Maintance by Water-Cleaning and Efficiency Reduction of PV Panels

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Abstract: With the increase in the use of solar energy, both in civil and industrial environments, the problem of maintenance of photovoltaic panels becomes extremely important. In this work attention is restricted to the problem of cleaning and safety conditions of the photo-voltaic (PV) panels and a brief review of main effects determining their efficiency reduction are reported. The discussion related to problems and unsafe functioning conditions concludes this paper.

Keywords: Energy, Solar panels, Water maintance, Safety.

INTRODUCTION

In recent years, the adoption of solar photo-voltaic (PV) as a sustainable renewable energy production system is increasing. One of the most important problem in the photovoltaic installations is related to the maintenance of the PV panels. In fact, the ordinary maintenance of the PV panels is extremely important for guaranteeing both the energetic efficiency of the system and the safety conditions of users and structures.

A proper maintenance ensures that the life of the system is preserved for as long as possible and the original conditions of the system are sustained. Although PV systems require less maintenance than other systems (as an example fuel-based generators), they are not generally well maintained.

The PV system is mainly composed by five components (Figure **1**): 1. the battery; 2. the solar array (PV panel); 3. the charge controller; 4. the inverter; 5. the line connections. Thus, the maintenance of the PV system should be done for each of the aforementioned components. In this work, particular attention is devoted to the solar array which is constituted by a number of solar panels connected together.

The maintenance of the solar panels is required to ensure their optimal performance. In order to guarantee the PV panel optimal performance it would be necessary to keep its surface clean from any excess of dirt, by simply washing the panel with water.

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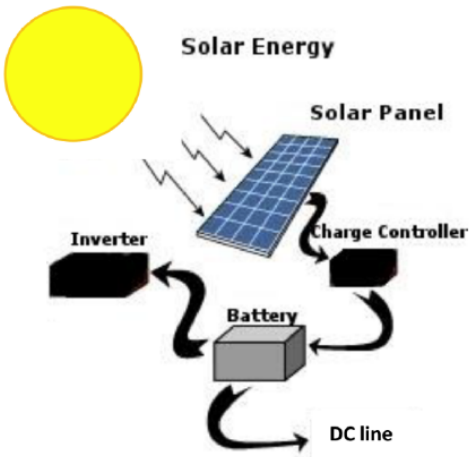

Figure 1: Scheme of components of a PV system.

2. MAINTANCE PROBLEMS AND EFFICIENCY REDUCTION

Literature indicates that the deposit of material (sand, dust, mud, bird guano, etc ...) on the PV panel can induce a decrease in the generated power depending on the typology of the material deposited [among others 1, 2). In particular, the decrease in the generated power, with respect the full generating power by the panel, ranges between 15% [3] to 80% in the case of mud formation [4].

Solar panel's performance decreases with increasing the temperature [5]. This means that the operating temperature plays a key role in the photovoltaic conversion process. For this reason, many equations expressing either the relation between the PV cell temperature and the weather variables or the relation between the temperature and the system's electric efficiency can be found in the literature [see as an example in [6]].

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However, it should be considered that, because of the presence of deposited material above the panel an increase in the probability of panel's failure or damage also occurs. As an example, when a PV panel is covered either by dust or by foliage or by birds' excrements (see Figure **2**) a localized overheating and the Joule effect occur. This could determine the initiation of localized fire of the panel. Such a phenomenon is known as a Hot-Spot phenomenon.

Figure 2: An example of the presence of bird's excrement.

On the other hand, the partial shading of a solar cell could produce a braking action in the energy production of the remaining cells totally irradiated by the sun, thus causing an alteration in the functioning of the entire panel. Such a phenomenon is known as a Mismatch phenomenon.

Both the Hot-Spot and the Mismatch phenomena can lead not only to a progressive malfunctioning of the panel, which induces a considerable reduction in its energy production, but also they could determine fire and serious incidental phenomena.

Actually, the cleaning of the panels is carried out by washing it with water splashed through different systems: a) manual brushes with splashes of water (Figure **3a**); b) water sprinklers, which consist of non-invasive hoses splashing water and soap mixture (Figure **3b**); c) heavy machinery requiring an operator, which are not automatic solutions and are also highly intrusive and produce pollutant (Figure **3c**); d) robots or automatized systems, which are automatic but really expensive and can cause damage to the PV panels during installation (Figure 3d).

Especially in north countries, the presence of snow over the panel (Figure 4) represents another cause of its malfunctioning. The snow causes the panel's covering (partial or total) with a consequent reduction of the energy production. On the other hand, the presence of snow could determine the damage of the support structures of the panel because the snow slides on the panel's surface infiltrating inside the support frames. As a consequence, of the formation of the ice inside the frames, the damage of the support structures could be determined. Furthermore, the infiltration of water, which is due by the snow smelting in the panel's surface and in the supporting frames, can result in a possible short circuit phenomenon in the electrical contacts connecting the electric line to the panel itself [7].

3. DISCUSSION ON RELATED PROBLEMS AND CONCLUDING REMARKS

The aforementioned considerations highlight that the lack or the discontinuous maintenance of the PV panels not only could determine a reduction of their performance but it could also induce accidental scenarios (fires, electrocution risks, electrical risks, etc...) with high risk of dangerous conditions for both the structures and the users.

This indicates why it is important to guarantee a constant maintenance of the PV panels. In fact, on the contrary, the continuous cleaning of the PV panels would allow both the maintaining of their efficiency in terms of energy production and the increasing of their duration and the reducing of probability of their

(**a**) (**b**) (**c**) (**d**)

Figure 3: Examples of water-cleaning systems: **a**) see as an example at https://www.youtube.com/watch?v=_L170fuk98c; **b**) see as an example at https://www.solarpanelcleaningsystems.com/photos.html?galAlbum=2; **c**) see as an example at Turkeyhttps://groundworkexperts.com/product/solar-panel-cleaners/mazaka-40-solar-panel-cleaner/; **d**) see as an example at http://www.washpanel.com/index.php.

Figure 4: An example of the presence of snow covering.

damage. This last aspect is especially important for guaranteeing safety conditions both during installation operations and during incidental events (as an example during the panel's fire event). In particular, the major problem occurring both during the panel's installation operations and during a fire is related to the fact that the solar panel is powered directly by the sun generating Direct Current (DC) (see Figure **1**) which cannot be switched off. Thus, because of the current running through the PV panel and the connected electric line, a risk of electrocution for who may accidentally come into contact with them exists. This can particularly result in problematic situations for firefighters and operators during a fire event, as highlighted by the media especially in the last few years.

The above-mentioned considerations explain why the no-efficient maintenance of PV panels is strictly connected both to the reducing the energetic efficiency and to the reducing of the safety conditions of the photovoltaic system.

The point is that still today, no simple and efficient maintenance system allowing the continuous cleaning of the PV panel exists. In fact, generally, the cleaning of the PV panels is operated through unsafe (as the use of manual brushes) and expensive (as the use of complex mechanical sliding systems, robots, drones, etc.) which are mainly reserved for the extraordinary maintenance of the PV panels (see Figure **3**).

But, the increasing trend of the energy production through photovoltaic systems, a fortiori indicates the importance in adopting adequate measures both to guarantee safety and efficient conditions for operators and to maintain a high performance of the PV panels. These aspects could more easily obtained by ensuring a constant and efficient maintenance of the PV systems.

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