Sizing Method of an Autonomous Photovoltaic Generator

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***Abstract*—For a given site and known weather parameters, the sizing of an autonomous photovoltaic generator consists to seek the power which it should develop to satisfy the power consumption imposed by the load. The number of the PV modules and the capacity of the accumulators of storage to be installed are optimized so as to have the most economic generator with acquisition and the maintenance and which is capable to fill up the conditions of the contract. We expose into this paper, a model of energy supplied by the photovoltaic generator followed by the model of the provided average energy and a simplified method of sizing the PV system by introduction a production factor in order to determine the optimal surface of the PV collector to install, which answers the constraints imposed by the consumption profile of the load for a residential photovoltaic installation completely autonomous, while minimizing the cost. Finally for the numerical validation of the suggested method, we chose the data of the Tlemcen site.**

***Index Terms*—Modelling, solar irradiation, PV generators, output, sizing.**

I. Introduction

Renewable energies, of natural origin, are inexhaustible and do not harm the environment. They are in general transformed in suitable forms then standardized to adapt them to the conditions of use. Among these transformations, the photovoltaic conversion, intended mainly for the electricity supply of industrial equipment and domestic apparatuses, is very widespread. It is implemented in autonomous photovoltaic projects at a weak consumption and in the achievements of electro-solar power stations adapted to the isolated sites or connected to the local electrical supply network.

II. The Power Model of the Photovoltaic Generator

A. Power Model provided by the PV Array

The photovoltaic modules are delivered with a peak value of power. This power represents the power delivered by the modules under the standard test conditions, i.e., with an illumination G0 of 1kW/m2 and the modules reference temperature Tr at 25°C, it is defined by:

$$Pc = \eta_r .S.Go \quad \text{(W)} \tag{1}$$

S is the active surface of the module and hr its nominal output.

A photovoltaic array is a group of elementary modules associated in series and in parallel; so that *Ns* the number of modules in series per branch and *Np* the number of parallel branch. The instantaneous power output *Ps* of the PV arrays is given by [1, 2, 3, 4,5]:

$$Ps = \eta_G GsSNop \tag{2}$$

Nop: the global number of modules forming the field

Dividing the parts of the equation (2) by the parts of the equation (1), we find the following relation:

$$Ps = \frac{\eta_G}{\eta r}\frac{GsNop}{G_O}Pc \tag{3}$$

The cells junction temperature affects the instantaneous efficiency η_G of photovoltaic arrays according to the following relation [3], [4], [5], [6], [7]:

$$\eta_G = \eta r(1-\alpha(T_M - Tr)) \tag{4}$$

α is the thermal losses coefficient due to the variation in the modules temperature.

B. Model of the Average Power Delivered by the PV Array

The averages of the physical parameters η_G and Gs of the equation (4), they allow us to define the average power output of the PV arrays, which is given by:

$$\overline{P}s = \frac{\overline{\eta}_G}{\eta r}\frac{\overline{G}sNop}{G_o}Pc \tag{5}$$

$\overline{G}s$ is the average solar radiation received by the PV arrays and $\overline{\eta}_G$ is the average efficiency. $\overline{\eta}_G$ depends of the average modules temperature TM. The temperature TM is related to the monthly ambient temperature Ta by the Evans relation given by the following expression [6], [8], [9]:

$$TM - Ta = (219 + 832\overline{K})\frac{NOCT-20}{800} \tag{6}$$

NOCT: nominal operating cell temperature.

The equation (6) is valid only if the tilt of the photovoltaic arrays is equal to the latitude less the solar declination; but for others inclinations the part of right-hand of the equation (6) has to be multiplied by a correction factor, defined by the following equation [6, 8, 9]:

$$Fc = 1 - 1.17.10^{-4}\left(\phi - (\delta + \beta)\right)^2 \tag{7}$$

ϕ : Site Latitude

δ : Solar declension

β: Real Angle Inclination PV surface

ϕ,β, δ are expressed in degrees

For the estimate of the average temperature of the modules, we thought to introduce the monthly average value of the

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