On the Dependence between the Step Orientation and the Received Direct Solar Radiation of a PV Panel Part I: The Step Azimuthal Orientation

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1. Interest of the Work:

The objective of this first paper part is to optimize correlation between the panel received direct solar radiation and the daytime tracking steps' number, in case of an azimuthal tracked PV panel (Fig.1). The paper presents a graphical solving of the problem; from these solutions, an optimization analytic model will be developed in the future.

Keywords: azimuthal tracker, step orientation/tracking, direct solar radiation, PV panel, incidence angle.

2. Objectives of the Paper:

A. Unit Vectors Modelling

One of the objectives of this first part of the paper is to model the azimuthal PV tracker incidence angle. Firstly, using Fig. 1, there are established the sun-ray unit vector and the PV panel normal unit vector.

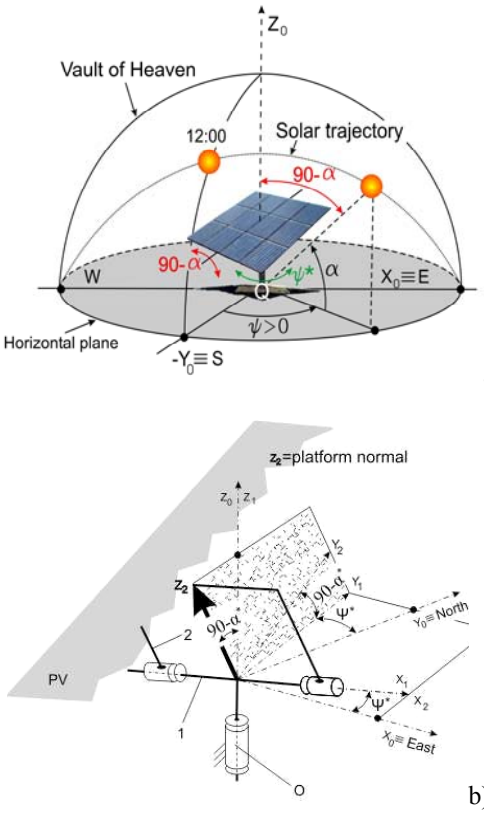

Fig. 1 The sun-ray angles in the azimuthal system $Qx_0y_0z_0$ (**a**); Geometrical scheme of the azimutal tracker (**b**)

B. Sun-PV Panel Incidence Angle

Using the previous unit vectors, there is modelled the incidence angle and there are made some numerical simulations, considering the input data corresponding to the location of *Brasov/Romania* latitude $\varphi = 45.65°$ N, during the Summer Solstice (day N =172, June 21st, δ = +23,45°).

C. Step Azimuthal Orientations

In order to establish the *step azimuthal orientations* there are considered the following requirements: a) minimization of the extreme tracking angles and b) accomplishment of an optimal received direct solar radiance using the minimum number of steps.

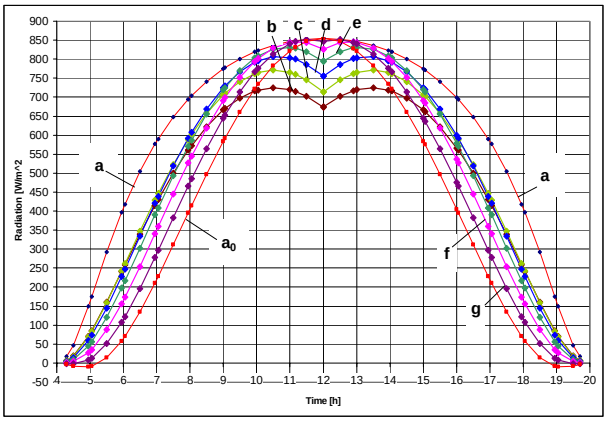

Fig. 2 Nomographic chart with variations of the solar direct radiation during the Summer Solstice (at α^*=68º): a- for available radiation, a_0 for ψ^*= 0º (tilted fixed PV panel), b for ψ^*= ±120º, c for ψ^* = ±100º, d for ψ^* = ±80º, e for ψ^* = ±60º, f for ψ^* = ±40º, g for ψ^* = ±20º

D. Received Direct Solar Radiance

Using the numerical simulations (for the Brasov/Romania location), there are analysed the variations of the received direct solar radiance and the surfaces under these diagrams (see Fig.2). By means of the obtained models, some nomographic charts are generated trough numerical simulations (see Fig. 2); for the azimuthal tracking, these charts allow graphical establishment of the parameters that assure the optimization of the correlation between the daytime (active) steps' number and the direct received solar radiation (see Fig.3).

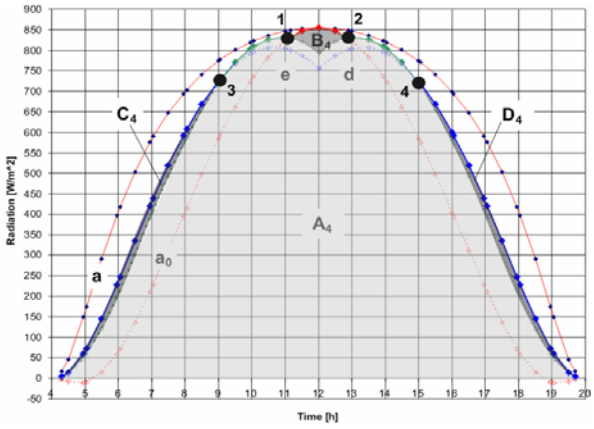

Fig. 3 Variations of the solar direct radiation durring the Summer Solstice (for α^*= 68º) at 4 steps (1, 2, 3 and 4): a- available radiation, a_0- for ψ^*= 0º (tilted fixed PV panel), d- for ψ^*= ±80º and e- for ψ^*= ±60º

3. Main Contributions of the Paper

1) The gained energy amount per step decreases when the order number of the step increases.
2) The optimal steps' number is that in which the energy brought by last step is more than driving energy of this step.
3) According to previous conclusions, the step number choosing and the tracking programs depend on the energetic performances of the tracking actuators.
4) In the tracking program design, there must be done an optimization modelling for a big enough steps' number; this modelling will provide the angles' values ψj and αj which assure the maximum gained energy for the each considered step number.
5) An optimization analytic model will be developed in a following paper, using the MatLab software.

References

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