EXPERIMENTAL INVESTIGATION ON BIFACIAL SOLAR PV MODULE USING DIFFERENT REFLECTIVE MATERIALS UNDER ALBEDO VARIATION

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Abstract

Bifacial panels are ideally suited for commercial or utility-scale solar installations, but they can also be employed in some household applications. Bi-facial panels can be used in free-standing structures like the pergola to provide some shade while also generating energy. Bifacial panels can also be used in any other situation where the solar panels are not directly facing the sun. Awnings and canopies made of bifacial solar panels, for example, allow reflected light to reach the panels' backside. Bifacial photovoltaic (PV) is a potentially developed technology that uses absorptivity from the albedo to enhance the amount of power produced per square meter of the PV module. Because both sides of the cell, front and back, can absorb solar radiation, bifacial solar cells may provide a higher energy output than mono-facial solar cells. Improved cell efficiency, module reliability, and deployment design of bifacial arrays in a PV plant should continue to be emphasized in bifacial PV efforts to co-optimize front-to-backside energy output for fixed and tracking systems throughout the day. The efficient thermal flow for front, rear, and combination irradiance was determined using these spectra. Single-cell laminates exposed to indoor irradiance had their power output, bifacial gain, and module operating temperature measured. Aluminium foil is a common component of laminates and is widely used in food packaging. It has a higher barrier function against the migration of moisture, oxygen and other gases, volatile fragrance, and light than any plastic laminate material. Recently, plastic-derived products have become a vital commodity for various purposes. It has three reflecting materials for comparison of reflectivity; first the typical surface readings, then the different reflective materials at various irradiance levels. A white paint reflector, plastic film, and aluminium foil sheet components are used. The aluminium foil sheet material has a high power density of 1000W/m^2 in Standard Test Conditions. Aluminium foil sheet is a highly reflective material with a maximum voltage of 38 V and a maximum current of 12.3A. This enhances the power of the reflective material 466W. The regular surface increases the power by 1.166%, whereas the aluminium foil layer increases the maximum power by 1.3%.

Keywords: Albedo Variations, Aluminium Foil sheet, Bifacial Solar Panel, Reflectors

1. INTRODUCTION:

Traditional (monofacial) solar panels collect sunlight on one light-absorbing side and reflect the light energy that cannot be captured. Bifacial solar panels, on the other hand, have solar cells on both sides, rather than just one. This allows the panels to absorb light from both the front and back. In practice, this means that a bifacial solar panel can collect light reflected from the ground or another surface. Bifacial cells and modules gather light that falls on the front side of the panels as well as light that falls on the back. The total irradiance absorbed by the panel will grow as a result, and the current generated by the panels will increase as well. Three key aspects influence the thermal balance in a PV module: I absorbed, transmitted and reflected irradiance; ii) conversion losses due to thermalisation, entropy production, recombination, or parasitic absorbance and iii) heat losses due to radiation and convection.

The irradiance that enters the cell is either absorbed or transmitted (M.W.P.E. Lamersa,). Consumers are increasingly demanding food that is ready to eat or that can be stored for a few days or up to several years. Furthermore, modern items must be delicious, enticing, healthful, and secure. Food is an inherently unstable system that is always changing. It could only be accomplished using packaging materials safe for human consumption, have balanced sensory qualities, provide the necessary environmental protection, and prevent the unintended loss of volatiles from food. Furthermore, packages provide all pertinent information; confirm the validity of the food for appropriate disposal. All of these factors contribute toward packaging's high position in the modern production process (manuela lamberti). Because of some of its key characteristics, such as insolubility in water, resistance to corrosion and electricity, ease of processing by heat and moulding, high lifetime, and compact size, micro plastics play a significant role in our daily lives. The constituent units of ethylene, propylene, styrene, and vinyl chloride in plastics can be linear and cross-linked. Thermoplastics are a type of plastic made out of linear or minimally cross-linked polymers that do not undergo chemical changes in composition when heated and may be molded repeatedly.

A large amount of used plastic pollutes the environment, endangering marine life, reducing soil fertility and contaminating ground water, inefficient soil management and lack of funds for trash management. Are the path of plastic trash creation and the current plastic waste management system have been thoroughly examined in this study (Monjur Mourshed). The thermosetting plastics are those that have a lot of cross-linking. A chemical reaction happens during the thermal formation phase are irreversible (Klein2012). Thermoplastics might melt and assume shape just once; once solidified, they stay solid for a longer time. Solid waste (SW) is non-liquid, non-gaseous, hazardous, or non-hazardous, organic, or non-organic, fresh, biodegradable, or non-biodegradable useless items that result from our daily work in the form of trash, garbage, and sludge (Monjur Mourshed). The albedo refers to the ratio of reflected light to incident light, which is used to boost power based on the front and rear side irradiance. To increase the power, reflective materials for plastic film, white paint reflectors, and aluminium foil sheets is highly reflective material enhance reflect the irradiance based on mechanical and chemical qualities.

Table 1: Bifacial panel without material

Irradiance (W/m^2)	V_m (v)	I_m (A)	P_m (W)
1000	38.3	11.0	421.3
920	38.2	10.1	386.6
850	38.1	9.4	356.2
780	38	8.6	326.0
715	38	7.9	298.9
650	38	7.2	271.7
450	37.7	5.0	186.6
350	37.6	3.9	144.8
275	37.3	3.0	112.8
166	37.2	1.8	67.9
87	36.3	1.0	34.7

Table 2: Bifacial with white paint reflector

Irradiance (W/m^2)	V_m (v)	I_m (A)	P_m (W)
1000	38.2	11.3	432.4
920	38.2	10.4	397.8
850	38	9.6	365.6
780	38	8.8	335.5
715	38	8.1	307.6
650	38	7.4	279.6
450	37.4	5.1	190.5
350	37.3	4.0	147.8
275	37.3	3.1	116.1
166	37	1.9	69.5
87	36.1	1.0	35.6

Table 3: Bifacial panel with Plastic film reflector

Irradiance (W/m^2)	V_m (V)	I_m (A)	P_m (W)
1000	38.1	11.6	442.3
920	38.1	10.7	407.0
850	38.1	9.9	376.0
780	38	9.1	344.1
715	37	8.3	307.1
650	37	7.5	279.2
450	36.8	5.2	192.3
350	36.8	4.1	149.5
275	36.8	3.2	117.5
166	36.1	1.9	69.6
87	36	1.0	36.4

Table 4: Bifacial panel with Aluminium foil sheet reflector

Irradiance (W/m^2)	V_m (V)	I_m (A)	P_m (W)
1000	38	12.3	466.3
920	37.8	11.3	426.7
850	37.6	10.4	392.1
780	37.5	9.6	358.9
715	37	8.8	324.6
650	36.9	8.0	294.3
450	36.7	5.5	202.6
350	36.5	4.3	156.7
275	36.3	3.4	122.5
166	35.8	2.0	72.9
87	35.5	1.1	37.9

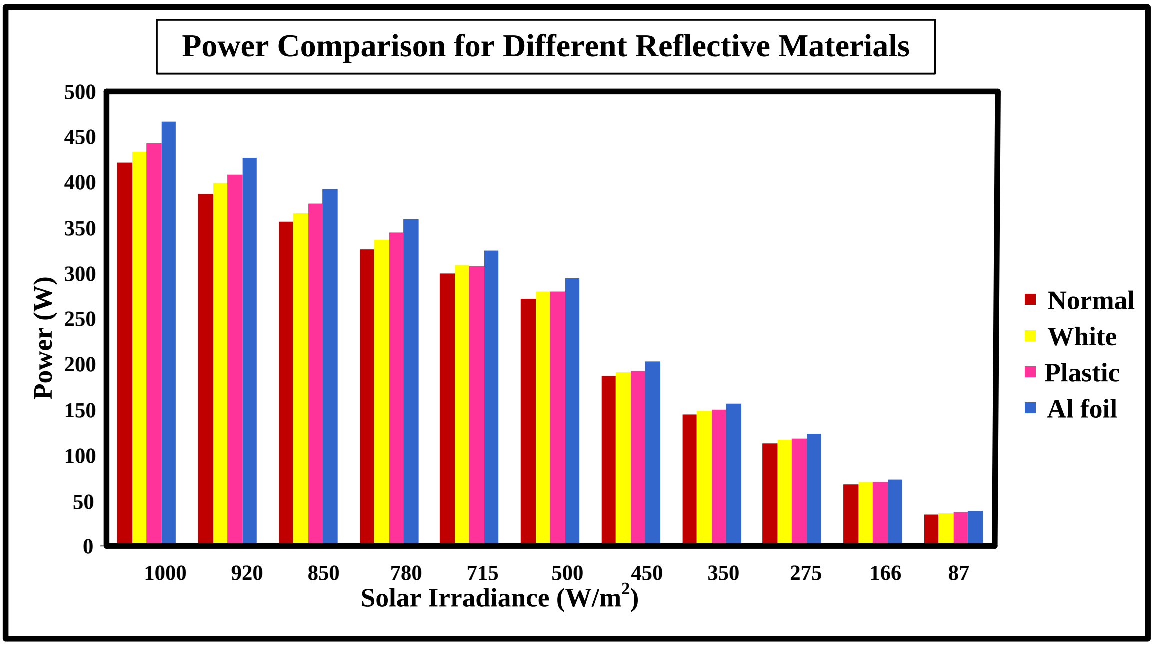

Figure 1: Power Comparison for Different Reflective Materials

II. EXPERIMENTAL PROCEDURE:

Material preparation:

This research looked into several materials to see whether they could boost power based on reflection for these albedo changes. Materials such as plastic film, white paint reflector, and aluminium foil sheet are collected from shops and industries then the reflective value compared to albedo radiation based on a normal surface or without material reading to compare the power from a bifacial PV module. The colour white was chosen for all surfaces since it has a high reflectivity for these panels.

Procedure:

Solar panels with a bifacial design generate power from both the front and back of the panel. The front of the panel will look like any other, while the rear will contain a thin-film layer that can collect indirect light and provide a power boost. The boost will be different depending on what's beneath the panel, such as a bright, white, flat commercial roof, grass, gravel, light-colour cement, or black asphalt. The power gain might range from a few percent to up to ten percent under optimal conditions, according to some manufacturers. Solar panels with bifacial modules, on the other hand, are frequently more expensive. The experimental setup was designed to improve the accuracy of measurements made with the following instruments:

ammeter, voltmeter, pyranometer, and thermal imaging camera. In comparison to the standard, the materials used include plastic film, white paint reflector, and aluminium foil sheet. The ammeter is used to measure bifacial current levels for different materials; the voltmeter has been used to measure voltage levels; the thermal image camera is also used to capture temperature levels; and finally, the pyranometer is then used to measure different irradiance levels to help determine albedo variations.

III. EXPERIMENTAL SET UP:

Figure 2: Experimental set up for white reflector

IV. RESULT & DISCUSSION:

To improve power for different reflecting materials based on albedo differences, for comparing materials with or without material reading by voltage, current, or power based on reflectance.

Without material:

The bifacial PV panel both side reflection for front and rear side variations, experimental verification for normal surface or without materials albedo variation based on the different irradiance levels shown in Table.1 produces a power of 421.3 Watts for the standard test conditions, which is higher than the balance irradiance levels without material albedo level of 1.666%.

White paint reflector:

The white paint reflector on the bifacial panel surface enhances the rear side irradiance based on the front side irradiance. The white colour has highly reflective properties, but it cannot absorb the radiation to reflect the surface. The standard test conditions of solar irradiance produce the power of 432.3 Watts as shown in Table 2, the white paint reflector albedo level of 2.3 percent.

Plastic film reflector:

The plastic film reflector surface bifacial panel rear side irradiance increased by the reflectivity on rear side irradiation compared with the front side irradiance. The full radiation by the rear side irradiance enhanced the power compared to the normal surface power. As shown in Table 3, the plastic film produces the power in Standard Test Conditions (STC) of 442.3 Watts and an albedo level of 1.23%.

Aluminum foil sheet reflector:

The aluminium foil sheet mostly enhanced the power based on these chemical and mechanical properties. It has highly increased the reflectivity based on the albedo level compared to the other reflective materials. The standard test condition or full radiation to generate power is 466.3 Watts. These materials have high reflectivity and enhance their power based on their irradiance. The albedo value for an aluminium foil sheet is 1.3%.

V. CONCLUSION:

Because both sides of the cell, front and back, can absorb solar radiation and albedo, bifacial solar cells were designed with the goal of obtaining higher photovoltaic energy output than BPV solar cells with various reflective materials. It's worth noting that, depending on the material, the efficiency of the back of a bifacial solar cell is about 1% lower than that of the front side. According to studies, the condition for obtaining higher output energy from bifacial solar cells depends on the reflectivity of nearby ground (e.g. snow) or other artificial surfaces, as well as the reflective material aluminium foil sheet, as opposed to other reflective materials such as normal surface, white paint reflector, plastic film, and other reflective materials. Variations in albedo levels were compared. To summarize, even when high rear irradiation results in warmer bifacial modules, the advantage from bifaciality overcomes the losses from moderate heating. Even under high albedo conditions, changes in different materials, such as plastic film or aluminium sheet, which increase efficient heat transmission, may further reduce the steady state temperature of bifacial PV panels compared to material PV panels. The bifacial PV module uses an aluminium foil sheet with a high reflectivity under albedo conditions to increase the power by 466.3 Watts.

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