Correction factor of the influence of the horizon on the shading of a photovoltaic installation

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Abstract **The work presents a method of determining the correction factor of direct radiation dependent on the horizon.**

Keywords **correction factor, shading, horizon, PV receiver, direct radiation**

I. Introduction

The energy of solar radiation on a horizontal surface can be divided into particular hours of the day. Thanks to that, it is possible to determine the correction factor for direct radiation due to shading with the horizon line. The Sun path diagram for every month which constitutes the shading diagram for the particular latitude is used for that purpose [1-3].

II. Shading Correction Factor

Depending on the position of the photovoltaic receiver directed towards the south (azimuth angle γ_s=0º), the shading diagram is created assuming different weight of the shadowing points. The weight of 3% is assumed for the deflection of $0º < |\Delta\gamma_s| \leq 30º$, 2% for $30º < |\Delta\gamma_s| \leq 60º$, and 1% for $60º < |\Delta\gamma_s| \leq 80º \div 110º$, depending on the receiver inclination angle β. Next, the total weight value ΣGPS is determined for all the points located on the Sun path for all the relevant months [1].

In order to determine the energy losses caused by shading, it is necessary to assume the appropriate weight for every point located below the horizon, in accordance with the shading evaluation diagram. The sum of all the weight percentage values for the shadowing points below the horizon line for particular months constitutes the total weight $\sum GPB$ for the shadowing points [1].

The shading correction factor k_B for the relevant months is determined with the use of formula 1 [1]:

$$k_B = 1 - \frac{\sum GPB}{\sum GPS} \quad (1)$$

The factor assumes values in the range from 0 (with full shading) to 1 (with no shading).

III. Example of Calculation of K_B

The object of analysis was a solar generator located in central Poland with the azimuth angle of $\gamma_s = -15º$ (oriented to the west) and with the inclination angle of $\beta = 45º$. The generator azimuth and the horizon line were charted on the appropriate shading diagram (as shown on figure 1).

The values of k_B were determined for all the months (with the exception of VI and IX, for which $k_B = 1$) in accordance with the example presented (2) (for the month of January) and summarized in table1.

$$k_B = 1 - \frac{\sum GPB}{\sum GPS} = 1 - \frac{6 \cdot 3\% + 1 \cdot 2\% + 1 \cdot 1\%}{24 \cdot 3\% + 12 \cdot 2\% + 1 \cdot 1\%} = 0{,}78 \quad (2)$$

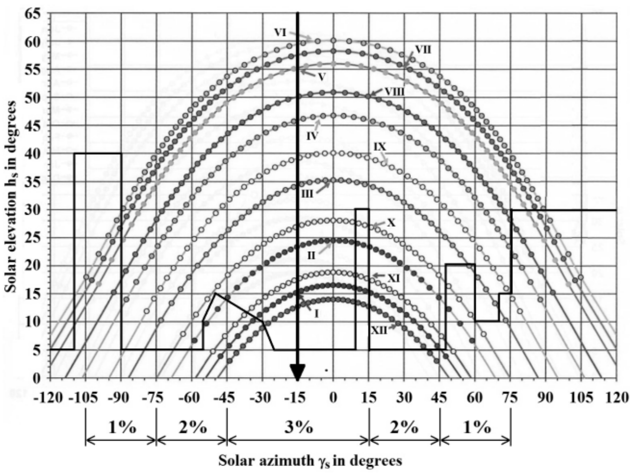

Fig. 1. Shading diagram and weight of shadowing points for 53°N [1]

TABLE I
SHADING CORRECTION FACTOR VALUES

Month	I	II	III	V	VI	VII	VIII	X	XI	XII
k_B	0,78	0,87	0,98	0,98	0,96	0,96	0,98	0,90	0,79	0,69

The shading correction factor values obtained express the value of the direct radiant flux reaching the solar receiver, considering the shading caused by the horizon.

IV. Conclusion

Direct solar radiation that has the most significant influence on the efficiency of PV cells can be limited by landscape features or buildings and, thus, it can reduce the energy gains from solar batteries. It is important to precisely place the horizon line on the shading diagram for a particular latitude and to determine the correction factor values in order to estimate the value of radiation reaching the surface of the receiver and the possible energy yield.

V. References

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