Electrical and thermographic characterization of a photovoltaic generator of 1,3 MWp.

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Abstract

This article is about the experience of the solar energy research center, Santiago de Cuba, in the field of characterization of photovoltaic generators. The results of electrical and thermographic evaluation are presented in a sample of 101 photovoltaic modules Si- polycrystalline, power 240 Wp, installed in the photovoltaic array of 1,3 MWp, after a year in the operation. The real value of the evaluated power presents a deviation of average power at standard test conditions of 7,57%, below its nominal value, the most significant being that the electrical power of 7 of these photovoltaic modules, which represents 6,93% of the total assessed is below 90% of its nominal value. The thermographic study yielded 28 modules with problems, including 11 in minor condition, 13 in serious condition and four in critical condition. Aim and approach used: Electrical and thermographic characterization of a photovoltaic generator of 1,3 MWp.

Scientific innovation and relevance: From the measurements performed, the actual value of the selected sample's power is 22,40 kWp, with this value being 7,57% lower than its nominal value.

Results or preliminary results and conclusions

Evaluation of electric power

Of a population of PV modules 5440, a sample of 101 PV modules using random sampling criterion, ensuring a level of error of 5% and a confidence level of 95% was extracted. During measurements, the irradiance (G) behaved between 769 and 1082 W / m2, reaching temperatures in the cell (Tc) of 63,9 ° C PV modules and minimum of 46,4 ° C.

Given that the assessed sample comprised 101 PV modules 240 Wp nominal, the nominal value of the total power of the PV modules to evaluate is 24.24 kWp, representing 1.86% of the total rated power of GFV, 1,3 MWp. As a result of measurements, the actual power value of the selected sample is 22,40 kWp, this value being 7,57% below its nominal value.

Table 3 shows the number of PV modules evaluated and the average of the measured power. As can be seen there is a single PV module with less deviation of 4% (231,9 Wp), while the largest number of PV modules (30) representing 29,70% are between 7% and 8% (222, 1 Wp), for an average of 7,42% below the nominal value. But, more significantly, PV modules 7 (6,93% of total rated) are below 90% of the nominal value, representing a loss of power per PV module about 27 Wp. Figure 1 shows the plot of average frequency relative to the measured power.

Table 3. Deviation from nominal power PV modules evaluated

Measure average power (Wp)	231,9	226,9	224,2	222,1	219,1	212,9
Number of modules	1	8	28	30	27	7
% Of all modules	1	7,92	27,72	29,70	26,73	6,93
Average Deviation (%)	- 3,35	- 5,45	- 6,57	- 7,42	- 8,67	- 11,2

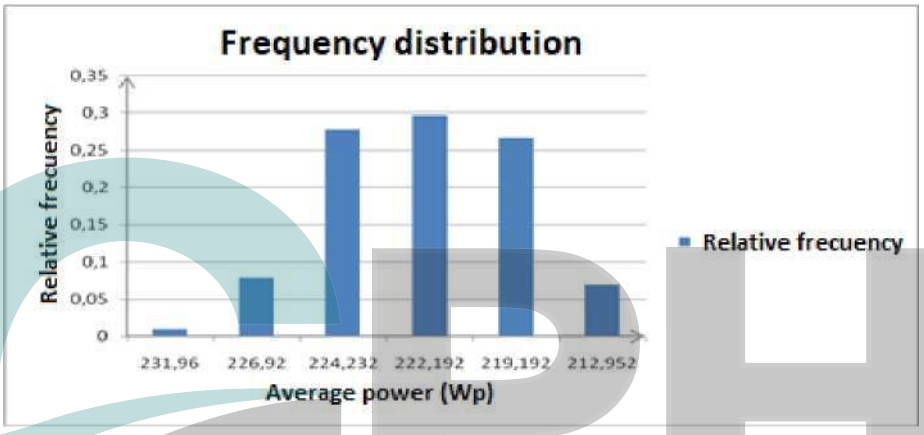

Figure 1. Graph of frequency relative to the average power measured

Thermographic study

Table 4 summarizes the results of thermographic study performed, detected with PV modules 28 thermographic problems, representing 0,52% of PV modules, classified as:

Table 4. Summary of PV modules Thermography

Minor modules	Severe modules	Critical modules
11	13	4

11 PV modules classified as minor, should be systematically monitored, severe and critical, should be replaced as soon as possible, as they decrease the tension of the strings, causing power losses.

By way of illustrating the power loss PV modules classified in three minor, severe and critical,

which represents 10,7% of total PV modules with thermographic problems were selected. The plot shown in Figure 2, from the IV characteristics of PV modules, shown as thermographic problems (hot spots) in PV modules worsen working conditions, since significantly affect the generated power, note that the red curve represents the power of the PV module under rated conditions given by the manufacturer, where the maximum power under nominal conditions that can deliver the PV module is 240 Wp nominal voltage of 30 V.

The PV module classified as minor (light blue curve) shows a reduction of maximum power by 9% at a voltage of 29 V, the PV module classified as severe (dark blue curve) shows a reduction in power 17% at a voltage of 28 V and the PV module classified as critical (black curve) exhibits a reduced power of 25% at a voltage of 25 V, affecting the operating voltage.

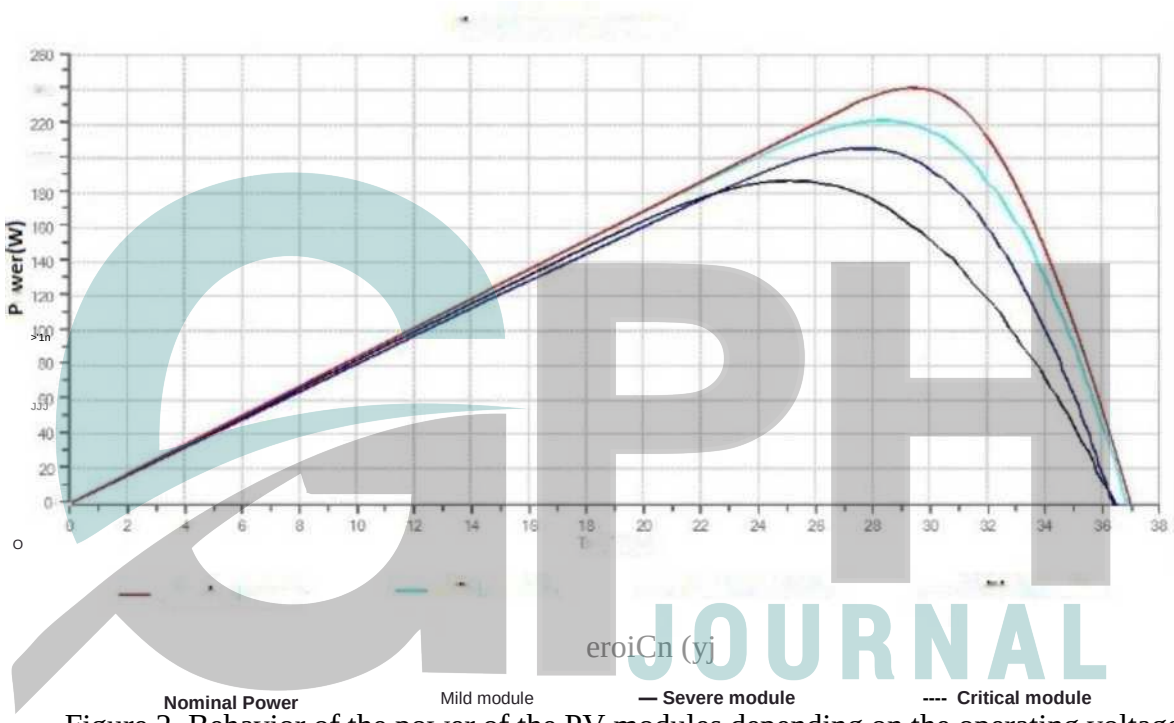

Figure 2. Behavior of the power of the PV modules depending on the operating voltage.

Conclusions

As a result of the electrical characterization of PV modules evaluated, there is a lower average power deviation of 7,57% CEM of extrapolating this behavior to the PV modules 5440 in the GFV, with respect to its nominal power (240 Wp) power loss for this item is 98,18 kWp. The largest number of FV (30) modules evaluated, representing 29,70%, show a measurement deviation (222,1) 7.42% power lower than the nominal value.

Thermographic study, threw 28 PV modules with problems, including 11 in minor condition, 13 in serious condition and 4 in critical condition, classified as serious and critical must be replaced, as they decrease the tension of the strings, causing power losses.

These experiences have spread to other photovoltaic grid connection facilities developed in the country, and has provided valuable lessons to minimize uncertainty, which plays a key role in quality assurance procedures in photovoltaic systems.