Bifacial solar modules increase energy production

Bifacial modules can convert light that strikes both the front and the back face of the module generating up to 25% more energy.

White Paper

Introduction

Traditional solar modules are considered monofacial, as they can only convert light that strike the front face of the module into electricity. Trina's Duomax Twin is a new bifacial module, which can convert light that strikes both the front face and the back face of the module into electricity. Under the same conditions, a bifacial module will produce more energy than a monofacial module with the same nameplate power.

The Bifacial Cell

The principal component of the bifacial module is the bifacial cell. The bifacial cell can absorb sunlight on both sides, and thus convert a greater portion the available solar resource into electricity (see Figure 1). Traditional solar cells have an aluminum back surface field, which blocks light from entering the back of the cell. The rear face of the bifacial cell does not have a fully metallized back surface field, allowing light to enter the cell. The back surface of the cell is further optimized for light trapping using an alkali texturization process. The back surface also has a grid of silver electrical contacts, similar to the front side of the cell. These changes allow the bifacial cell to convert light striking the back of the cell into electricity, boosting total energy production.

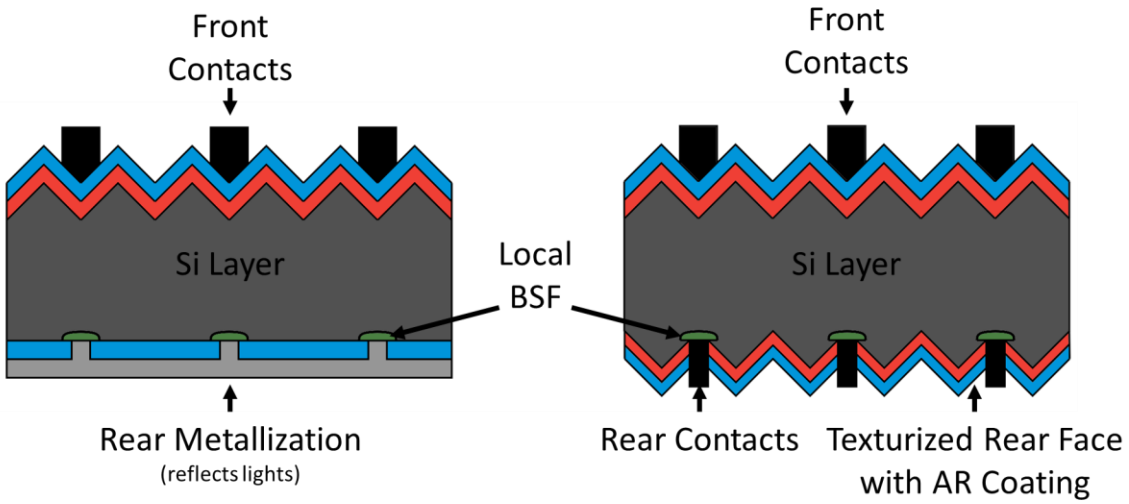

Figure 1: Standard PERC Cell vs Bifacial Cell

The Duomax Twin Module

The Duomax Twin module has been built to maximize the benefits of the bifacial cell. The Duomax Twin uses heat strengthened glass to replace the polymer backsheet used in traditional modules. The glass provides better protection for cell and improves the long-term reliability of module, while providing a transparent medium that allows for back-surface power generation. The improved durability of the module is backed by a longer 30 year power warranty and a lower annual power degradation rate of 0.5%. The back glass layer has the same transmitting effect as that of front surface, maximizing the energy generated by bifacial cells. All in all, the Duomax Twin module generates more power for a longer period of time than a standard module.

Figure 2: The Duomax Twin Module

Best Practices for Bifacial Modules

1. Minimize shading on the back surface of the module

Since the bifacial Duomax Twin generates power from both sides, issues like backside shading, which do not affect conventional modules, must be considered during installation. Trina Solar conducted an experiment to study the effect of shading from a back rail on bifacial module performance. We compared the power generated by a standard module, a bifacial module which has two back rails covering portions of the back of the module, and a bifacial module racked to avoid any backside shading. Figure 3 below shows the daily energy gain from the bifacial modules, compared to the standard module. Over the course of 7 months, the bifacial module with no back side shading produced 6.94% more energy than the standard module, compared to 3.89% more energy for the module with backside shading. Therefore, we recommend installing bifacial modules as shown in Figure 4, to avoid backside shading and maximize energy production.

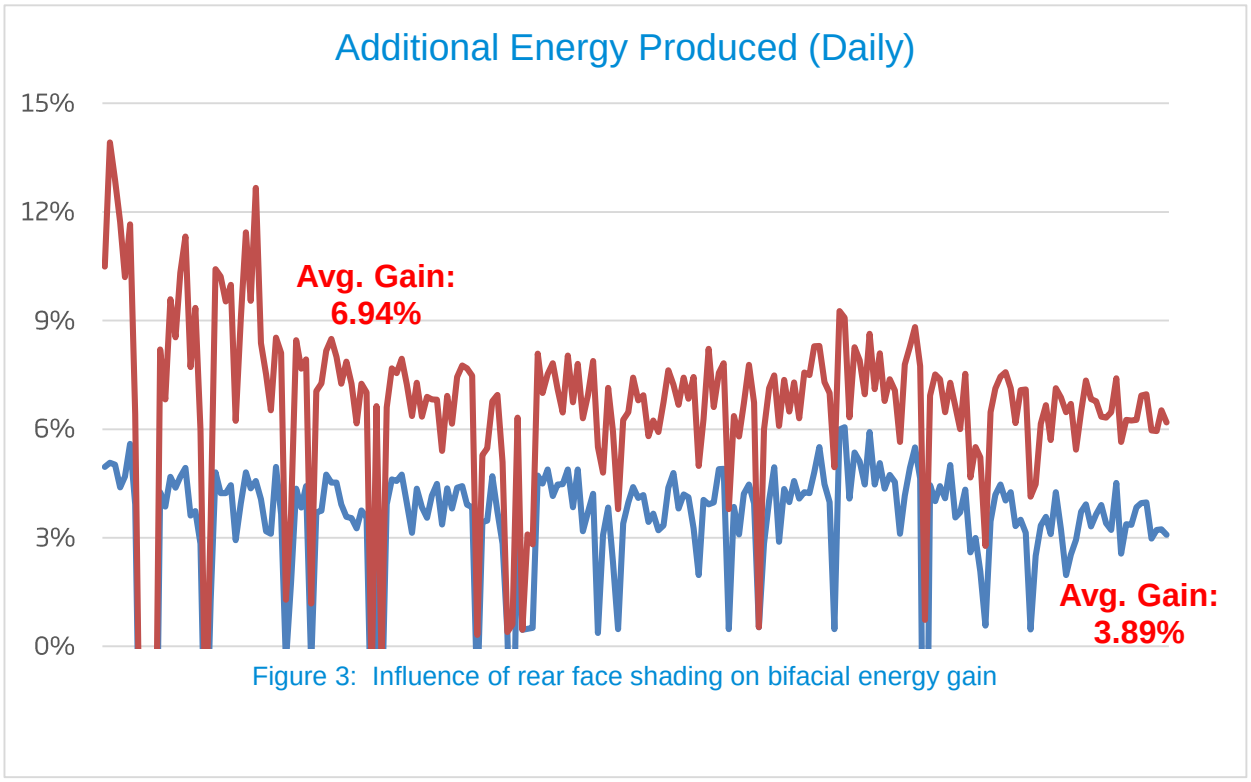

Figure 3: Influence of rear face shading on bifacial energy gain

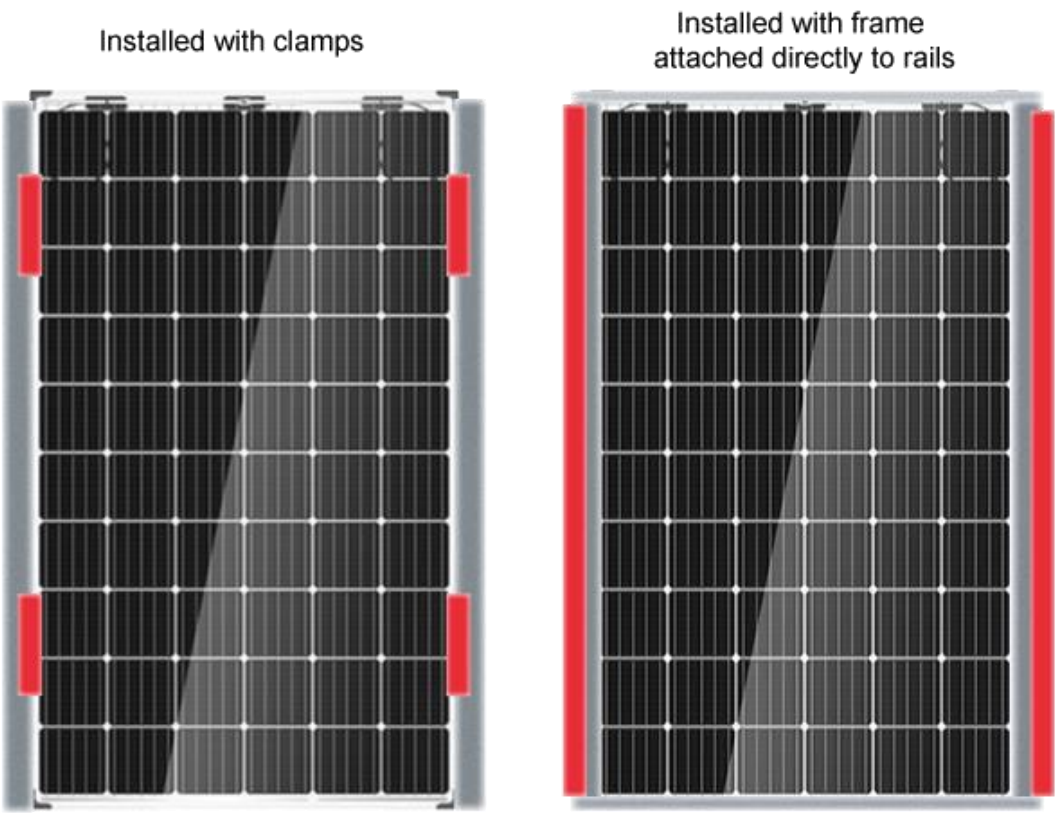

Figure 4: Duomax Twin modules installed to avoid rear surface shading from rails

2. Install modules in areas with high albedo

The albedo of the local environment has a major effect on the energy gain from bifacial modules. As shown in Figure 5, a majority of the sunlight that hits the back side of the module is reflected from the surrounding ground cover. This albedo can be highly variable, at ~0.10-0.25 for grassland, ~0.25-0.46 for cement or sand, and ~0.75 0.90 in a snowfield. Trina conducted an experiment early-2017, to compare the energy gained from bifacial modules in different settings with various albedo levels.

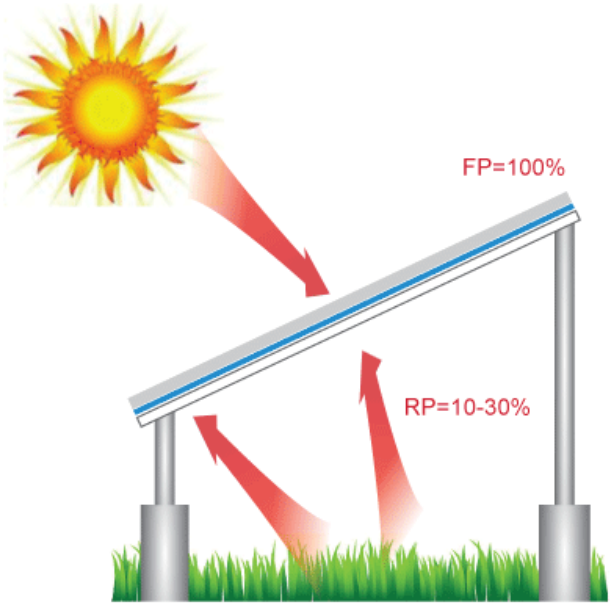

Figure 5: Power generation from light reflected onto the back surface of the module

A Duomax Twin module was tested against a standard PERC monocrystalline module. Both modules were installed at a fixed tilt of 27°, with the modules at least 0.4m above the ground. Figure 6 shows the extra energy produced by the bifacial module across several sunny days in April. With the fixed-tilt installation method, the generation capacity gain increases gradually with the increase of ground surface reflectance, with a maximum gain of 24.6% over a monofacial module with the background painted white (albedo of 0.75).

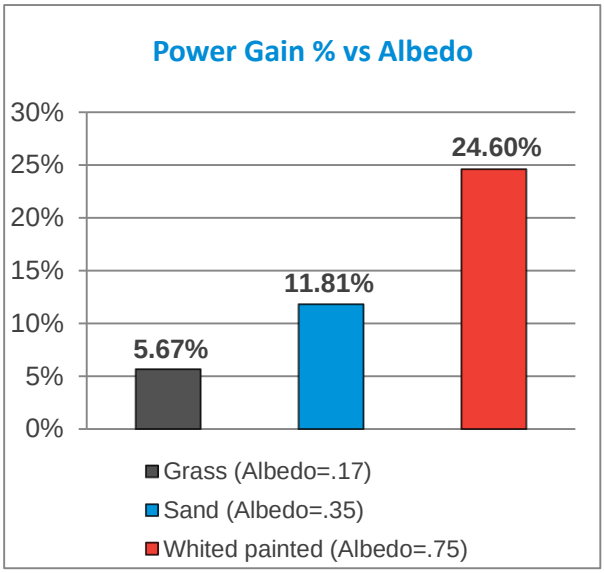

Figure 6: Bifacial power gain at different albedo levels

Figure 7 shows a comparison of the calculated and actual energy gain (compared to a monofacial module) for fixed tilt installations with various backgrounds. The theoretical gain is based on a common formula used to estimate gains from bifacial modules. On average, Trina Duomax Twin modules produced 5% more than expected based on the theoretical model.

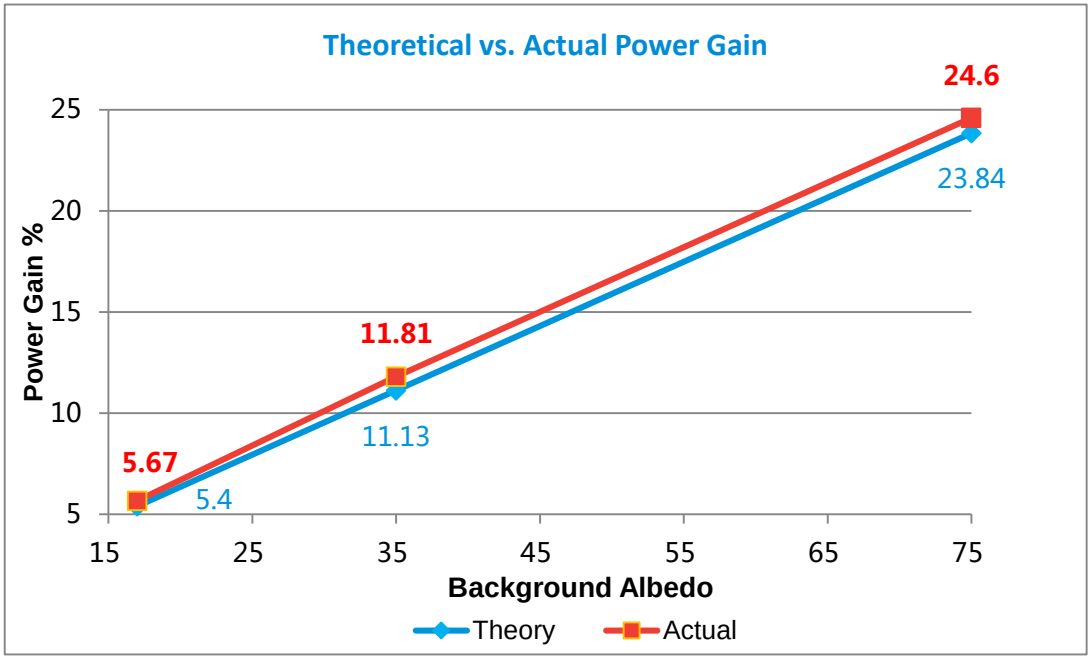

Figure 7: Actual vs Modelled Bifacial Energy Gain

Bifacial energy gain is present at all irradiance levels

Trina also tested the energy gain for bifacial modules at different irradiance levels. Figure 8 shows the energy gain at different irradiance level with three different background materials. The results showed that the energy gains were proportionally higher at lower irradiance levels. However, it is important to note that most of the energy produced by a solar panel is produced during periods of high irradiance. This means that in absolute terms, most of the energy gained due to production from the back side of the module occurs when irradiance is at or above 800W/m2. These results show that bifacial modules provide significant benefits regardless of local irradiance levels.

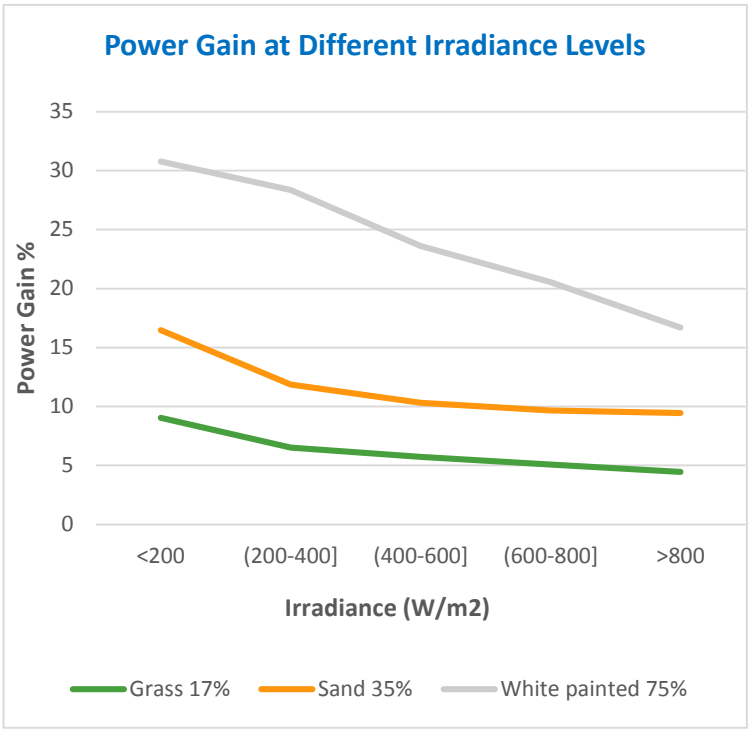

Figure 8: Energy gain at different irradiance levels

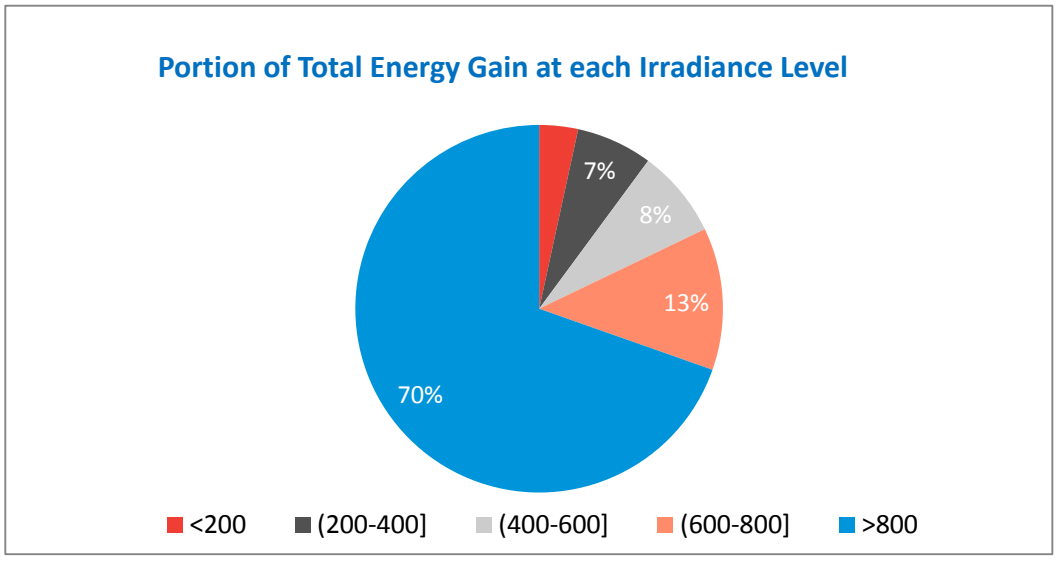

Figure 9: Distribution of accumulated power generation under different irradiation intensities

Bifacial energy gain is maximized by using trackers

Testing done by Trina Solar has also shown that using bifacial modules on a single-axis tracker maximizes the energy gains. This is particularly true during the early morning and evening periods. Trackers provide several benefits to bifacial modules, including keeping them at an optimal tilt and height to maximize the irradiance on the back side of the module. Figure 10 compares the energy gain from a fixed-tilt bifacial module and a bifacial module on a single axis tracker (using a fixed tilt monofacial module as the baseline). The module on a tracker produced 30.16% more energy than the baseline case, compared to 11.69% more with fixed-tilt installation. The results show that gains are particularly high early in the morning and in the late afternoon, with the bifacial/tracker combination producing over 117% more energy than a fixed tilt monofacial module between 7am and 8am.

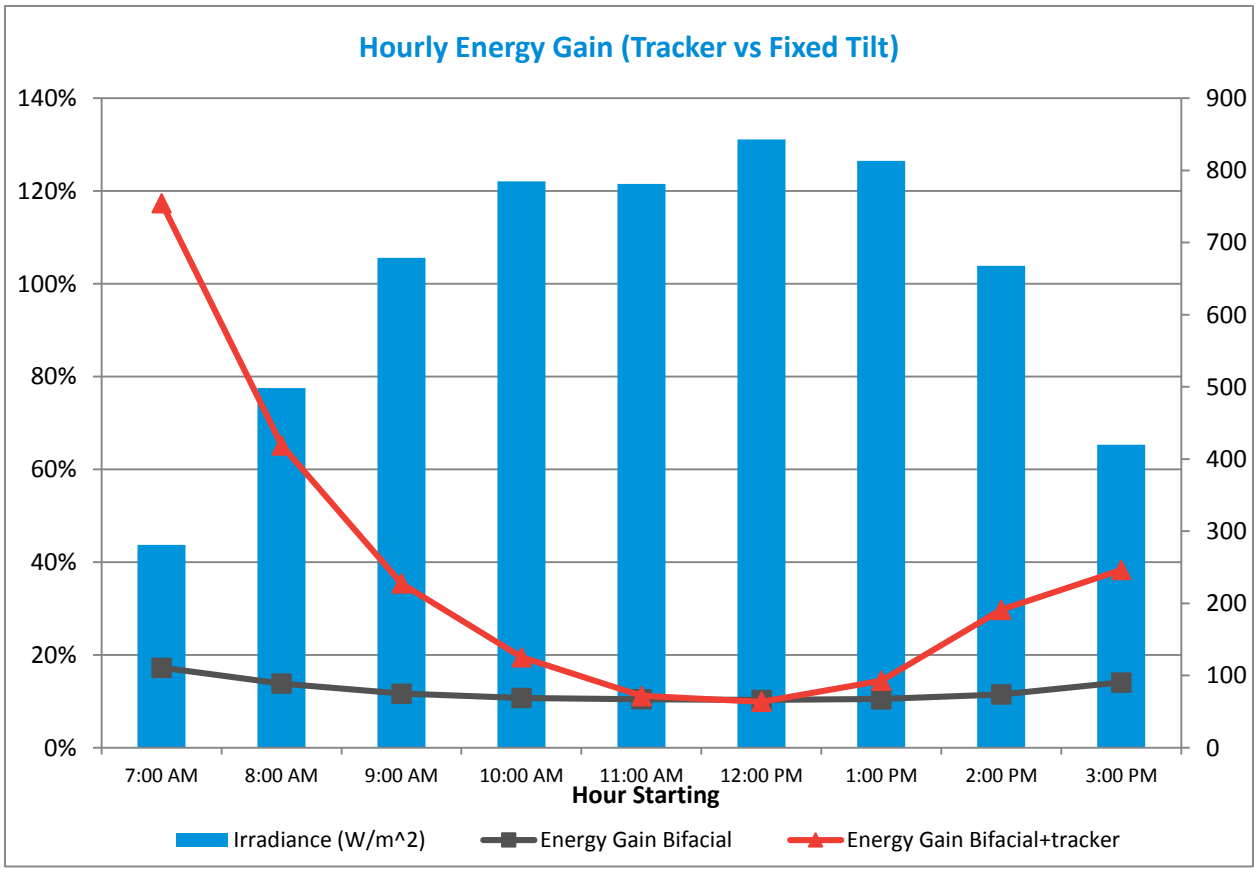

Figure 10: Comparison of energy gain over fixed tilt PERC monocrystalline system (sunny day, sandy ground)

From that data another comparison is highlighted in Figure 11.showing the energy gain for a Duomax Twin module that was mounted on a single axis tracker, when compared to a monofacial module at a fixed tilt, on a variety of ground cover conditions. The gains are significant regardless of the background, with a maximum gain of 40% with a white painted background with an albedo of 0.75. These results were gathered across several high irradiance days in Apr 2017.

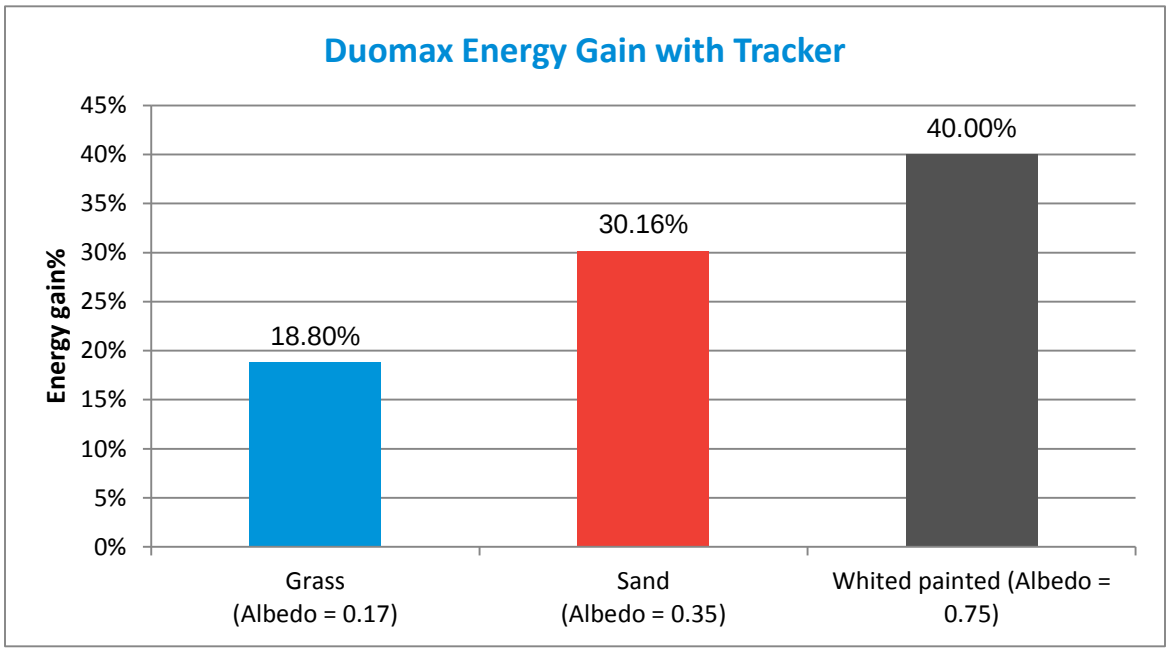

Figure 11: Energy gain of bifacial Duomax Twin module installed on horizontal single-axis tracker under different ground cover conditions

Summary

The Duomax Twin module can increase the useful life of you solar PV system while increasing the energy production as well. However, to maximize the benefits you get from the bifacial cells in the Duomax Twin, you do need consider certain installation issues that could be ignored with a standard module. Using the proper racking system, avoiding shading on the rear face of the module and choosing a site with high albedo maximizes the extra energy production you get from the Duomax Twin. Please contact your sales representative for more information and how to order these modules.