

F R O S T & S U L L I V A N

FROST & SULLIVAN BEST PRACTICES AWARD

SOLAR PV - GLOBAL

Technology Leadership 2019

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Building Your Trust in Solar

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2019

BEST
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Background and Company Performance

Industry Challenges

Reduction in subsidies and tariffs is the main challenge in the solar PV market as it is highly reliant on government support. Feed-in tariffs, tax benefits, rebate programs, and fund allocations are regarded as key drivers of market growth. Therefore, the cut in incentive programs reduces the growth potential of solar PV. Especially in developing countries, policy support can reduce the cost of system financing and operational risks. The other challenges faced by the solar PV industry are from an energy storage and transmission perspective. As the world becomes more dependent on solar power, there is a pressing need to come up with innovative and cost effective large-scale energy storage solutions and high speed transmission lines to optimize the use of solar power; or in other words avoid wastage of excess unused power.

Technology Leverage and Business Impact

Commitment to Innovation

The most intriguing aspect about JinkoSolar is its rock solid determination and relentless pursuit for technology innovation and excellence. JinkoSolar's products represent the next generation of solar solutions that not only offer superior quality and efficiency but are also highly cost effective. Its deep understanding of end user needs and specific market requirements is the foundation of its product development process. The company's excellence in the solar industry can primarily be attributed to its ability to develop products that perfectly align with customer expectations as its product designs are directly inspired and influenced by evolving customer needs.

There are two facets to JinkoSolar's innovation excellence; Product Innovation and Manufacturing Innovation. The company's meticulous efforts to drive manufacturing excellence through agile and intelligent operations is a perfect example to prove its dedication and focus on pushing boundaries to revolutionize the fab operating structure from "Automated" to "Intelligent". On the other hand, the company's tremendous focus on product innovation with a vision to enhance customer value is nothing short of remarkable. Its ground breaking achievements in producing economically viable, high efficiency, advanced solar module technology is a vivid testament to this. In spite of reaching the highest efficiency in P-type monocrystalline cell and setting multiple world records (by beating its own previous records), it is highly impressive to see the effort and dedication of JinkoSolar in raising the bar even higher to further enhance the efficiency levels. In Q2, 2018, the company set another new world record by achieving 23.95% efficiency. It was able to achieve this by further optimizing selective emitter (SE) formation, silicon oxide passivation and rear side passivation. Furthermore, it is able to increase the short-circuit current with its unique light-capturing technology by leveraging black silicon and the multi-layer ARC technology that reduces the front side reflectivity of cells to <0.5%. It is also noteworthy that JinkoSolar holds the world record for 60-cell P-type Poly PERC and Mono PERC module output at 347.6W and 370W respectively. Frost & Sullivan firmly believes that JinkoSolar's excellence in innovation and its ability to develop

technically advanced solar power products and solutions will further elevate its leadership position in the global market.

Commitment to Creativity

JinkoSolar's futuristic approach towards product development has placed it in the forefront of this highly competitive industry. It constantly strives to be a step ahead of its competitors with respect to technology and innovation and has been successful thus far. This is primarily driven by its high focus on tracking and analyzing mega trends while applying creativity to come up with products that not only address current market needs, but also future anticipated needs. This out of the box thinking is the key differentiator that sets JinkoSolar apart from its competitors. While traditional solar companies explore ways to enhance the efficiency of their products, JinkoSolar is not only highly successful at that, but is also taking meticulous efforts to expand the horizon and accelerate the development of PV industry through application diversity. A fitting example to prove its tenacity in this space is its initiative to integrate solar with electric cars, charging stations and so on. The company is currently working with OEMs in the automotive industry to integrate its technology with electric vehicles. On the other hand, it is vigorously creating new PV applications with its bifacial modules with an ultimate aim to convert any surface exposed to the sun into solar power stations. Some examples include highway fencing, railways, greenhouses, sunrooms, and other building integrated photovoltaics (BIPV) and so on. Frost & Sullivan finds this highly commendable.

JinkoSolar has gained a reputation in the global market as a company that delivers the most cost-competitive, high efficiency modules. This is backed by its core ideology of achieving grid parity by producing highest efficiency modules at lower cost. With its vast technology know-how and creative excellence, JinkoSolar has developed a flair to overcome conventional limitations of solar modules. This is demonstrated by its design and development of half-cut modules to address partial shading issues and bifacial modules to allow vertical installation. By end of 2017, the company launched its new half-cell "Eagle HC" series that minimizes module power loss through lowering the module electrical current with small cells and optimized circuit design. It is intriguing to see the level of sophistication that has gone in to the design and development of JinkoSolar's HC series; as a result it is able to achieve seamless power boost and unprecedented price-performance ratios. It has the ability to improve the efficiency of standard cells by increasing power output by 5-10W. Simply put – It empowers end users to deploy cost effective solutions without having to make a trade off on power output; its half-cell modules have comparable output to that of PERC modules, but without the extra cost. It is also noteworthy that JinkoSolar is one of the first companies to achieve gigawatt scale mass production of half-cell products; furthermore its HC product series delivers 5Wp higher outputs on average when compared to similar offering in the industry. On the other hand, JinkoSolar's commitment to creativity is further substantiated by its smart module, the Eagle AC series, where it has integrated a micro-inverter with its module allowing simplified logistics and faster installation times. It leverages a split junction box design and a specially designed dual glass module installation fixture which further enhance customer value.

Excellence in Technology Incubation

JinkoSolar's focus and efforts to continually innovate and ensure that its product offerings are state of the art is highly commendable. Its products are embedded with a wide range of features and functionalities that are unique in the industry and ultimately enhance end user value multi-fold. An integral part of the company's innovation excellence is its unparalleled manufacturing capability. The company is a torch bearer in equipment automation; it has established the world's most automated gigawatt scale manufacturing facility in Shangrao, Jiangxi province. Moreover, the company has gone another step further to establish intelligent manufacturing by leveraging advanced applications such as big data, machine learning, HPC platforms, IoT, and mobile robots. With its intelligent manufacturing, it has gained significantly enhanced capabilities such as intelligent scheduling and precise wafer/cell dispatch, precise process control, process matching, quality monitoring, intelligent equipment & process tuning, and equipment performance improvement. It is Frost & Sullivan's finding that this unique and highly innovative manufacturing capability of JinkoSolar is a boon to the end users in the global solar industry. It not only offers cost effectiveness of the highest magnitude, but also significantly enhances efficiency, flexibility and quality of the products.

Commercialization Success

JinkoSolar's vision to create multiple solutions to cater to diverse end user requirements and its meticulous efforts to incorporate value added features and functionalities in each of those products is highly commendable. Capitalizing on its extensive intellectual property, technology know-how and history of creating high efficiency products, JinkoSolar has assembled a portfolio of the most popular and frequently requested specifications to satisfy the bespoke needs of the Global market. The fact that JinkoSolar has held the top spot in the world for the second consecutive year in 2017 in terms of shipments is a testament to its commercialization success. One of the other milestones to prove its commercialization success is the Sweihan project, which is a 1,177MW solar PV independent power project being constructed in Abu Dhabi, UAE. JinkoSolar is developing this project in association with Marubeni which is expected to be completed by early 2019. Once completed, this is expected to become the world's biggest solar PV plant with an anticipated power capacity sufficient to supply for nearly 195,000 homes while offsetting approximately seven million tonnes of carbon emissions a year.

The company recently released its latest Cheetah Series panels equipped with a range topping module output of 410 Wp in the 72-cell form factor, making it the world's most powerful, commercially available C-Si mono-facial module which offers higher module efficiencies without adding much to the cost. The other significant aspect about this module is that it offers 30 Wp higher performance compared to similar offering in the market. It is also crucial to note that JinkoSolar is making significant progress in the bifacial module technology and is expected to further increase its commercialization success in the coming years. It is the only tier 1 module manufacturer to offer both N-type and P-type bifacial modules. In terms of commercialization of PV technologies in 2017, JinkoSolar leads the way for volume production of half cut cell & module, bifacial module,

black polycrystalline module, and the 12-busbar module. It is also on track for its goal of mass producing 158" wafer in 2018 and has plans to complete mass production of the industry-leading 410 Wp Cheetah series in its next-gen ultra-smart P5 super factory by early 2019.

Excellent Financial Performance

JinkoSolar's unwavering focus on technology and innovation has propelled it to the leading position in the global market. By aggressively increasing its market share over the past seven years, it has now established itself as an undisputed leader in Global Solar PV market with a track record of being the world's top selling solar module brand for the second consecutive year in 2017. The company made significant strides in leading-edge process technologies in 2017 and achieved total solar module shipments of 9,807 MW during that year, registering a brilliant year-on-year (YOY) shipment growth rate of 47.3%. In terms of revenue growth rates, JinkoSolar hugely surpassed the industry average growth rate by registering a staggering 23.7% YOY growth rate and RMB26.47 billion in actual revenues compared to RMB21.40 billion in 2016.

Brand Equity and Human Capital

JinkoSolar's brand name is synonymous with technology excellence, innovation, and most importantly, customer focus. Its product positioning has played a crucial role in its brand equity; it has created a sense of excitement amongst its customers who are in pursuit of engaging with future technologies to enhance their overall user experience. It has gained a reputation of delivering solutions, products, and services of the highest standard that specifically addresses customers' unmet needs. It is Frost & Sullivan's finding that JinkoSolar, not only demonstrates unparalleled excellence in quality, performance, and price competitiveness, but also shines the brightest in establishing excellent customer relationships and ensuring "best in class" practices to distinguish itself in this highly competitive industry.

Conclusion

JinkoSolar's visionary innovations and technology excellence places it at the forefront of the Global Solar PV industry. Its strong R&D culture combined with extensive intellectual property provides it with a unique edge in the market. It is Frost & Sullivan's finding that JinkoSolar is a company that is obsessed with constant improvement of its products and solutions with respect quality and efficiency; a trait that is expected to drive its success to greater heights in the global arena. Its unshakable determination to contribute to the betterment of the planet through renewable energy is highly commendable.

With its strong overall performance, JinkoSolar has earned Frost & Sullivan's 2018 Global Technology Leadership Award.

Significance of Technology Leadership

Technology-rich companies with strong commercialization strategies benefit from the increased demand for high-quality, technologically-innovative products. Those products help shape the brand, leading to a strong, differentiated market position.



Understanding Technology Leadership

Technology Leadership recognizes companies that lead the development and successful introduction of high-tech solutions to customers' most pressing needs, altering the industry or business landscape in the process. These companies shape the future of technology and its uses. Ultimately, success is measured by the degree to which a technology is leveraged and the impact that technology has on growing the business.

Key Benchmarking Criteria

For the Technology Leadership Award, Frost & Sullivan analysts independently evaluated two key factors—Technology Leverage and Business Impact—according to the criteria identified below.

Technology Leverage

Criterion 1: Commitment to Innovation

Requirement: Conscious, ongoing development of an organization's culture that supports the pursuit of groundbreaking ideas through the leverage of technology

Criterion 2: Commitment to Creativity

Requirement: Employees rewarded for pushing the limits of form and function, by integrating the latest technologies to enhance products

Criterion 3: Technology Incubation

Requirement: A structured process with adequate investment to incubate new technologies developed internally or through strategic partnerships

Criterion 4: Commercialization Success

Requirement: A proven track record of successfully commercializing new technologies, by enabling new products and/or through licensing strategies

Criterion 5: Application Diversity

Requirement: The development of technologies that serve multiple products, multiple applications, and multiple user environments

Business Impact

Criterion 1: Financial Performance

Requirement: Overall financial performance is strong in terms of revenues, revenue growth, operating margin, and other key financial metrics.

Criterion 2: Customer Acquisition

Requirement: Overall technology strength enables acquisition of new customers, even as it enhances retention of current customers.

Criterion 3: Operational Efficiency

Requirement: Staff is able to perform assigned tasks productively, quickly, and to a high-quality standard.

Criterion 4: Growth Potential

Requirements: Technology focus strengthens brand, reinforces customer loyalty, and enhances growth potential.

Criterion 5: Human Capital

Requirement: Company culture is characterized by a strong commitment to customer impact through technology leverage, which in turn enhances employee morale and

retention,

Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices

Frost & Sullivan Awards follow a 10-step process to evaluate Award candidates and assess their fit with select best practice criteria. The reputation and integrity of the Awards are based on close adherence to this process.

STEP	OBJECTIVE	KEY ACTIVITIES	OUTPUT
1 Monitor, target, and screen	Identify Award recipient candidates from around the globe	<ul style="list-style-type: none"> • Conduct in-depth industry research • Identify emerging sectors • Scan multiple geographies 	Pipeline of candidates who potentially meet all best-practice criteria
2 Perform 360-degree research	Perform comprehensive, 360-degree research on all candidates in the pipeline	<ul style="list-style-type: none"> • Interview thought leaders and industry practitioners • Assess candidates' fit with best-practice criteria • Rank all candidates 	Matrix positioning of all candidates' performance relative to one another
3 Invite thought leadership in best practices	Perform in-depth examination of all candidates	<ul style="list-style-type: none"> • Confirm best-practice criteria • Examine eligibility of all candidates • Identify any information gaps 	Detailed profiles of all ranked candidates
4 Initiate research director review	Conduct an unbiased evaluation of all candidate profiles	<ul style="list-style-type: none"> • Brainstorm ranking options • Invite multiple perspectives on candidates' performance • Update candidate profiles 	Final prioritization of all eligible candidates and companion best-practice positioning paper
5 Assemble panel of industry experts	Present findings to an expert panel of industry thought leaders	<ul style="list-style-type: none"> • Share findings • Strengthen cases for candidate eligibility • Prioritize candidates 	Refined list of prioritized Award candidates
6 Conduct global industry review	Build consensus on Award candidates' eligibility	<ul style="list-style-type: none"> • Hold global team meeting to review all candidates • Pressure-test fit with criteria • Confirm inclusion of all eligible candidates 	Final list of eligible Award candidates, representing success stories worldwide
7 Perform quality check	Develop official Award consideration materials	<ul style="list-style-type: none"> • Perform final performance benchmarking activities • Write nominations • Perform quality review 	High-quality, accurate, and creative presentation of nominees' successes
8 Reconnect with panel of industry experts	Finalize the selection of the best-practice Award recipient	<ul style="list-style-type: none"> • Review analysis with panel • Build consensus • Select recipient 	Decision on which company performs best against all best-practice criteria
9 Communicate recognition	Inform Award recipient of Award recognition	<ul style="list-style-type: none"> • Present Award to the CEO • Inspire the organization for continued success • Celebrate the recipient's performance 	Announcement of Award and plan for how recipient can use the Award to enhance the brand

STEP	OBJECTIVE	KEY ACTIVITIES	OUTPUT
10 Take strategic action	Upon licensing, company is able to share Award news with stakeholders and customers	<ul style="list-style-type: none"> Coordinate media outreach Design a marketing plan Assess Award's role in future strategic planning 	Widespread awareness of recipient's Award status among investors, media personnel, and employees

The Intersection between 360-Degree Research and Best Practices Awards

Research Methodology

Frost & Sullivan's 360-degree research methodology represents the analytical rigor of our research process. It offers a 360-degree-view of industry challenges, trends, and issues by integrating all 7 of Frost & Sullivan's research methodologies. Too often companies make important growth decisions based on a narrow understanding of their environment, leading to errors of both omission and commission. Successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. The integration of these research disciplines into the 360-degree research methodology provides an evaluation platform for benchmarking industry players and for identifying those performing at best-in-class levels.

360-DEGREE RESEARCH: SEEING ORDER IN THE CHAOS



About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, enables clients to accelerate growth and achieve best-in-class positions in growth, innovation and leadership. The company's Growth Partnership Service provides the CEO and the CEO's Growth Team with disciplined research and best practice models to drive the generation, evaluation and implementation of powerful growth strategies. Frost & Sullivan leverages more than 50 years of experience in partnering with Global 1000 companies, emerging businesses, and the investment community from 45 offices on six continents. To join our Growth Partnership, please visit <http://www.frost.com>.