resources (2). World-wide solar PV installed capacity is estimated to be increased from 540GWp in 2019 to 1580GWp by 2030 (3). One of the challenges with solar PV system is its low efficiency. Since, now a days bifacial PV module are in trends with tracker technology which results in better LCOE (Levelized cost of energy) over others configuration, it's become very much important to select the value of albedo as gain of the bifacial PV modules increases with increasing value of albedo which leads to better yield from the system. Also, selecting a wrong value of albedo may impact on the PR guarantee which is a risk to the project bidding firm. Considering the fact, albedo impact on the system yield, this paper proposes method and calculation of albedo value selection.

2. An introduction to Albedometer and its working:

Albedo is defined as the ratio of global incoming irradiation to the reflected irradiation. Albedometer is a device used to measure albedo. It consists of two pyranometers placed side by side, one facing toward the sky while other facing toward the ground surface. Albedometer is mounted on the tripod. Height of the tripod should be matching with the structure height on which PV modules are to be placed. Mounting Location of the albedometer should be shade free. Pyranometer facing upward measure global incoming irradiation while the one facing toward ground surface measure reflected irradiation. Various models and makes are available in the market. Depending upon accuracy and precision requirement model can be selected.

3. Locations of Albedometer placement based on soil type and colour and albedo value selection:

In utility scale project land requirement is in acres due to which it is very rare that land surface colour and type are same for the entire land where PV modules are to be placed. As colour of the land surface varies in the entire land, albedo value will also vary. To measure the value of albedo for the entire land area it is required to place the albedometer on each colour of the land surface which is not feasible and economical. To decide the locations of the albedometer mounting, land is divided based on its surface colour. Bifurcation is done by taking google earth image of the land, refer Figure 1.

Refer to Figure 1, albedometer is mounted on the marked locations P1, P2, P3 and P4, reading is taken for each location. Duration of reading may vary which is totally an individual choice but should be such that to gather enough reading for different day time and weather if possible. More reading will lead to the better accuracy in albedo value selection. Parameters which are captured in the reading is up irradiation, down irradiation, date and time in HH:mm:ss.

Figure 1 Google image of the land and its bifurcation based on surface colour.

4. Worked example of albedo calculation based on considered value:

Let us consider that maximum irradiation on the project location on the measured day is 800 W/sqm. As per the ASTM E1918, only those value of albedo should be considered in the calculation which are higher than at 70% of the measured irradiation value.

i.e., maximum irradiation on the day of measurement is 800W/Sqm
as per ASTM E1918 (4) irradiation to be considered for albedo captured value = 800 x 70% = 560 W/Sqm.

Which means only those value of albedo should be considered which have irradiation value equal to or more than 560 W/Sqm.

Refer to the Figure 1, entire land is divided into P1, P2, P3 and P4. Consider that data is captured for one day for each location. Albedo value is considered only for irradiation higher or equal to 560 W/Sqm. Weightage and reading of the plots are as follows.

Plot	Land area Weightage (A)	Albedo Reading (B)	Calculated albedo value (A x B)
P1	25%	19%	4.75%
P2	25%	22%	5.50%
P3	35%	24%	8.40%
P4	15%	19%	2.85%
Total	100%		21.50%

Table 1 Albedo calculated value for selected plots

From the Table 1 and calculation, maximum value of albedo is 24% while minimum is 19%. To be on safer side it is better to consider the albedo value after multiplying land weightage with albedo reading and then sum of all the plots. From the calculation, 21.5% is the value to be considered. Over the calculated value of 21.5% there should be correction factor of 7% to be considered as sum of error which may occur during data measurement and due to weather uncertainty. This 7% correction factor also depends upon individual firm choice and risk they can consider.

After considering the correction factor final value of albedo to be considered in the energy analysis is
21.5% * 93% = 20%.

Conclusion:

Selection of albedo value is a matter of an individual firm choice. However, to select the value close to the real value or accuracy there must be analysis of the data captured from site for the various plots and for different duration. There must be an uncertainty and risk factor consideration also which should be considered in the value arrived after extrapolation of data.

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