

# Solar Panel Dust Cleaner

*Prof. Ankita Mankar*

*Department of Electrical Engineering*

*Wainganga College of Engineering and Management Nagpur*

*Rajan Bramhankar*

*Department of Electrical Engineering*

*Wainganga College of Engineering and Management  
Nagpur*

*Priyanka Suryawanshi*

*Department of Electrical Engineering*

*Wainganga College of Engineering and Management  
Nagpur*

*Vaijayanti Dalwe*

*Department of Electrical Engineering*

*Wainganga College of Engineering and Management  
Nagpur*

*Shilpa Nagtode*

*Department of Electrical Engineering*

*Wainganga College of Engineering and Management  
Nagpur*

*Kanchan Lanjewar*

*Department of Electrical Engineering*

*Wainganga College of Engineering and Management  
Nagpur*

*Monali Gawande*

*Department of Electrical Engineering*

*Wainganga College of Engineering and Management  
Nagpur*

**Abstract:** In this research paper, various studies revolving around how dirt and dust affect the performance of solar panels depending upon different regions, as different areas have different soil compositions and how they are different from one another. A new way of approach to the domestic solar panel cleaning system, researchers have proposed many ways to improve and classify the object and present it in an image in the past. However, there have few projects related to domestic cleaning of solar panels. Due to the inconsistencies in cleaning especially in region where rain is not the most convenient option for cleaning. On continuous using of solar panels, a layer of accumulated dust particles is settled on the surface of solar panels or PV panels which affect the result of decreasing in efficiency by 50 %. By cleaning on regular intervals it decreases this soil loss. Various data have been collected which shows the importance of domestic solar panel cleaning for future generation.

**Keywords:** Solar panels, Efficiency, 3D printer, Cleaning, Soil loss, Dust accumulation.

## I. INTRODUCTION

(1) The solar power where the sun hits atmosphere is 10W, whereas the solar power on earth's surface is 10W. The total worldwide power demand of all needs of civilization is 10 W. therefore the sun gives us 1000 times more power than we need. As of this in 2009

India's first-ever commercial 2MW solar power plant is setup in Amritsar.

The Ministry of New and Renewable Energy has set a target of making 175 GW capacities of solar installations by March2022. India is among the leading countries having good Direct Normal Irradiance<sub>1</sub> (DNI), which depends on the geographic location, earth sun movement, tilt of Earth rotational axis and atmospheric attenuation due to suspended particles.

(2) India is estimated to have huge potential for solar energy which is about 5000 trillion kWh per year. Now the main un-highlighted problem is that on continuous using of solar panels, a layer of accumulated unwanted dust particles is settled on the surface of solar panels or PV panels which affect the result of decreasing efficiency of solar.



Figure 1: Clean solar panel and dust accumulated solar panel.

## II. LITERATURE SURVEY

The principal objective of this work is to study the effect of dust and dirt on solar panels and study all aspects of a possible cleaning system which increases the efficiency of solar panels. We studied almost 20 research papers, daily articles and attended the 13th edition of Renewable Energy India 2019 Expo which helped us to expend our research at different stages. Throughout our whole research; we read several papers from different sources some of the important points are given below.

(3) The accumulated of dust is responsible for soil loss on solar panels which decreases its efficiency of generation of solar energy. It has to be cleared on regular interval of time for better results. Dust settlement for the most part depends on numerous components like compound properties, size, weight, shape, site, tilt point surface completion, stickiness, wind speed, etc. Dust exposure affects many parameters of SPV; so several attempts have been made to address this issue.

(4) Dust particles are very common in the atmosphere. In some places, it is found settled but at some it is not; for example in National Capital Region (NCR) the dust particles coming from Rajasthan drift towards NCR and causes a dip in the air quality of Delhi also considering the fact that Delhi and NCR region is highly polluted on its own making the are much more polluted. And when it gets settled it may be also settled on solar panels or PV panels and according to studies the layer accumulated dust on the surfaces of solar panels or PV panels can come from many different sources and can have a major impact on electricity production. The efficiency of the solar panel can be reduced by up to 50% in a dusty environment, as this interferes with the amount of direct sunlight received to the PV array. (Figure2)

The main cause of the reduction of solar cell power is the attenuation in transmittance of light due to the dust accumulation on the glass cover. The dust accumulation process is very easy it starts first by a simple layer accumulation until it covers all the surface, then a second layer will deposit on top of it and so on. To calculate the scattered light efficiency, we suppose that the dust particles are spherical and are composed mainly of  $\text{SiO}_2$ , thus the refractive index for the Silicon oxide as a function of the wavelength was used. When these particles are illuminated they will absorb and scatter the light, which will reduce the intensity of the light beam, this effect is known as the extinction efficiency that is governed by the ratio of the particle size to the wavelength of the incident light.

### Cause of dust accumulation:

(5) There are two interdependent parameters that effect on the characterization of soiling accumulation on solar panels, the property of dust and the local environment. Dust property consists of size, components, shape, and weight. For example in metropolitan cities like Delhi, Mumbai etc, the dust in acidic and can cause erosion to the surface of the panel. The local environment refers to the surroundings that the human activity has directly or indirectly created such as the built environment, types of vegetation, and weather conditions. Furthermore, the surface is also a very important contributing factor in the soiling process. If the surface is not smooth, and instead is rough, furry, sticky, and etc, it allows more soil to accumulate. The position of the panel which depends on the sunlight direction and wind is also important in the soiling process. The more horizontal the surface is, the more dust will be accumulated. Besides, the slow breeze also can result in dust accumulation whereas strong wind can clear the panel surface. However, airflow due to wind is able to affect the dust accumulation or dissipation at particular places of the solar panel. Technically, Dust reduces output power from PV between 2% to 50% in different areas. In Asian reign, most of the dust materials are sand and soil and also in African countries dust comes from the desert area that accumulates on surface.

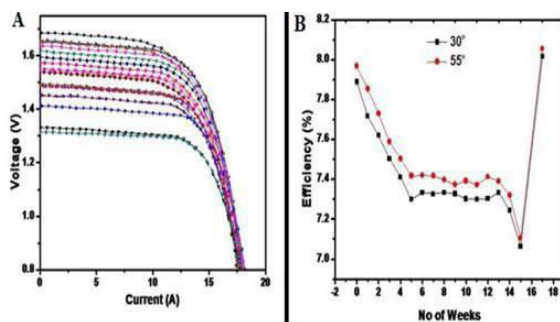


Figure2: The efficiency of solar panel reduced by 50%.

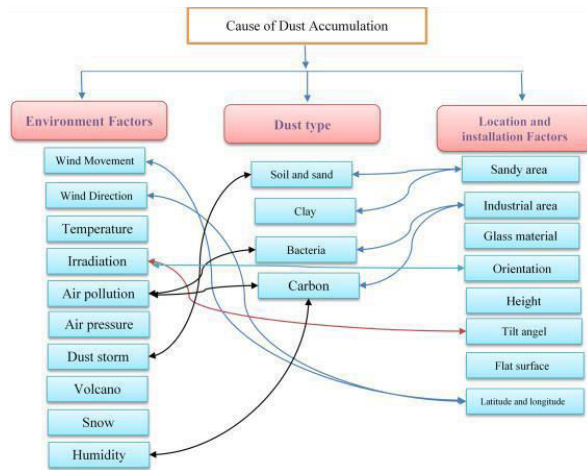


Figure3. Cause of dust accumulating on the surface of solar array

### III. METHODOLOGY

The cleaning methods of solar panel can be broadly classified into active methods and passive methods. Passive methods leads to dependent on human but active methodes leads to dependent on power at industrial and domestic sector of solar cleaning we see the possible vision of it.

The main objective of our team is that to give a simple and compact mechanism of cleaning system for industrial and domestic region.

#### Proposed cleaning system:

An Automatic drive system that works along with the length of solar panels which is controlled by base circuit and trigger the cleaning system of solar panels with the help of switches. As result it helps solar panels to regain their original efficiency to generate solar electricity for work. We make cleaning mechanism as much simple as we can, basically the idea of making this design comes from an FDM 3D printing mechanism it is so because 3D printer gives high accuracy precision in coordination to print the objects as they are designed to balance an inverted pendulum requires the accuracy and precision stabilizer mechanism is built. This model counters various limitations regarding solar energy and its consumption focusing on domestic as well as industrial consumption of solar panels for example in domestic purpose houses, colleges, and buildings consisting of assemblies of 10-20 panels And in industrial Tata, Lokamat.

#### Essential parts of the mechanism (figure4):

1. **Supporting frame:** Frame provides strength to the model which makes the project capable of exhibited by the 3D printer, hence the sustaining different weather conditions.

2. **Guide blocks:** Blocks provide path for the motion of the cleaning and also connects the cleaning block to the motor.

3. **Leadscrew:** Converts rotation motion of motor into translation motion of the rods for cleaning.

4. **Rotating cleaning cloth:** Micro- fiber cloth attached to a rotating rod which allows it to rotate at a specific speed for cleaning.

5. **Cleaning block:** The middle part of the mechanism which does the primary motion covers the plane of the solar panels. The bottom surface has been integrated with micro-fiber cloth which is quite common in the cleaning of solar panels.

6. **Water Pump:** For the cleaning purpose we are spraying water through water pump.

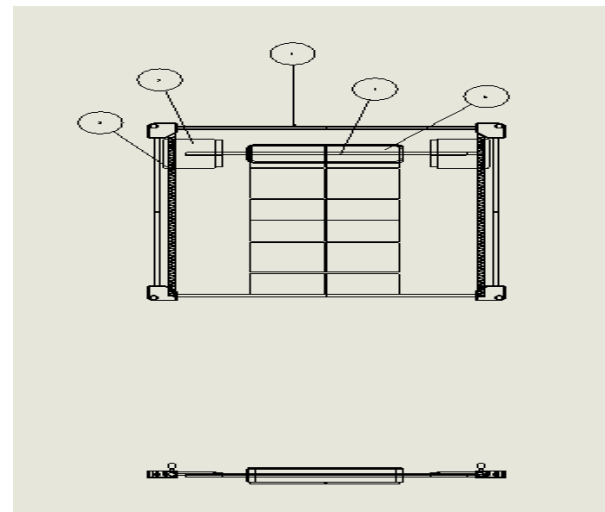


Figure 4(i). Top and front view

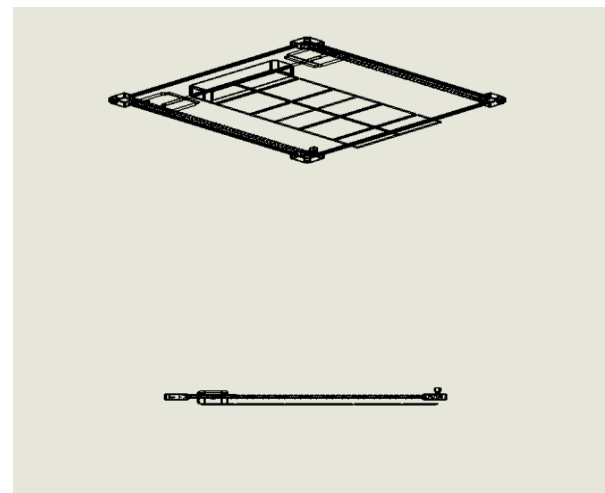


Figure4(ii). Isometric and side view

#### IV. RESULTS :

(6) According to our observation  
Before cleaning :

	Before Cleaning	After Cleaning
Voltage at maximum power	14.15	18.20 V
Current at maximum power	0.275 A	1.10 A
Open circuit voltage	16.80 V	20.40 V
Short circuit voltage	0.362 V	1.45 A

Number of cells : 36

After cleaning efficiency will be increase about **26%**.

#### V. CONCLUSION AND FUTURE PERSPECTIVE

Deposition of dust (biological or chemical) leads to a decrease in the efficiency of solar panel which affects its performance.

So cleaning of the solar panels is equally important also in this paper we have discussed different types of cleaning systems and methods that can be applied.

Compared to other methods our system is the best and more importantly cost-effective.

The system developed by us is to overcome the following problems faced after solar panel installation: reduced power due to dust accumulation, cost reduction for the overall cleaning of solar panel, manual labor for cleaning which has inevitable physical harms is avoided, reduced time for cleaning. By replacing conventional cleaning methods of the solar panel with the automation we can maintain the efficiency without affecting its performance, developing a new method in the solar panel cleaning industry involving leadscrew as the working mechanism in the project in order to reduce the complication in the working mechanism making it a mechanical device rather than an electronic device.

Hence, periodically dust must be removed from the solar panel, in order to ensure the highest performance. Taking inspiration from a 3D printer mechanism and making necessary changes in the system. The whole propose of the project is to study the current state of domestic solar energy and focusing on the major points which degrade the use of it due to the low energy generation factor, the main reason behind is the cleaning practices of the solar panels which is poor.

Installation of an automatic cleaning system would be a game changer. Not only the cleaning would be possible with just one click reducing human effort but also introducing a cleaning system in the industrial and domestic market which has never been done before on promising basis along with reasonable prices.

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#### FIGURES

- Figure 1: Clean solar panel and dust accumulated solar panel.
- Figure 2: The efficiency of solar panel reduced by 50%. [Solar Panel Cleaning Systems, University Address, Amman. Jordan]
- Figure 3: Cause of dust accumulating on the surface of solar arrays.[ An overview of cleaning and prevention processes for enhancing efficiency of solar photovoltaic panels , Department of Research and Development, Electronics, Instrumentation and Control Engineering, Aerospace Engineering, and Mechanical Engineering, University of Petroleum and Energy Studies, Dehradun 248 007, India, CURRENT SCIENCE, VOL. 115, NO. 6, 25 SEPTEMBER 2018. ]
- Figure 4(i): Top and front view.[ SolidWorks ]
- Figure 4(ii): Isometric and side view.[ SolidWorks ]

#### REFERENCES

- Arvind chhabra , India today- India's first solar power plant opens in Punjab : December 15,2009.
- Pandey S, Singh VS. "Determinants of success for promoting solar energy in India," Renewable Sustainable Energy Review, 16, pp. 3593-98, 2012.
- Silicon in Soils and Plants, Brenda Servaz Tubaña and Joseph Raymond Heckman K. Elissa, © Springer International Publishing Switzerland 2015 7 F.A. Rodrigues, L.E. Datnoff (eds.), Silicon and Plant Diseases, DOI 10.1007/978-3-319-22930-0\_2.
- Design and fabrication of Automatic Solar Panel Cleaning System , International Journal of Innovative Research in Science, Engineering and Technology, Vol. 8, Issue 3, March 2019.
- Aslan Gholami, Ali Akbar Alemrajabi, Ahmad Saboonchi, "Experimental study of self-cleaning property of titanium dioxide and Nanospray coatings in solar applications" paper published in sciencedirect.com, journal 2017.
- Influence of Environmental Dust on the Operating Characteristics of Solar PV Module in Tripura [ISSN:2319-6890,2347-5013 Volume No.4, Issue No.3, pp : 141 - 144 01 March. 2015]
- 5 F. Mejia, J. Kleissl & J. L. Bosch, 2013. The Effect Of Dust On Solar Photovoltaic Systems, Energy Procedia 49 (2014), pp. 2370 - 2376.