

# Critical Review on Automatic Solar Panel Cleaning System

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**Abstract:** *The Solar Power is the most abundantly available energy available on the Earth and depletion of current non-renewable sources has led to the need for efficient harnessing of this source. The Solar Panels used for the purpose are open to the environment and hence would frequently get obscured by dust and other impurities. Energy is one of the major issues that the world is facing in India, the supply of energy has been one of the major problems for both urban and rural households. Solar energy is a renewable source of energy, which has a great potential and it is radiated by the sun. Renewable energy is important to replace the using of electric energy generated by petroleum. Solar power has become a source of renewable energy and solar energy application should be enhanced. The solar PV modules are generally employed in dusty environments which are the case tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The automatic dust cleaning system of solar panels has taken to overcome the difficulties arise in the traditional cleaning and also produces an effective, non- abrasive cleaning and avoids the irregularities in the productivity due to the deposition of dust .*

**Keywords:** Solar panels, Dust accumulated, Automatic Cleaning

## I. INTRODUCTION

The awareness regarding global warming, CO<sub>2</sub> emissions (greenhouse gases), peaking of most oil reserves and impending climate change are critically driving the adoption of solar photo voltaic as a sustainable renewable and Eco friendly alternative. Solar panels are the most favorite among the entire renewable sources, because of the abundance of solar energy and its free and easy availability. In India with about 300 clear sunny days in a year, the daily average solar energy incident over India varies from 4 to 7 kWh/m<sup>2</sup> with about 1500–2000 sunshine hours per year, depending upon location. While installing the PV panels appropriate installation design such as orientation, exposure, sun tracers to maximize solar insolation can potentially ensure sustained yield (electricity). However, the panels are vulnerable to often overlooked, on site omnipresent practicalities such as deposition of dust, bird droppings and water stains which significantly degrade the efficiency of the solar installations. Dust is a lesser acknowledged factor responsible for decreasing the efficiency of PV installations. As we know solar panels are left under open sky in dusty environment. When not cleaned for a long duration of time (from few days to many months), the dust gets accumulated on the front surface of the panels which block the direct incident light from the sun. Thus it is significantly important to clean the panels at regular intervals of time for maintaining a constant efficiency of the panels.

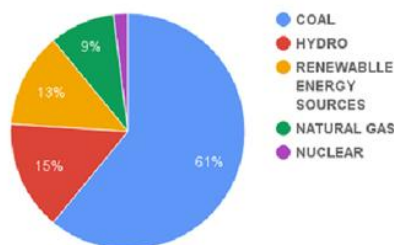


Figure 1: Pie Chart of Energy Consumption

## **II. SOLAR PANEL CLEANING GUIDELINES**

While cleaning solar panel is no rocket science and can be equated with regular washing of your car. There are certain things that need to be remembering to guarantee elongated service life and efficiency of the system. Wrong cleaning practices, bad quality water and use of inappropriate cleaning agent may damage modules and other array components and lower system performance as well. It is also essential to train the cleaning personnel on proper cleaning methods and use of appropriate cleaning tools.

### **Safety of personnel:**

- Solar modules are connected in series and it generates up to 800V DC. Cracks in modules or damaged cable or joints in a string are extremely dangerous for cleaning person particularly when the modules are wet. Even during low level of sunlight the array will generate lethal voltage and current. Therefore, it is important to inspect modules thoroughly for cracks, damage, and loose connections before cleaning. Cleaning personnel shall wear appropriate electrically insulating Personal Protective Equipment (PPE) during cleaning.

### **Cleaning time:**

- The recommended time for cleaning modules is during low light conditions when production is lowest. However, when sun shines during the day, the panels also get heated up and cleaning solar panels with cold water in evening may result in thermal shock for panel which can permanently damage them. Hence, the best time to clean Solar Panels is early mornings, when the plant is not in operation, risk of electrical shock hazard is minimum and also temperature of solar panels is not high.

### **Quality of water:**

- De-ionized water should be used to clean the modules. If de-ionized water is not available, rainwater or tap water can be used. Tap water must be of low mineral content with total hardness less than 75ppm. Water must be free from grit and physical contaminants that could damage the panel surface.

### **Use of cleaning agent:**

- A mild, non-abrasive, non-caustic detergent with deionized water may be used. Abrasive cleaners, Acid or alkali detergent must not be used.
- Don't use metal objects or harsh abrasive products for removing caked on materials – scratching the glass on a solar panel can affect its performance as scratches will cast shadows.

### **Removing stubborn marks:**

- To remove stubborn dirt such as birds dropping, dead insects, tar etc., use a soft sponge, micro-fiber cloth. Rinse the module immediately with plenty of water.

### **Water pressure:**

- Water pressure should not exceed 35 bar at the nozzle. Use of high pressure hoses for cleaning may exert excess pressure and damage the modules.

### **Water temperature:**

- Temperature of water used for cleaning should be same as ambient temperature at the time of cleaning. Cleaning should be carried out when the modules are cool to avoid thermal shock which can potentially cause cracks on the modules.

## **III. CLEANING METHODS FOR PV PANEL'S**

### **3.1 Natural Removal Of Dust**

- The natural powers are employed to remove the dusts, such as wind power, gravitation and the scour of the rainwater. The effect of this method is not very well. It is seen that the solar cell array can be turned to vertical or oblique position to remove the dusts easily when early morning, late evening, night and a rainy day. However, the rotation of the large solar cell array is very difficult.

### **3.2 Mechanical removal of dust**

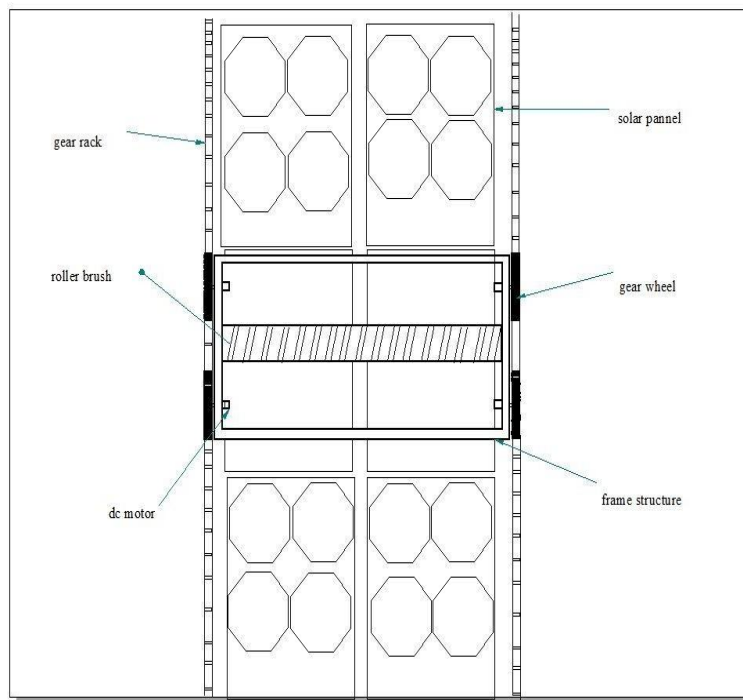
- The mechanical methods remove the dusts by brushing, blowing, Vibrating and ultrasonic driving. The brushing methods clean the solar cell with something like the broom or brush that were driven by the machine was designed just like windscreen- wiper. However, firstly, because of the small size and the strong adhesively of the dusts, the

cleaning method is inefficient. Secondly, the abominable working environment of the solar cell makes the maintenance of the machine difficult. Then, due to the large area of the solar cell array, the cleaning machine is powerful. Lastly, the surfaces of the solar cell maybe were damaged by the brush when wiping. The blowing method cleaning the solar cell with wind power is an effective cleaning one except the low efficiency, high energy-consumption and the unsatisfactory maintainability of the blower.

**3.3 Electrostatic removal of dust**

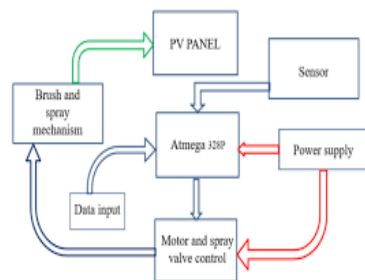
If there are a high potential on the surface of the solar panels, the charged and uncharged dusts will be attract to the panels because of the electrostatic forces. Then, the dust particles will be charged by the solar panels finally, so they have the same electric charge and the electrostatic forces between them are repulsion. At last, the dust particles will float away the solar panels. However, this strategy cannot be used in PV system, because of the effecting of the rain on earth.

**IV. 2-D DIAGRAM OF SOLAR PANEL CLEANER**



**Figure 2. Top view of solar panel cleaner**

**V. WORKING PRINCIPLE**



**Figure 3. Block diagram Solar panel cleaner**

Electrostatic charge material is used on a transparent plastic sheet or glass that covers the solar panels. Sensors monitor dust level and activate the system into cleaning mode. The dust is shaken off the solar panels when an electrically charged wave breaks over the surface material. The cleaning unit moves on the solar panel in a back and forth motion. The cylindrical brush mounted on the cleaning unit rotates in the clockwise direction. The cleaning unit along with the rotating brush moves along the solar panel towards the bottom of the panel. Along the entire path, it forces the dust to move in the direction of the motion of the cleaning unit and finally blows it away at the edge of the panel. Once the cleaning unit reaches the lower end of it, it again returns back. Once it reaches the top of the panel, the cleaning unit stops there. Then the locomotion units come into action. Then the wheels move in the direction parallel to the edge of the solar panel until it reaches the part of the panel that is not cleaned.

#### **VI. OBJECTIVE**

- To clean the solar panel effectively.
- To make the system automated
- To avoid the manual work.
- To avoid dust associated problems on solar panels.

#### **VII. SOLAR PANEL CLEANING SYSTEM REQUIREMENTS**

1. The system should be environmentally friendly.
2. The system should endure various conditions.
3. The system must fit within current Cal Poly DC House solar panel parameters.
4. System operation must have a minimal learning curve.
5. The system must efficiently clean the solar panels.
6. The whole system must have a low cost.
7. The solar panel itself should power the system.
8. The system should draw and utilize low power.
9. Solar panel output power should increase after cleaning.
10. The system poses low weight.
11. The system operates on various buildings.
12. Easy installation characterizes the system

#### **VIII. ADVANTAGES**

1. Cost of production is low
2. No need to purchase heavy machinery
3. Reduces threat to human life
4. Manual assistance is not required
5. Working principle is quiet easy.
6. Portable.
7. Autonomous self-cleaning mechanism that can be attached to solar panels and operated without human operation.
8. It is easy to construct, low cost and low maintenance.

#### **IX. DISADVANTAGES**

1. Rolling brush which consists of electrostatic cloth would need to change.
2. Needs to be scaled for a larger project (ex: increase in the torque of the motor)
3. System is not powered by photovoltaic cells instead it consumes electric power for its necessary actions which leads to additional cost for power.
4. Ineffective for sticky dust and cannot clean the dust at the corners.
5. The sticky dust need to be removed using hard brush or through mopping action.

### **X. FUTURE WORK**

- In this review work there is a great scope to modify it in different ways like increasing its operation by using surface vacuum cleaners and spray of waters.
- This can be modified by sensors.
- In this review work electric supply has been used through power supply, this can be modified by using solar panel for power supply.
- Silicon brushes can be used where it gives max life of cleaning.
- Arduino programs can be replaced by better and variety of micro-controllers.
- It can also be controlled by using remote controllers for necessary cleaning actions.
- Rack system can be replaced by belt drives.
- Even though process worked perfectly and was functioning as initially planned, there are still a lot of improvements that can be made to make it more effectively in cleaning.

### **XI. CONCLUSION**

- Existing automated cleaners mainly focus on large arrays and in general are unsuitable for installing on smaller arrays namely residential roofs. For those with limited space this means that a smaller array only needs to be installed, hence their idea serves as a huge advantage for those smaller sites.
- System can be installed for roof top solar panels.
- Comparing the costs of cleaning by Manual operation and Automatic operation the cost for automatic cleaning is proved to be more economic and significantly less cumbersome particularly in systems having large number of solar panels
- The solar panel cleaning system was first designed taking into consideration the design parameters.
- The cleaning action of the brush was good but it failed to scrub the dust which was sticky in nature.
- The sticky dust needs to be removed using hard brush or through mopping action.  
So as we know prevention is better than curing as a result the cleaning action prevents the primary accumulating surface dust on the solar panel before it becomes too sticky to remove.

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