TrinaTracker

TrinaTracker Intelligent Tracking Technology

White Paper on SuperTrack™

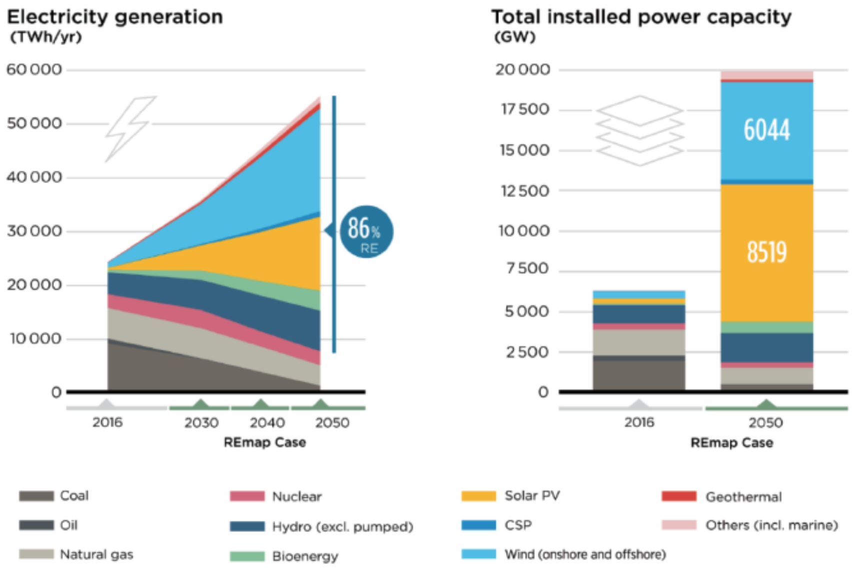
Trinasolar

Content

1. The Development of Solar Trackers

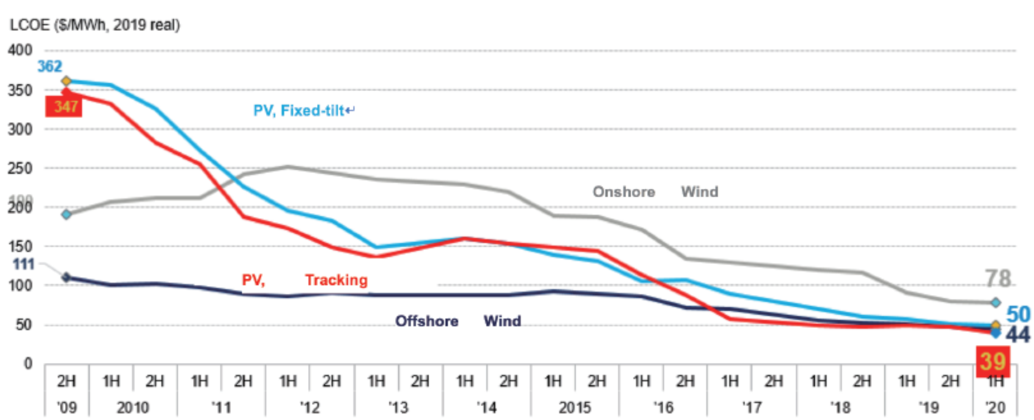
According to the International Renewable Energy Agency (IRENA)'s forecast (Figure 1), renewable energy will account for 86% of global power generation by 2050, of which 25% is expected to be generated from PV power, a ten-fold increase compared with the figure in 2016.

By 2050, the global cumulative installed capacity of PV is forecast to reach 8,519 GW, representing 42% of global cumulative installed capacity, which means that PV power generation will become one of the world's primary sources of electricity in the future.



▲ Figure 1: Future forecast of PV energy yield and installed capacity (Source: IRENA).

The promising prospects for PV power generation benefit from the continuous reduction in LCOE (Levelised cost of electricity). Amongst other factors, module and system are key elements in reducing power generation costs. Modules adopt cutting-edge advanced technologies such as HIJ (Heterojunction Technology) , TopCon and mass-produced technologies such as multi-busbars and bifacial power generation applications to reduce the LCOE; System application, such as trackers, can be used to reduce LCOE. Compared to fixed-tilt, a tracker's most prominent advantage is the increase in electricity generation capacity. Based on Bloomberg research, although the initial investment cost is higher than that for fixed tilt, the overall LCOE for trackers worldwide has been lower than that of fixed tilts since 2017 (Figure 2). Thus, the use of trackers around the world is gradually growing and, so far, the application of trackers in ground-mounted photovoltaic stations in Europe and the United States has exceeded 50%.

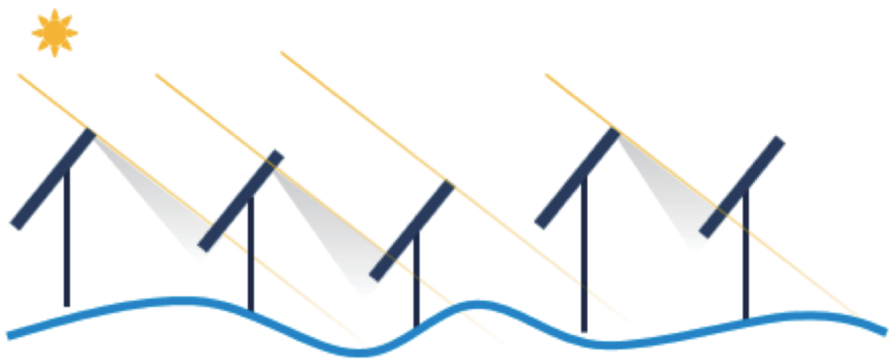


▲ Figure 2: The development of LCOE of PV with trackers versus fixed-tilts (Source: Bloomberg)

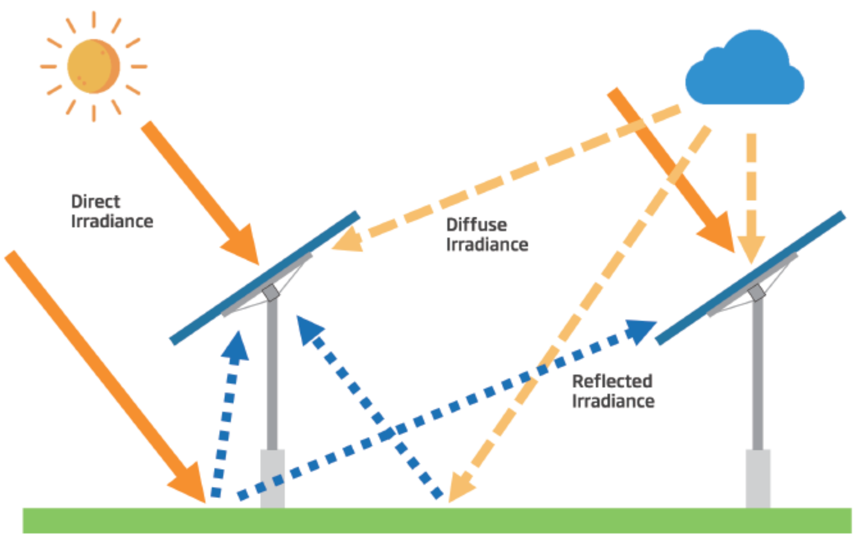
2. The Current Challenges for Tracking Technology

The most significant difference between trackers and fixed tilts is that the tracker allows the angle of modules to follow the sun's position as it moves by using a tracking algorithm. Most of today's tracker manufacturers adopt traditional astronomical algorithms. With the latitude and longitude of the project site. These traditional algorithms can accurately calculate the angle of the module facing the sun at every moment of the year, thereby selecting the corresponding position of the tracker. This fast and straightforward method allows the trackers to calculate the energy yield gain in data simulation so that the project owner can intuitively understand the advantages of choosing them.

However, as more and more PV power plants are installed with trackers, it turns out there is large potential for enhance the traditional astronomical tracking algorithms to improve the electricity generation gain from using trackers. One primary reason is that the traditional algorithms focus on geographical location and astronomical changes when processing calculations, instead of considering the influence of actual weather conditions. Secondly, under conditions of undulating rugged terrain, the front-row modules will shade the rear-row modules during the backtracking stages in the morning and evening periods, increasing the loss of power generation of the rear-row modules and even the risk of a hot spot effect (Figure 3). Last, but not least, the traditional astronomical algorithms focus more on the module's front surface energy gain. Today, when bifacial modules become more widely used, we need to balance the energy yield of both the front and back sides of the modules to maximize the total energy yield (Figure 4).



▲ Figure 3



▲ Figure 4

3. The Birth of TrinaTracker SuperTrack

To achieve further improvement in tracking technology and to address the shortcomings of the traditional astronomical algorithms, Trina Solar independently developed a brand-new intelligent tracking technology, TrinaTracker SuperTrack (hereinafter called "SuperTrack"). This intelligent tracking technology will take full account of the weather's impact on the tracking position, reduce shading loss due to the position of front and rear modules during the backtracking stages, and fully consider the global generation performance of the bifacial modules. This will further release the potential of the trackers and increase power generation gain as well as reduce LCOE.

Figure 5: Panaroma of Trina Solar's demo project in Tongchuan

4. The Technology Features of TrinaTracker SuperTrack

4.1 Two Core Smart Algorithms

With two core smart algorithms, SuperTrack ensures that the tracking system generates the maximum power at all times:

1) Smart Tracking Algorithm (STA): Based on Trina Solar's patented Bifacial Model technology, weather (irradiance) conditions (Figure 6) and system parameters (Figure 7), SuperTrack can perform deep-learning of high-diffuse irradiance weather and power generation characteristics of bifacial modules to dynamically set the optimal tracking angle to further increase energy yield (Figure 8);

2) Smart Backtracking Algorithm (SBA): Based on Trina Solar's Slope Model and neural network algorithm, SuperTrack uses the Decision Model as a means to determine the optimal tracking angle group with the best output performance through three-dimensional modelling of the terrain and iterative simulation. Furthermore, drone is used for dual verification to optimize the tracking angle for complex terrain.

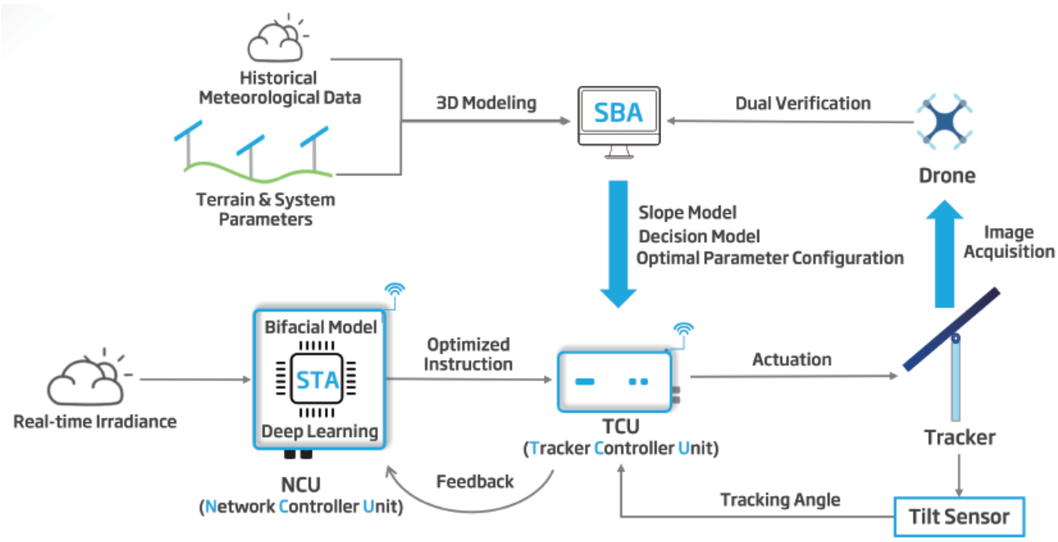


Figure 6: Smart control logic diagram of SuperTrack

(Note: STA, Smart Tracking Algorithm; SBA, Smart Backtracking Algorithm)

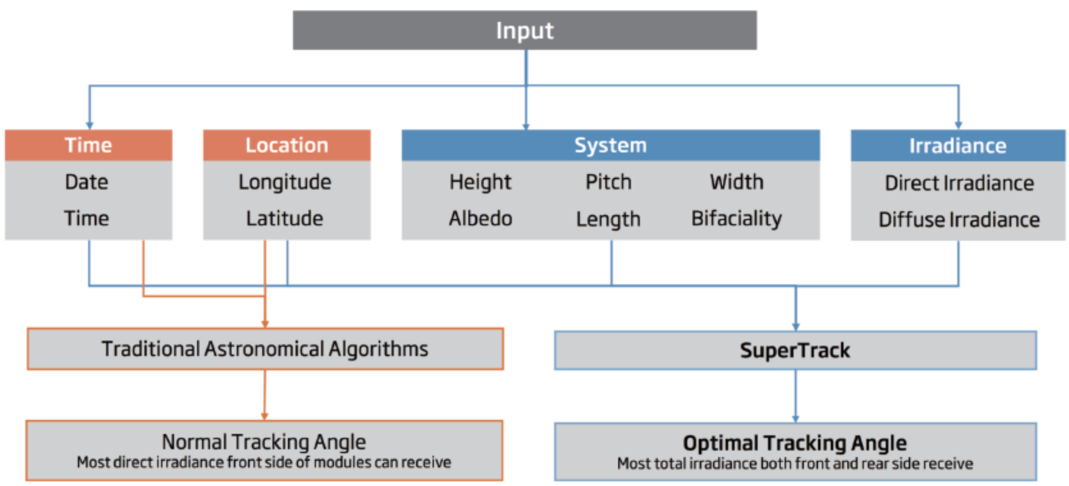


Figure 7: The twelve key parameters of the optimal tracking angle calculated by the Bifacial Model

(Note: Traditional astronomical algorithms only consider four parameters for calculating the tracking angle)

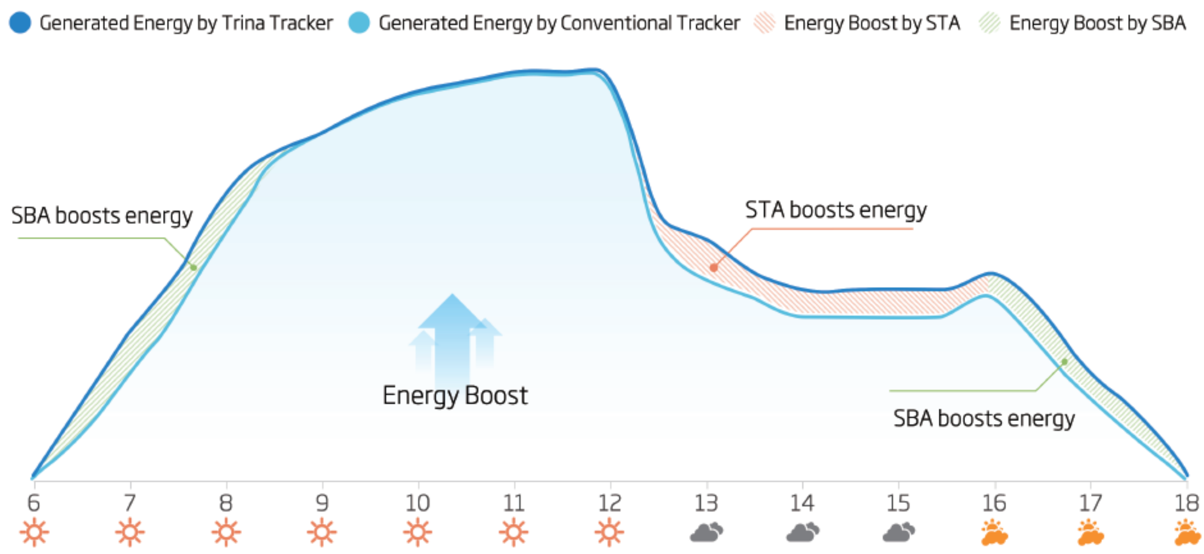


Figure 8: Schematic diagram of energy boost by SuperTrack

4.2 Efficient and Stable Communication

SuperTrack adopts wireless communication and self-powered technology to reduce the use of communication and power cables and related wiring and labour costs. The "broadcast + polling" communication control strategy is innovatively introduced to ensure communication efficiency and stability.

4.3 Protection Strategies in Extreme Weather

Relying on the intelligent control of the controller, SuperTrack integrates multiple extreme weather protection strategies, targeting the characteristics of strong wind, heavy snow and hail. It also combines wind tunnel testing and CFD simulation to improve the reliability and O&M efficiency of the tracker.

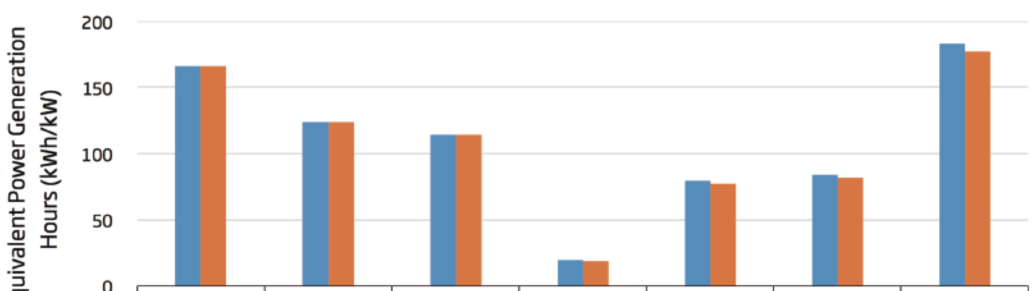
5. The Superiority of TrinaTracker SuperTrack under Various Conditions

To verify the potential of boosting energy against the traditional astronomical algorithm after the tracker is integrated with SuperTrack, a normally functioning power station is selected for actual validation. The test was conducted at a PV power plant located in Yijun County, Tongchuan City, Shanxi Province, China. The power station uses bifacial modules + single-axis trackers, from which arrays with similar terrain are selected for verification. The panoramic view of the demonstration power station is shown in Figure 9.

Figure 9: Panorama of the demonstration power station

The demonstration power plant was connected to the grid in May 2020. From May to July, all the arrays used astronomical algorithms, and the corresponding power generation data was used as the evaluation benchmark for the difference between arrays. From August to mid-September, the test officially started in late September 2020. Some arrays are integrated with SuperTrack, with others still applying astronomical algorithms. The test will continue for one year.

Figure 10 shows the comparison of equivalent power generation hours and energy gains in different months between the arrays which integrate SuperTrack and the others using the astronomical algorithm. From May to July, the test results show that the power generation benchmarks of the arrays with SuperTrack and the astronomical algorithm are similar. Since late September, SuperTrack has increased the cumulative energy yield by 3.08% compared with the astronomical algorithm, and the monthly energy gain is also in a relatively stable state.



	May 2020 (Benchmark)	June 2020 (Benchmark)	July 2020 (Benchmark)	September 2020	October 2020	November 2020	Cumulative
SuperTrack	166.4	124.3	114.1	19.4	79.5	84.2	183.1
Astronomical Algorithm	166.3	124.2	114.2	18.7	77.1	81.8	177.6
Energy Gain	0.06%	0.08%	-0.09%	3.76%	3.09%	2.92%	3.08%

Figure 10: Comparison of power generation hours between SuperTrack and astronomical algorithm

5.1 Sunny Weather

Figure 11 shows the shading comparison between the array integrated with SuperTrack and the array using the astronomical algorithm in the backtracking stage. It can be seen that the array integrated with SuperTrack presents different tracking angles according to the terrain features during the backtracking stage. There is no shading for the modules. In the meantime, some trackers using astronomical algorithms are shaded during the backtracking stage, causing a large loss of power generation. Compared with the standard backtracking algorithm, SuperTrack will adjust the best tracking angle according to the specific characteristics of the terrain of each row of trackers: For low-lying terrain, the tracking angle is reduced to avoid shading and reduce power generation loss; for a high landscape, combined with the rear terrain, the tracking angle can be appropriately increased to obtain more solar irradiation and increase power output.

Figure 11: Comparison of shading between using SuperTrack and the astronomical algorithm during the backtracking stage

(The trackers marked ST in the picture are integrated with SuperTrack, while the trackers without marking are using the astronomical algorithm)

In order to determine the energy gain after the integration of SuperTrack under different weather conditions, three typical weather types (sunny, cloudy and overcast) were selected, based on irradiance data. Figures 12 and 13 are the comparison diagrams of the demonstration group's output power and energy gain before and after the integration of SuperTrack and that of the reference group (using the astronomical algorithm) on a typical sunny day. It can be seen that, compared with the reference group, the main difference in the output power of the demonstration group is during the backtracking stage. Before integrating SuperTrack, the output power of the demonstration group in the morning backtracking stage is lower than that of the reference group and the output power of the two groups in the afternoon backtracking stage is similar. After integrating SuperTrack, the demonstration group was optimized. Thus the output power is increased in the morning backtracking stage and the gap between the demonstration and reference groups is reduced; The output power of the demonstration group is higher than that of the reference group in the afternoon backtracking stage. The demonstration group shows a 2.23% increase in daily power generation output compared to the reference group.

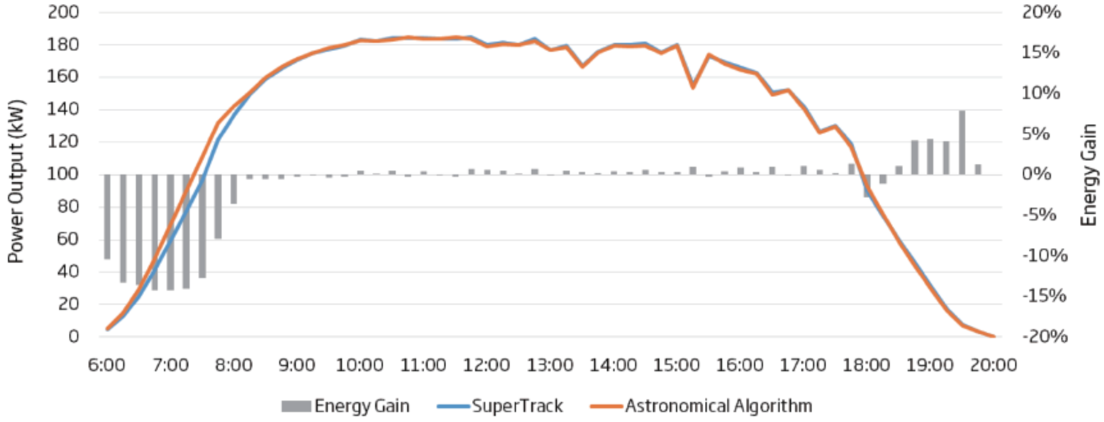


Figure 12: The energy output comparison between the demonstration group and the reference group before integrating SuperTrack

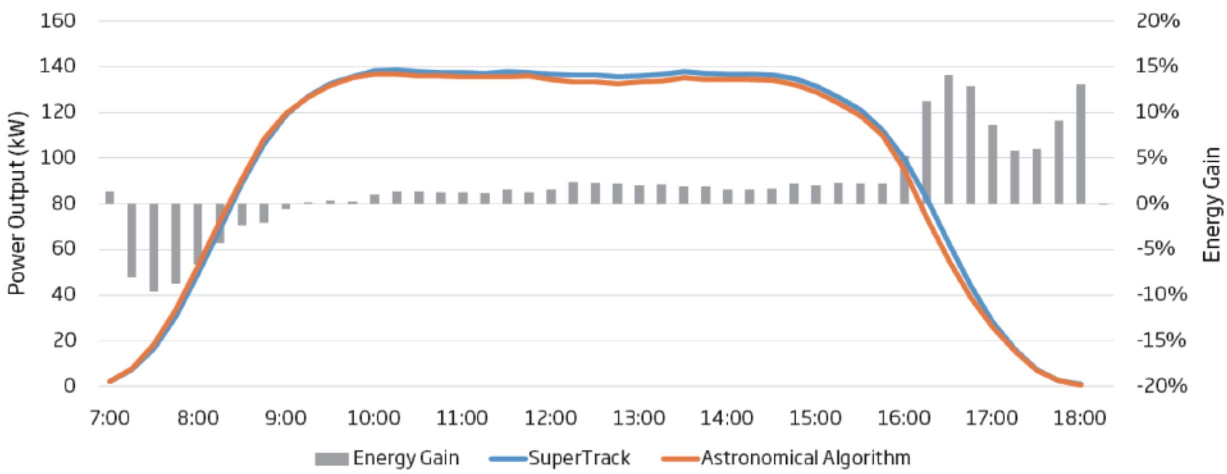


Figure 13: The energy output comparison between the demonstration group and the reference group after integrating SuperTrack

5.2 Cloudy Weather

One of the core technologies of SuperTrack is integrating its Smart Tracking Algorithm with the Bifacial Model. On cloudy days with varying irradiance (Figure 14), SuperTrack can optimize the tracking angle based on the real-time irradiance. Both the front and back surfaces of a bifacial module receive the maximum irradiance so as to ensure the best overall energy generation performance. Figures 15, 16, and 17 are the comparisons of current, power output and energy gain, and daily cumulative power generation between the demonstration group and the reference group. It can be seen that, compared with the reference group, the demonstration group has greatly improved in current and power output, and the energy gain based on SuperTrack is 3.00%.

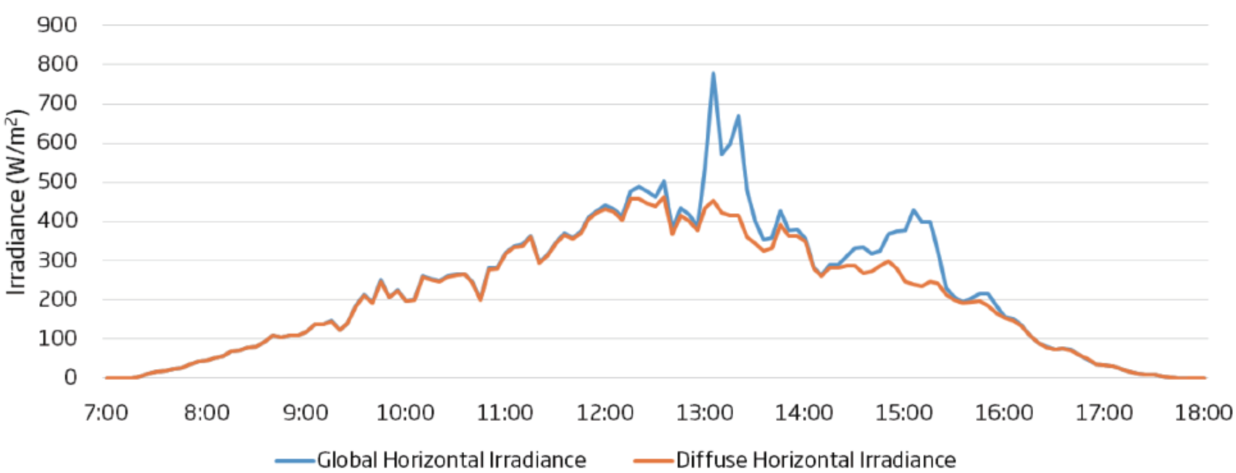


Figure 14: Global horizontal irradiance and diffuse horizontal irradiance on a typical cloudy day

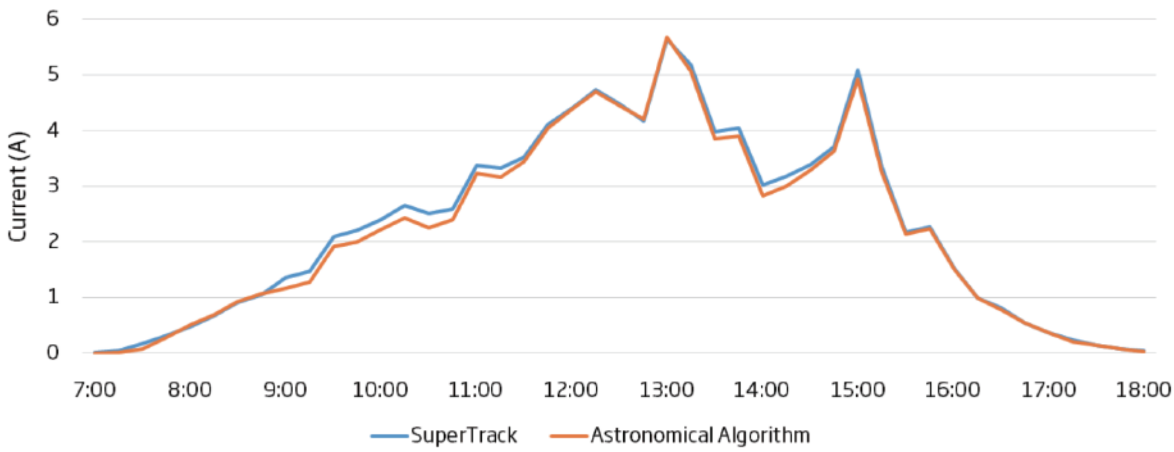


Figure 15: Comparison of current between the demonstration group and the reference group

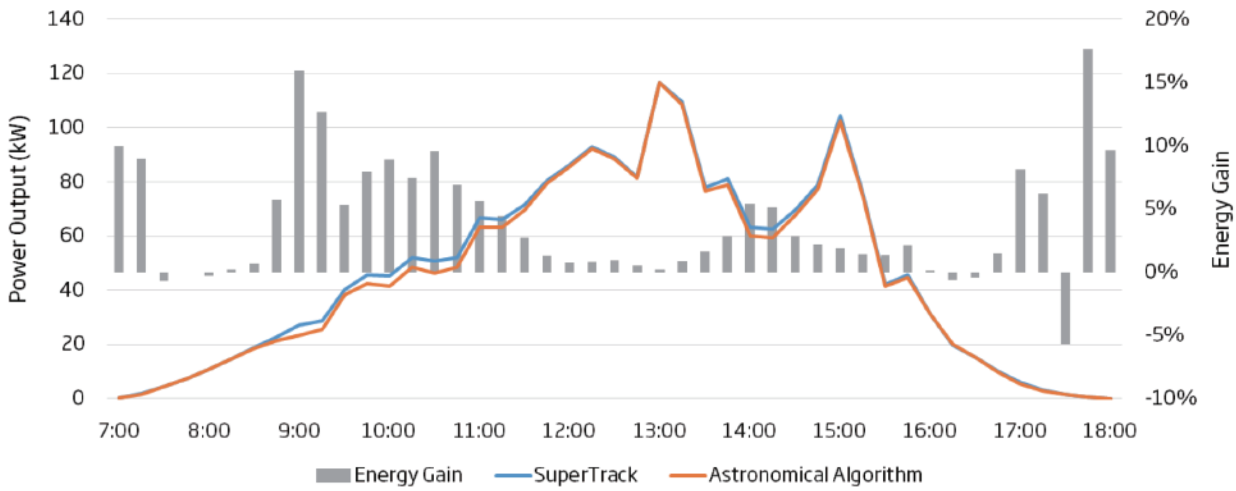


Figure 16: Comparison of power output between the demonstration group and the reference group

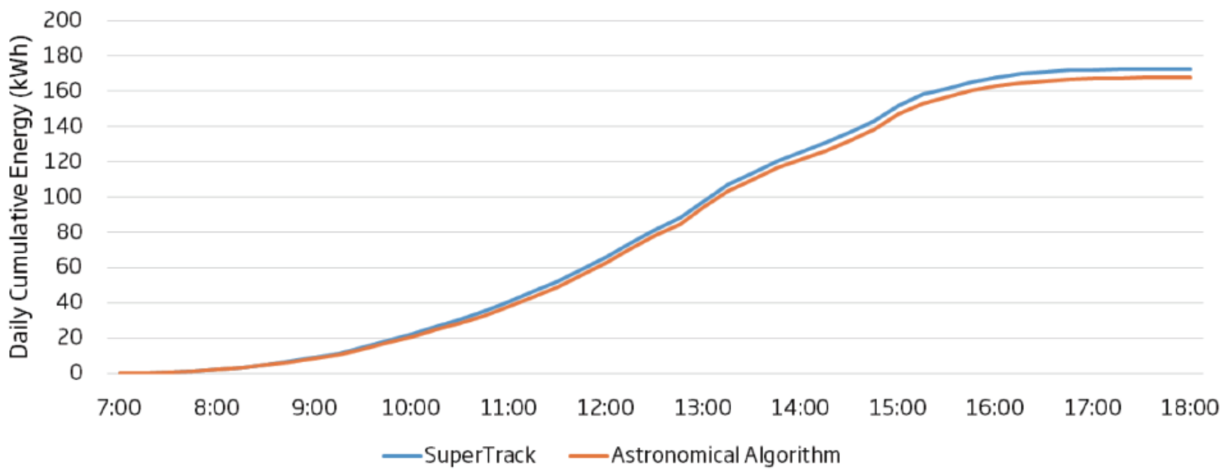
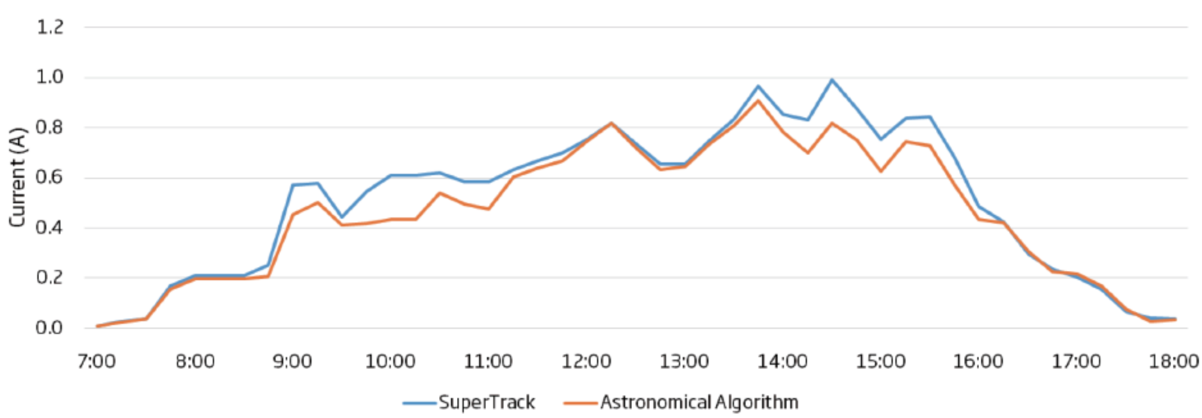


Figure 17: Comparison of daily cumulative power generation between the demonstration group and the reference group

5.3 Overcast Weather

Similar to cloudy days, on overcast or rainy days SuperTrack will maintain the trackers at a small or flat angle, catering for the weather conditions (Figure 18). The bigger the difference between the tracking angle of the astronomical algorithm and the optimized angle of SuperTrack, the greater the energy gain SuperTrack delivers. At the site of the demonstration project, the daily energy gain can reach 12.86% under overcast or rainy weather conditions. Figures 19, 20 and 21 are the comparison graphs of typical current, power output and energy gain, and daily cumulative power generation using SuperTrack and the astronomical algorithm.

▲ Figure 18: Comparison of tracking angles between the demonstration group and the reference group on a typical overcast day



▲ Figure 19: Comparison of the current between the demonstration group and the reference group

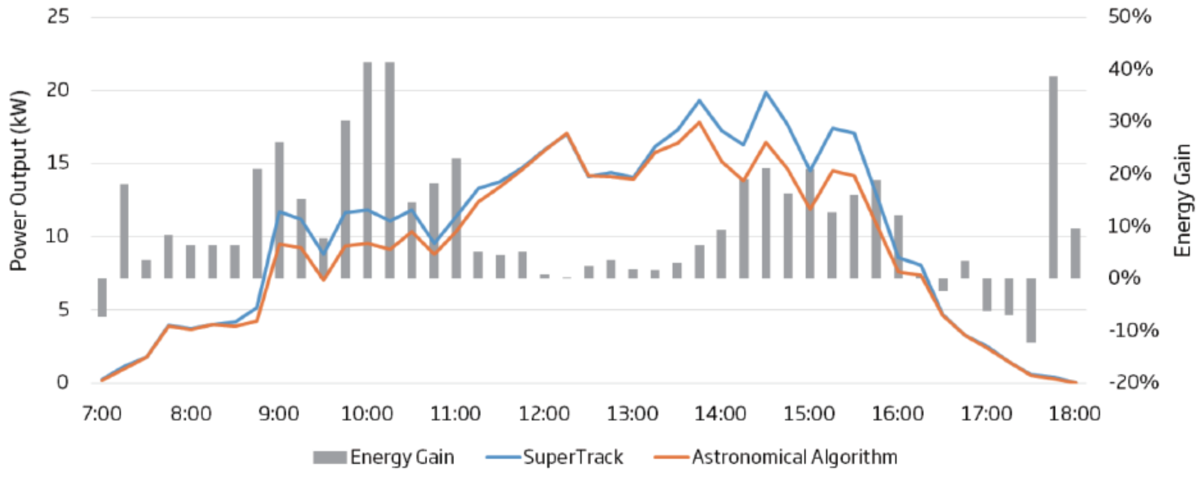


Figure 20: Comparison of the power output between the demonstration group and the reference group

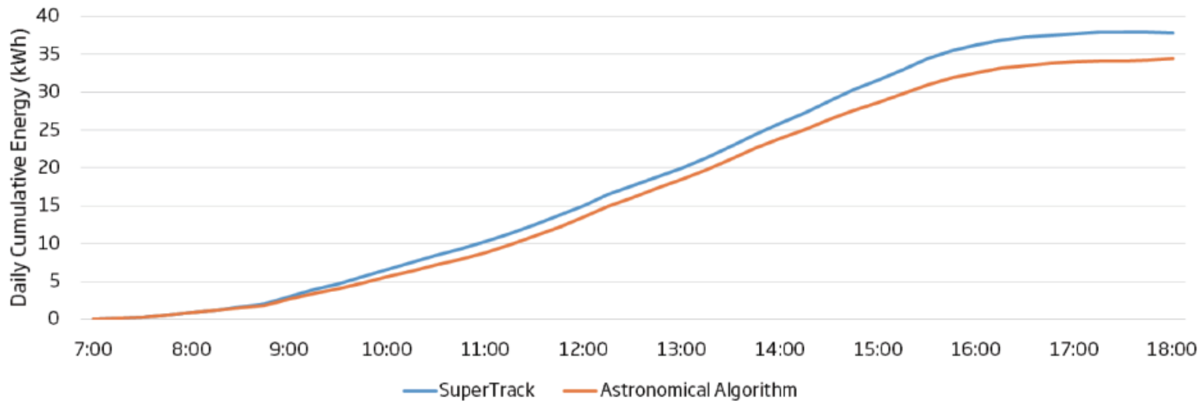


Figure 21: Comparison of daily cumulative power generation between the demonstration group and the reference group

5.4 Conclusion

1) After three months of continuous testing and validation, SuperTrack shows a significant gain in power generation under conditions of high-diffuse irradiation weather and complex terrain. Simultaneously, it fully takes into account the power generation characteristics of bifacial modules to make up for the shortcomings and defects of traditional astronomical algorithms, highlighting its advantages when coupled with the bifacial modules on trackers.

2) In the three-month comparative test at the demonstration power plant, a 3.08% energy gain was achieved. In the future, we will continue to observe and analyze the power plant's functioning status to evaluate this technology's potential in the aspect of energy gain throughout the year.

6. Future Prospects for TrinaTracker SuperTrack

SuperTrack integrates the features of smart tracking and backtracking, which significantly improves processing capacity to respond to various weather conditions and complex terrains, and further enhances the tracker's potential in power generation. In November 2020, SuperTrack was vertified by stage by the authoritative third-party organization CGC (China General Certification), achieving a 3.08% energy gain when compared with traditional astronomical algorithms.

Allied with the wide application of bifacial modules, SuperTrack will help trackers deliver a further jump in energy gain, which will contribute to reducing LCOE and will in turn increase their application in the PV industry going forward.

鉴衡认证
CHINA GENERAL CERTIFICATION

Project name	Trina Solar TrinaPro Demonstration Project
Project location	Yijun county, Tongchuan city, Shan'Xi province, China
Empirical study scope	To verify the potential of boosting energy against the traditional astronomical algorithm after the tracker is integrated with SuperTrack.
Empirical study period	May 2020 to Sep 2021 Remark: data from May to July 2020 as benchmark review, this quarterly report shows the data from Sep to Nov 2020.

Add: No.2 Tianhe Road, Trina PV Industrial Park, New District, Changzhou, Jiangsu, 213031
Hotline: 400-988-0000
Email: sales_china@trinasolar.com
No.: WP-TC-0001, Version: A