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MATHEMATICAL MODELLING OF AEROSOLS IN SOLAR PANELS

Abstract

The continuous demands for electricity, the fulfillment of standards in relevance with European directives have fostered Kosovo to think seriously about the use of alternative energies. The study of this study presents the effect of aerosols on the potential of solar panels in the production of electricity from solar energy. Changing the solar radiation that comes to the ground during unclear clean days is a good indicator concerning the efficiency of energy conversion. Assessing the level of concentration in aerosol concentrations from sunlight into the atmosphere is done by looking at the solar energy in the time unit and in the surface unit after the last rain when aerosol smog's are present at this time. This paper is primarily focused to scrutinize the impact of climate conditions on the general pollution on the surface of solar panels, the efficient use of solar energy with mathematical modeling, the geographic possibilities of installing solar plants without any other impact of CO2 and aerosol smog's, which can contribute sensitive to the security of power supply and solar thermal energy in an energy system for certain localities. Consequently, in this research we have come up to a conclusion that with the fall of rain the concentration of aerosol present at the surface of the solar panels are diminished at a large extent and the days after rain there is witnessed an increase in concentration of polluting particles which leads to reducing the efficiency of the sun's rays coming to the surface of solar panels.

Keywords: *polluting particles, radioactive potential, mathematical modeling, incident light*

1. Introduction

First and foremost, this paper aims to analyze and profoundly scrutinize the effect of aerosol particles and the efficacy of solar radiation in the incise line under normal conditions. Generally speaking, polluting particles are deposited on the surface of the solar panels and greatly degrade the performance of PV cells due to the distribution of reticulate lines in the backward hemisphere and are normally influenced by the effect of the radiant energy from the deposit of the smog. A fully-fledged analysis of the outcomes in this field of research have found out that dust smog deposited on the surface of the solar panel has directly influenced the performance of the PV system as optical cell degradation, as by the cellular excursion angle function. The radiated power lost in this case influenced by voltage (V) and current (I) and other climatic factors, although it is thought that the complete function of the aerosol effects is influenced by the complex parameters that are in this case at the optic flux. Besides that, we have analyzed the pollutant particles, the distribution and the lines of the ted rites as an interaction with the aerosol particles that they are in high layers and appear in the insulating form during the conversion of the light beam transformation process. The main focus of our work has been to detect the optical losses caused by the evaluation of the efficiency of the PV system in efficiency, comparing it with the optimization of the cleaning time and the increase of the effective working at the nominal conditions of the PV cells. Continuous energy requirements are urgently required in predicting the most appropriate strategies for the purpose of using the natural resource of the sun as an untapped power potential. Due to the fact, there have been made lot of efforts to analyze systems which are hampering solar energy prediction [1]. As a result, the perspective of mathematical modeling, the goal of collecting the PV potential is to derive maximum utilization of the conversion of solar energy into the diffusing form of electromagnetic power in electricity. The

deposition of aerosol particles in PV cells adds to the complexity of this purpose, and therefore the requirements for finding the mode of light converter barriers have increased. Obviously to have a lucid and straightforward comprehension of the grounds that cause the loss of transmission of sun rays that depend on the internal optical characteristics of deposited aerosol particles, we have been trying to carry out a multifaceted scrutiny of convertible barriers that come as a result of aerosol deposits to PV cells [2]. Instead, we discern the dispersion in the hemisphere from the hemispherical backward distribution, including absorption, and also consider the optical interaction between the PV cell surface and the deposited particles Aerosol particles collected on the surface of the PV modules absorb and overflow the cells of the day-to-day power of the incident and thereby reduce the optical power transmitted to the PV cell itself. This phenomenon is important because a large number of PV cells are located in the sunny and semi-dry regions of the present airspace and geographic locations where there is also the industry as well as Kosovo power plants , Ferronikli and Sharrcemi are aerosol contaminants and are subject to frequent deposition of mineral dust and other particles [3]. There have been carried out a large number of experiments in Fushkosovo, Shtimje, Prizren locations, where solar panels have been the subject of the experiment, report energy loss losses as a function of the PV exposure time on its environment [4].

2. Loss of efficiency of light rays due to aerosol particles in PV cells

Due to having a close elaboration of the radiant corundum and the efficiency of the incidental breaks on the surface of the solar panels, we will give a clear panorama of the practicality of the practical corridor as a possible schematic in the PV cell performance by analyzing the simulation loads by means of measuring instruments and contamination found on the surface of solar panels for some locations where they were a stucco object. Nevertheless there have been carried out numerous analyzes to subtly scrutinize the particles of fossil contamination, which have at a large extent caused diminishing of energy efficiency because of dirt and due to the lack of high purity [5].

2.1. Optical incident light settings

Significant parameters of the incident light, from the way of describing empirical formulas to eq. (1) and voiding the loss fraction (FL) eq. (3) modification allows us to describe te energy transmission in PV cells while:

$$P_{sc} = P_0 e^{-\tau_{eff}},$$

(1)

In cases when the effective (photovoltaic) optical efficacy is:

$$\tau_{eff} = \frac{N}{A}\sigma_{ext} FL = \rho_N \sigma_{ext} FL,$$

(2)

The quantity ρ_N is the density of the number of particles per unit in the cell area PV with the unit of m2. Alternatively, we can use the mass cross section (i.e., unit junction cross section) with m2 = kg units described as:

$$\tau_{eff} = \rho_M k_{ext} FL,$$

(3)

In cases when ρ_M is the mass sample density per unit unit of unit of kg / m ^ 2 · τ_ (eff) proportional to the particle density ρ_N and the mass of the sample ρ_M. These amounts of particles are broad in the depth of the cell and are proportional to the amount of deposited particles. Quantity σ_ext FL and k ext are intense; they depend on optical properties, but not the deposited amounts (4.5).

2.2. Concentration of pollutants in PV panels

The concentrated power of solar energy (KSE) relies on the position of the solar panel installation influenced by current and voltage. The efficiency of generating electricity from the PV system is achieved by the concentration of radiant optical fibers as generating performance in the entire geographic position in which the solar panels are located [6].

As a result of carrying out an overall analysis of the pollution on the surface of solar panels, especially for some locations in Kosovo such as Prizren, Pristina and Peja, there have been on regular basis repeated scrutiny's on the efficiency of solar radiation, as wells as the measurements done in the sites where the fossil fuel industry has been found that the pollution was at a large-scale. in this case it has been created unfavorable to exploit the natural resource of the sun. Based on the findings of the analysis made for the locations of the cities of Kosovo it has been shown that the places where aerosol contamination has caused losses in efficiency at the scale of 0.2% [7].

2.2. Aerosol particles and complex properties

During the research work, two optical approaches to aerosol particles have been calculated:
The first is the well-known theory Mie (Mie, 1908) and
The second is the approach of dipol (DDA) approach (Draine and Flatau, 1994).
My theory is widely used for calculating the optical properties of homogeneous, spherical particles in a homogeneous environment, while DDA may be used for more complex morphology particles (including irregular shapes) and to calculate electromagnetic (EM) melting of particles in area. An alternative and more efficient method to calculate the EM distribution of spheres or spheroids with the interaction content is the T [8] matrix method. In DDA and as far as my theory is concerned it has been assumed that an airplane wave EM is discharged from a precondition and the wave of the incident is represented by:

$$E_0 = \begin{bmatrix} E_{0r} e^{i\emptyset_1} \\ E_{0l} e^{i\emptyset_r} \end{bmatrix} e^{i(kr-\omega t)}$$

(4)

The land figures are used to represent the parallel and inclined components (in relation to the distribution plane) of the electric field E0 with respective phases ∅_ (l) and ∅_r, respectively vector k = kr + iki is the number of complex wave defined by

$$k \cdot k = \omega^2 €\mu$$

(5)

Letter k is used to refer to the angular frequency, is the electric permissibility, and l is the purpose of permissibility. The vast majority of optics in aerosol particles has been estimated for many areas as a good solution for distributing equations by:

$$E_{sca} = \frac{1}{kr}\begin{bmatrix} S_1 S_2 \\ S_3 S_4 \end{bmatrix} E_0$$

(6)

Letter r is used to refer to the distance from the particle center to the detector, and through 1 component of the distribution matrix [9].

2.3. PV system with aerosol particles data

It is worth emphasizing that there have been set up small and medium-sized photovoltaic (PV) plants in different places in Kosovo, such as Prizren, Peja and Pristina, have a solar impact, and there is a critical need to analyze the impacts of the sites PV installations in particulate concentrations (PMs) resulting in environmental and health impacts. This paper is the first to determine the impact of a PV plant at a high level in the concentrations of PMs in the project area. Concentration data Figure 1 of particles PM 2.5 and PM 10 (PM with aerodynamic diameter <2.5 and <10μm) have been collected from several Kosovo monitoring stations.

Automatic monitoring stations with electronic data are located in several cities of Kosovo for measurement of SO_2, CO, NO_2, O_3, PM 10 and PM 2.5. TELEDYNE device, referred as advanced pollution instrument, respectively ANALYZER – MODEL T 300 for monitoring of particulates PM 10 and PM 2.5 in Obilic, at the time of extraction of findings with electronic data. It has been proved that in the region of Prishtina pollution comes as a result of combustion of CO_2. As a result, a large level of this contamination has resulted to be present on the surface of solar panels in the form of smog [10,11].

Figure 1: TELEDYNE electronic device for the measurement of polluting particles

The results reveal that there have been proved high levels of PM concentrations during measurements. They have surpassed all the allowed norms and owing the fact are active in the radioactive efficacy including PM 2.5 and PM 10 pollutants. At the Pristina station, concentrations of PM 2.5 and PM 10 are above any permissible norm up to 100% according to European standards, monitoring is electronic, 2018 is installed online monitoring of pollution with technology. This increase may be due to the emissions of Kosovo's thermal power plants with fossil fuels and very old vehicles. Findings point out that the results taken by these measurements are worrisome and there is an urging need to take immediate measures to reduce the scale of this particles by taking strict measures in the industry by setting filters and other technological measures, these measures affect the overall environmental benefit of reducing the emission of an PV installation [12 , 13].

2.4. The aerosol particles in Peja, Prizren and Obilic with TELEDYNE device

If we compare the pollution of aerosol particles, as shown in Table for Peja, Prizren and Obilic, it is clear that Obilic is beyond the allowed limits of pollution as a result of electricity generation from burning of CO_2 and is a major obstacle to the exploitation of natural resources as is the sun [14].

Table 1: Pollution of aerosols in some cities of Kosovo

Regions	$SO_2(mg/m^3)$	$NO_2(mg/m^3)$	$O_3(mg/m^3)$	$CO(mg/m^3)$	$PM10(\mu g/m^3)$	$PM2.5(\mu g/m^3)$
Peja	5.63	10.93	54.43	0.66	43.1	36
Prizren	6.98	21.65	97.7	0.75	50.3	35.5
Obilic	7.86	13.92	48.3	0.629	53.1	37.3

Based on the measured data given in Table 1, the fossil fuels are mainly concentrated in the region of Prishtina Priština due to the Kosovo thermoelectric power plants are mostly located there. According to data which are mentioned in the Prizren by electronic measurements is above the allowed value of O3 = 97.7 mg / m3. Peja is in the allowed parameters and is the most suitable place for the use of natural resources that derive from the sun [16].

Conclusion

In order to carry out the collection of solar radiation in the PV system, the measured data in some locations in Kosovo have been found to have aerosol polluting particles and affect the conversion of light into energy. Indeed to

have a better generating system, it is required to build a mechanism with innovative technology which will independently clean the contaminating particles. The respective field of studies have confirmed the degradation of PV cells from dust deposition indicate that deposited aerosols significantly reduce PV cell efficiency, with studies that report up to 85% loss within 5-8 years in locations of Pristina, Elezehan and Drenas industry with fossil fuel mechanism which is largely independent of this content. Mie theory is widely used particularly for the estimation of homogeneous aerosol particles, in places where potential PV potentials are available. It is an alternative and more efficient method to calculate the EM distribution of spheres or spheroids with the content of interaction is the matrix method. Analytical Analyzes from the Thorax I do not calculate improper refills by analyzing hemispherical losses as small particles that are unsuitable. It is worth emphasizing that at a large-scale PV system has sufficient generating potentials throughout the territory of Kosovo with some preventive specifications of aerosol pollutants as it is Prishtina.

Particle concentrations PM 10 and Pm 2.5 are particles located on the surface of the panels in the smog form, therefore their treatment is required.

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