

## RESEARCHING OF THE INFLUENCE OF THE EXTERNAL ENVIRONMENT ON THE ENERGY EFFICIENCY OF SOLAR PANELS

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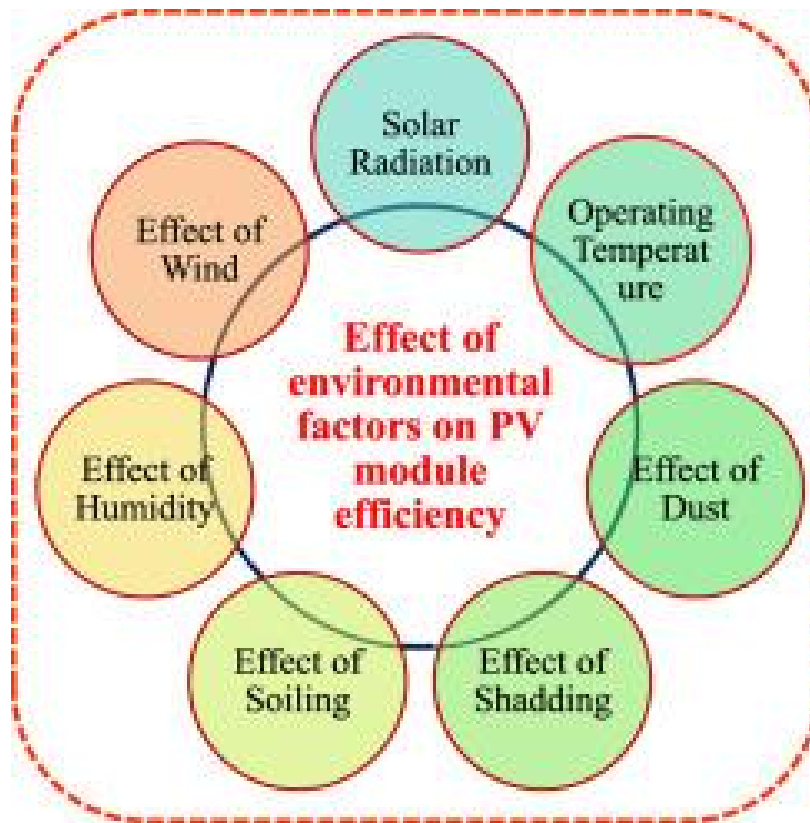
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**Annotation:** When it comes to environmental impact, gathering silicon and glass are both non-issues, as they're abundant and non-toxic. However, the process of mining for those metals creates greenhouse gas emissions and can lead to soil, water and air pollution. Solar energy, a plentiful and renewable source of power, is harnessed through the use of photovoltaic cells or solar panels. However, the energy efficiency of these panels is largely influenced by several external environmental factors. Understanding these factors and their respective impacts can be essential for optimizing the design, installation, and utilization of solar energy systems. The effect of environmental factors on photovoltaic panel performance was examined, and it was concluded that temperature reduces panel efficiency; wind speed, radiation, and air pressure have a positive effect on panel efficiency; and humidity causes corrosion.

**Key words:** panel efficiency, environmental impact, air pollution, solar energy systems, global warming.

**Introduction:** Dust or shadow deposition is the main factor that decreases the effectiveness of solar panels. The accumulation of dust or shadows on solar panels can reduce their output power and efficiency by 20% to 80% depending on the thickness of the accumulation. The problems with energy supply and use are related not only to global warming but also to such environmental concerns as air pollution, acid precipitation, ozone depletion, forest destruction, and radioactive substance emissions. To prevent these effects, some potential solutions have evolved including energy conservation through improved energy efficiency, a reduction in fossil fuel use and an increase in environmentally friendly energy supplies. Among them, the power generation with solar cells system has received great attention in research because it appears to be one of the possible solutions to the environmental problem. Today, most home solar panels have efficiency ratings between 19% and 21%. But as solar technology improves, more and more solar manufacturers are reaching 22% or higher efficiencies. Sunlight Intensity: the amount of sunlight received by a solar panel significantly affects its energy efficiency. Simply put, the stronger the sunlight, the greater the electricity that can be generated. Not surprisingly, geographical location and seasonal variations play a substantial role concerning sunlight intensity. Equatorial regions tend to have higher efficiency due to more direct and consistent sunlight. Contrary to the assumption that the hotter the better, high temperatures can actually diminish the efficiency of solar panels [1]. Photovoltaic cells operate by using light, not heat. Elevated temperatures may increase the conductive properties of semiconductors in the panels, but they also augment resistive losses, lowering the overall efficiency. The shading of solar panels, whether partial or total, considerably reduces energy yield. Shading can occur due to buildings, trees, dust, dirt, and bird droppings. Even the shadow from a single leaf or a slight layer of dust can cause significant efficiency drop, as it inhibits the panel's exposure to sunlight. To avoid shading impact, solar panels should ideally be installed in well-exposed areas and undergo regular cleaning. The tilt angle and orientation of a solar panel can profoundly influence its exposure to sunlight, and therefore, its energy efficiency. Optimal position vaunts the most direct face towards the sun during peak hours. Panels should be adjusted according to geographical latitude, the time of the year, and the shifting position of the sun. Air quality and atmospheric conditions also can affect solar panel efficiency. Pollution particles, haze, or smog in the air can scatter and absorb sunlight, causing a reduction in the amount of sunlight that reaches the panels. The longer answer is that the efficiency of your solar panels depends on several different factors, such as the type of solar panels you choose, the weather conditions they are exposed to, and their degradation rate. The efficiency of energy conversion is still low, thus requiring large areas for sufficient insulation and raising concern about unfavorable ratios of energies required for cell production versus energy collected [2]. In order to

increase the energy conversion efficiency of the solar cell by reducing the reflection of incident light, two methods are widely used. One is reduction of the reflection of incident light with an antireflection coating, and the other is optical confinements of incident light with textured surfaces. They showed that the transformation of the wavelength of light could significantly enhance the spectral sensitivity of a silicon photodiode.



**Figure 1.** structure for effect of environmental factors on PV module efficiency

Photovoltaic (PV) systems are regarded as clean and sustainable sources of energy. Although the operation of PV systems exhibits minimal pollution during their lifetime, the probable environmental impacts of such systems from manufacturing until disposal cannot be ignored. The production of hazardous contaminants, water resources pollution, and emissions of air pollutants during the manufacturing process as well as the impact of PV installations on land use are important environmental factors to consider. The present study aims at developing a comprehensive analysis of all possible environmental challenges as well as presenting novel design proposals to mitigate and solve the aforementioned environmental problems. The results revealed that the negative environmental impacts of PV systems could be substantially mitigated using optimized design, development of novel materials, minimize the use of hazardous materials, recycling whenever possible, and careful site selection. The best solar panels usually also have the best efficiency ratings. The energy uses by solar cells that convert sunlight into direct current electricity. Solar cells are composed of various semi conducting materials [3]. Semiconductors are materials, which become electrically conductive when supplied with light or heat, but which operate as insulators at low temperatures. It is quite generally defined as the emergence of an electric voltage between two electrodes attached to a solid or liquid system upon shining light onto this system. Practically all photovoltaic devices incorporate a p-n junction in a semiconductor across which the photovoltage is developed.



**Figure 2.** Appearance of influence of the external environment on the energy efficiency of solar panels

Most commercially available solar panels have an efficiency of less than 23%, with an average range of 15% to 20%. Monocrystalline solar panels are the most efficient, with 15% to 22% real-world efficiency ratings at a higher price range. Polycrystalline panels are more affordable but only provide 12% to 17% efficiency. Solar panel efficiency measures a solar panel's ability to convert solar energy into usable energy. Solar panel efficiency has dramatically improved over time, and panels continue to push new limits each year [4]. The first solar cells, in the late 1800s, only generated about 1% efficiency. In mid 21st century, solar cells could produce nearly 7% efficiency. Contemporary panels are up to 30% efficient, with homes getting up to 21% efficiency. Often ranked as one of the most efficient energy sources, wind energy is harnessed all over the world. Of course, some spots are known as being windier than others, and companies typically make use of these spots by building wind farms filled with turbines there. Wind energy has also been used for hundreds of years [5]. The effectiveness of solar panels can be between 15% to 20%, whereas coal could reach 40% efficiency and natural gas can reach 60 percent efficiency. All fossil fuel energy and coal is used to heat, and is then gone for good.

**In conclusion,** a multitude of external environmental factors can influence the energy efficiency of solar panels. A comprehensive understanding of these factors can substantially inform the design, placement, and maintenance of solar panels, optimizing their energy production and contributing more effectively to a sustainable future. Temperature effects are the result of an inherent characteristic of solar cells. They tend to produce higher voltage as the temperature drops and, conversely, to lose voltage in high temperatures. The energy conversion efficiency is increased by reducing the reflection of incident light. The function of the maximum power tracker is to change the equivalent load take by the solar cell array, and adjust the working point of the array, in order to improve the efficiency.



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