BERGEN NEWS LETTER

BERGEN

NOVEMBER 2021, VOL 11

RENEWABLE ENERGY REFRESHER

BERGEN GROUP NEWS LETTER

Large Scale PV Manufacturing to happen in India

Time to take Technological Leapfrog to HJT

CONTENTS

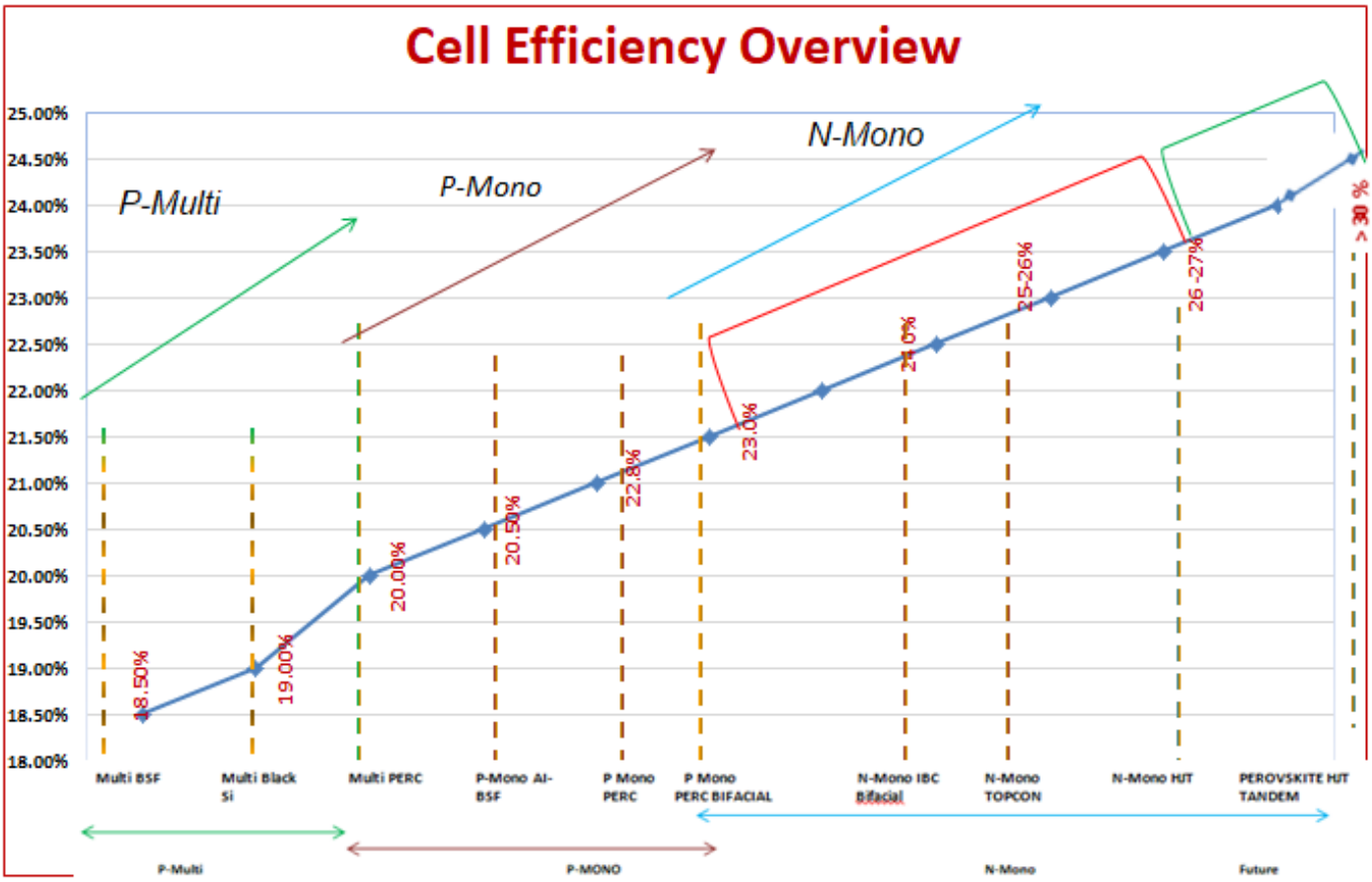
With the conclusion of PLI scheme, it is quite heartening to see that four big players namely, Jindal, Shirdi Sai Electricals, Reliance and Adani have been declared L1 to L4 respectively. Their proposals are for integrating all four stages PV supply chain namely Poly, Wafering, Cell and Module and setting up the capacities for manufacturing across all the 4 stages of 4+ GW.

There are three investors namely L&T, Renew Power and Coal India at positions of L7, L8 and L6 respectively who have applied for integrating 3 stages of supply chain and 4GW capacities. There are eight more applicants for integrating cell and module lines for a cumulative capacity of 20.6 GW placed between L9-L16.

It is quite a probability that present layout of Rs 4800 Crore for PLI scheme in PV may be enhanced and all applicants could be accommodated, and, in that case, India will be setting up more than 40 GW manufacturing capacities across the PV value chain. It will be appropriate to say that India is set to get into the big league of PV manufacturing. It, however, also brings the great responsibility on the investors that they choose the proper technologies at each of the stages of the value chain, so that they remain competitive and contemporary in the world market.

In here, we would like to talk specifically with respect to the cell technology which is at the heart of the whole solar energy production chain, cell being the fundamental building block of the solar systems and the only active device across the value chain.

In the following figure "cell efficiency overview" is given. Choice is either to go through the today's industry mainstay technology PERC and then to TOPCon to remain competitive with regard to Efficiency, the most critical metric in the solar energy generation. If one goes through the PERC-TOPCon route it will be a while and with appropriate upgradation only one will reach a competitive futuristic efficiency of 25% whereas one can straight way leapfrog to 26% efficiency with HJT technology.



There could be certain issues with HJT compared to a very matured technology of PERC but these would not be so daunting as compared to TOPCon. It is, therefore, advisable to go straight way to HJT technology rather than going to TOPCon technology in two steps as TOPCon technology also is not yet matured as PERC technology. This will quite akin to India leap frogging to mobile revolution by jumping several stages of the land line telecommunication technologies.

Rajinder Kumar Kaura
Chairman and Managing Director

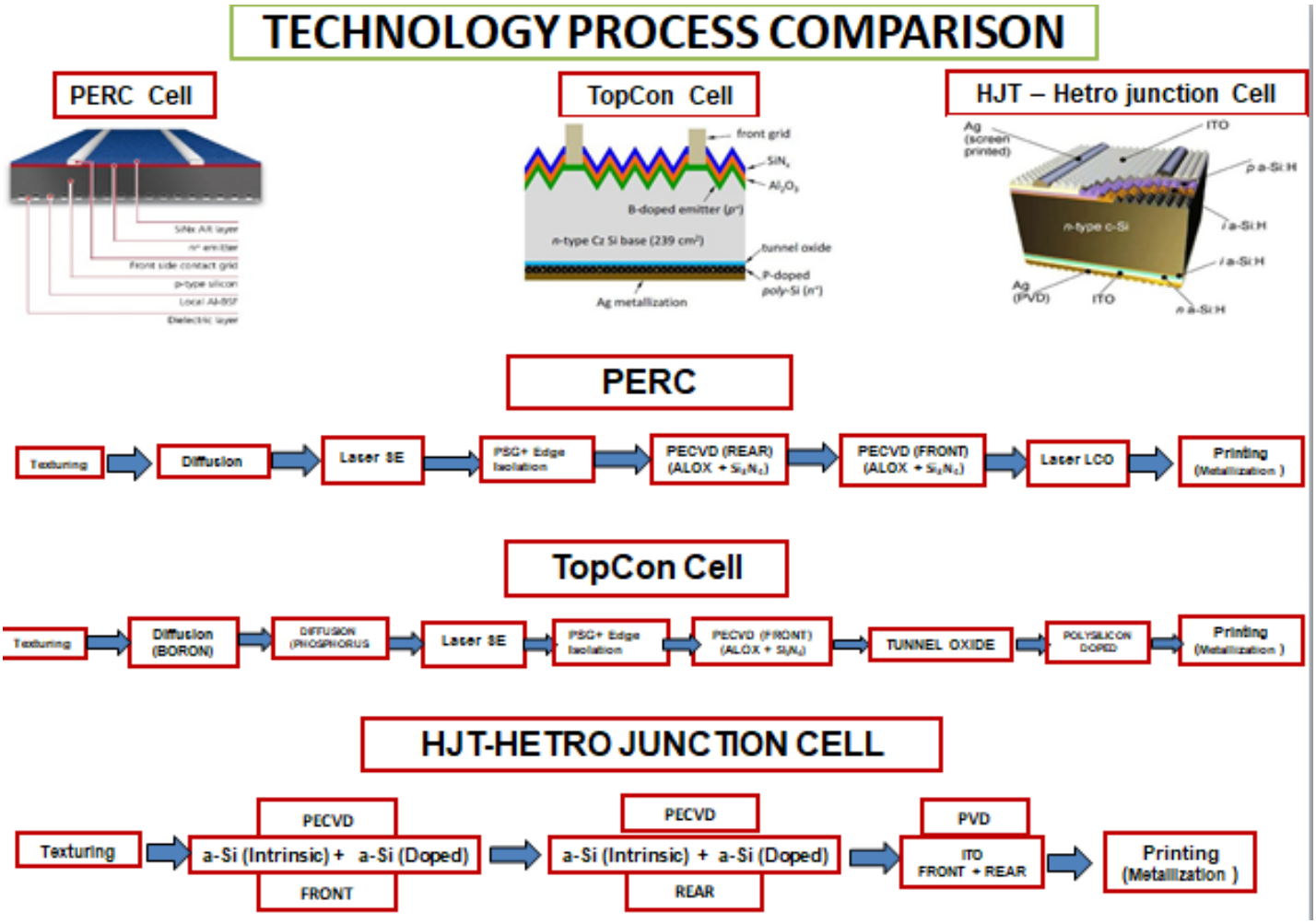
HJT FOR SOLAR CELL MANUFACTURING IS SIMPLER

If one looks at the historical evolution of c-Si solar cell manufacturing technologies, it could be seen that it has not been quite smooth like in semiconductor or Integrated Circuits or "Chip" manufacturing. Though the first silicon solar cell was invented in Bell Labs, NJ, USA on 25th April 1954 with 6% efficiency, it took more than 50 years (2005-06) for it being produced in large scale in efficiencies in the range of 14-15% on multi-crystalline silicon substrate. Contrary to it silicon transistor being invented in Dec. 1947, again in Bell labs, the technological evolution in that area has changed the face of the world completely and today it is so pervasive that no field of life can be imagined functioning without chips.

Multi-crystalline technologies have ruled the industry for almost a decade, though the scale of production had gone from few giga watts to more than 100 GW during that period. However, come 2015-16-time frame, cell manufacturing technology started moving at reasonably good speed. It has moved from multi to monocrystalline, from Al-BSF to PERC, from mono-facial to Bi-facial, 156mmsq to 210mmsq and now set to move to TOPCon in traditional homogeneous emitter junction technology. This promises to take the industry beyond 26% efficiency.

In the meanwhile, Hetro-Junction Technology(HJT), which is combination of c-Si and Si-thin film technology, has been making great strides in the last 2-3 years. China has already set up 10+ GW manufacturing capacity in this period.

The process technology comparison of HJT with PERC and TOPCon is given in the following figure:



What makes attractive this technology is only four steps of processing at low temperature compared to PERC and TOPCon which involve more than 8-9 process steps and various high temperature thermal processes. HJT is generally considered a difficult technology, because of yield issue. The initial capital invest is also higher compared to PERC but may not be that high if compared with TOPCon. As scale of production in this technology is growing very fast, it is matter of time that all issues related to yield will be solved and cost of investment also will go down.

HJT FOR SOLAR CELL MANUFACTURING IS SIMPLER

It may be noted that Texturing, PECVD and Printing process with certain variations are common with PERC and TOPCon processes and can be mastered very easily for HJT process engineers. Only different process is Physical Vapour Deposition (PVD) process which is required for TCO layers.

It may be recalled that Sanyo, Japan long time back mastered this technology under the patented name of Hetro-junction With Thin Intrinsic Silicon layer(HIT) and due to their patent this technology has lagged behind the PERC technology.

Discounting the fear of unknown, this technology can be adopted by Indian manufacturers as it is not very difficult to master. The cost of conversion from wafer to cell including depreciation is going to be less that PERC/TOPCon. So investors going for HJT will be finally winner on three counts:

1. High Efficiency- No upgradability required in future to be competitive
2. Lower coefficient of temperature for Pmax degradation
3. Low COC

Dr. D.N. Singh
Chief Executive Officer

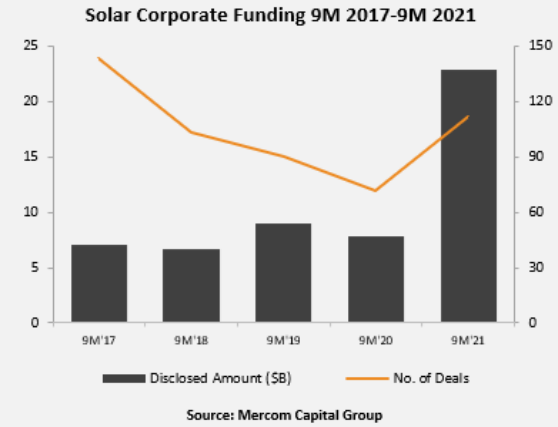
PLI LIST OF SUCCESSFUL BIDDERS

Sl.No	Organization ID	Capacity of Project (minimum 1000 MW)	Stages	PLI Quoted (In Crores)	Status
1	ETS-IN-2021-RS0000011 (SHIRDI SAI ELECTRICALS LIMITED)	4000	Stage 1 + Stage 2 + Stage 3 + Stage 4	1875	L2
2	ETS-IN-2021-RS0000112 (Reliance New Energy Solar Limited)	4000	Stage 1 + Stage 2 + Stage 3 + Stage 4	1917	L3
3	ETS-IN-2021-RS0000244 (Jindal India Solar Energy Limited)	4000	Stage 1 + Stage 2 + Stage 3 + Stage 4	1390	L1
4	ETS-IN-2021-RS0000247 (ADANI INFRASTRUCTURE PRIVATE LIMITED)	4000	Stage 1 + Stage 2 + Stage 3 + Stage 4	3600	L4
5	ETS-IN-2021-RS0000130 (FS INDIA SOLAR VENTURES PRIVATE LIMITED)	3009	Stage 1 + Stage 2 + Stage 3 + Stage 4	1752.6	L5
6	ETS-IN-2021-RS0000190 (Larsen & Toubro Limited)	4000	Stage 2 + Stage 3 + Stage 4	1360	L7
7	ETS-IN-2021-RS0000236 (Renew Solar (Shakti Four) Private Limited)	4000	Stage 2 + Stage 3 + Stage 4	1950	L8
8	ETS-IN-2021-RS0000252 (Coal India Limited)	4000	Stage 2 + Stage 3 + Stage 4	1340	L6
9	ETS-US-2021-RS0000229 (CubicPV Inc.)	1000	Stage 2 + Stage 3 + Stage 4	NA	
10	ETS-IN-2019-RS0000017 (TATA power solar systems ltd)	4000	Stage 3 + Stage 4	1500	L9
11	ETS-IN-2019-RS0000021 (Waaree Energies Ltd)	4000	Stage 3 + Stage 4	2340	L10
12	ETS-IN-2019-RS0000010 (VIKRAM SOLAR LIMITED)	3600	Stage 3 + Stage 4	1285	L11
13	ETS-IN-2021-RS0000139 (Avaada Ventures Private Limited)	3000	Stage 3 + Stage 4	878	L12
14	ETS-IN-2019-RS0000343 (PREMIER ENERGIES LTD)	2000	Stage 3 + Stage 4	499	L14
15	ETS-IN-2021-RS0000227 (Megha Engineering and Infrastructures Limited)	2000	Stage 3 + Stage 4	333	L13
16	ETS-IN-2021-RS0000246 (ACME ECO CLEAN ENERGY PRIVATE LIMITED)	2000	Stage 3 + Stage 4	625	L15
17	ETS-IN-2021-RS0000133 (Jupiter International Limited)	1200	Stage 3 + Stage 4	NA	
18	ETS-IN-2021-RS0000087 (EMMVEE PHOTOVOLTAIC POWER PRIVATE LIMITED)	1000	Stage 3 + Stage 4	349	L16

Corporate Funding for Solar Up 190% YoY With $22.8 Billion in 9M 2021

In the third quarter (Q3) of 2021, global VC funding in the solar sector was $593 million in 13 deals, a 224% increase compared to $183 million in 15 deals in Q3 2020. However, quarter-over-quarter, VC funding decreased 2% compared to $608 million in 12 deals in Q2 2021.

The solar sector raised $2.2 billion in VC funding through 39 deals in 9M 2021, a 446% increase compared to $394 million in 29 deals in the same period last year.



Some of the top VC deals in 9M 2021 included $800 million raised by Loanpal, $250 million raised by Aurora Solar, $240 million raised by Nexamp, $127 million raised by Intersect Power, and $125 million raised by Fourth Partner Energy.

NTPC Renewables Invites Expressions of Interest for Sourcing 15 GW of Solar Modules

NTPC Renewables, a wholly-owned subsidiary of NTPC Limited, has invited expressions of interest (EoI) to form strategic tie-ups for sourcing solar modules for a total capacity of 15 GW over a period of five years.

The sourced modules can have cells either manufactured domestically or sourced from anywhere in the world.

The purpose of the EoI is to evaluate the upcoming capacities of domestic solar module manufacturers, their techno-commercial requirements to initiate the process of long-term sourcing tie-ups.

The last date to submit the bids is November 8, 2021, and bids will be opened on November 9.

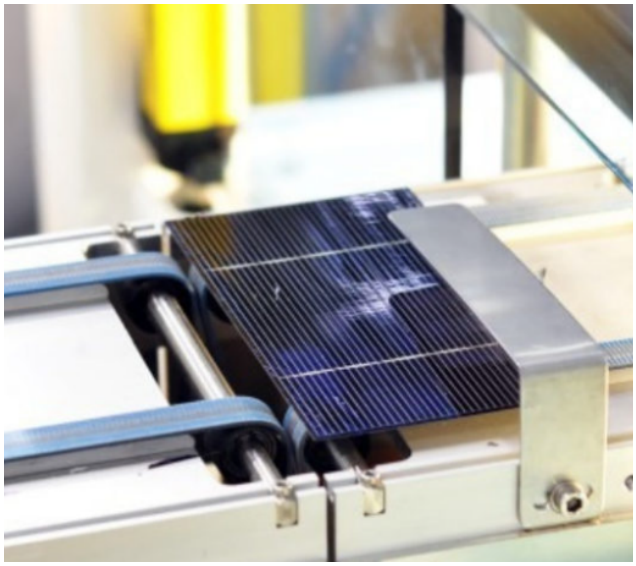
Rajasthan is Now the Top Solar State in India With 8.2 GW of Installed Capacity

Rajasthan is now the top state in solar installations overtaking Karnataka at the end of the third quarter of the calendar year (CY) 2021. At the end of September, the total solar installations in the state stood at 8.2 GW, out of which utility-scale projects accounted for 7.65 GW and rooftop installations accounted for 543 MW.

According to Mercom's India Solar Project Tracker, the cumulative installations in Karnataka at the end of September stood at 7.7 GW. Of this, large-scale projects accounted for 7.4 GW.

In 1H 2021, Rajasthan contributed to about 35% of large-scale installations with 1.2 GW of capacity installed.

Tender Issued for 7.1 million Multicrystalline Silicon Solar Wafers



Bharat Heavy Electricals Limited (BHEL) has invited bids for procuring 7.1 million 158.75 mm diamond wire saw (DWS) multicrystalline silicon solar wafers.

The last date to submit bids is November 8, 2021. The bids will be opened on the same day.

Bidders are not needed to furnish any earnest money deposit. However, for a contract value above ₹2.5 million (~$33,395), the successful bidder must submit 10% of the contract value as a performance guarantee within ten days from the date of issuance of the letter of award.

The wafers should be free from surface stains, watermarks, chips, pinholes, and breakages.

Tata Power to Jointly Develop 41 MW of Solar Projects With Tata Steel in Jharkhand and Odisha

Tata Power and Tata Steel have joined hands to develop grid-connected solar projects in Jharkhand and Odisha.

The companies have signed a 25-year power purchase agreement to develop 41 MW solar projects, including rooftop, floating, and ground-mounted. For Tata Steel, Tata Power will construct 21.97 MW of solar capacity in Jamshedpur, Jharkhand, and 19.22 MW in Kalinganagar, Odisha.

At Jamshedpur, Tata Power is expected to develop 7.57 MW of rooftop solar capacity, 10.8 MW of floating solar, and 3.6 MW of ground-mounted solar projects. The ground-mounted solar project will be installed at Sonari Airport, Jamshedpur. At Kalinganagar, Tata Power will develop 9.12 MW of rooftop solar capacity and 10.10 MW of floating solar projects.

Maharashtra Floats Tender for 444 MW of Solar Projects Under KUSUM Program

The Maharashtra State Electricity Distribution Company Limited (MSEDCL) has invited bids for 444 MW of decentralized solar projects of 500 kW to 2 MW capacity under component A of the Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) program in Maharashtra.

The estimated cost of the project is ₹15.54 billion (~$207.6 million).

The last date to submit the bids is November 23, 2021. The pre-bid meeting will take place on November 9.

Bidders will have to submit an earnest money deposit of ₹100,000 (~$1,336)/MW per project. The successful bidder must submit ₹500,000 (~$6,683)/MW as a performance bank guarantee within 30 days from issuing the letter of award.

NEWS UPDATE

BERGEN

Rate Contract Tender Issued for Manufacturing 10,000 Polycrystalline Solar Modules

Rajasthan Electronics and Instruments Limited (REIL), a joint venture between the government of India and the government of Rajasthan, has invited bids for rate contract manufacturing of 10,000 polycrystalline solar modules of wattage capacity greater than 330 Wp made from 72 polycrystalline solar cells.

The last date to submit the bids is November 8, 2021. Bids will be opened on November 9.

The tender is open for only Indian module manufacturers, and the bidder should specify that the cells have been procured from an Indian manufacturer or a foreign manufacturer.

The total quantity is to be supplied within three months from the date of the issuance of the purchase order.

West Bengal Sets Feed-in-Tariff of ₹3.20/kWh for Solar Projects up to 5 MW Capacity

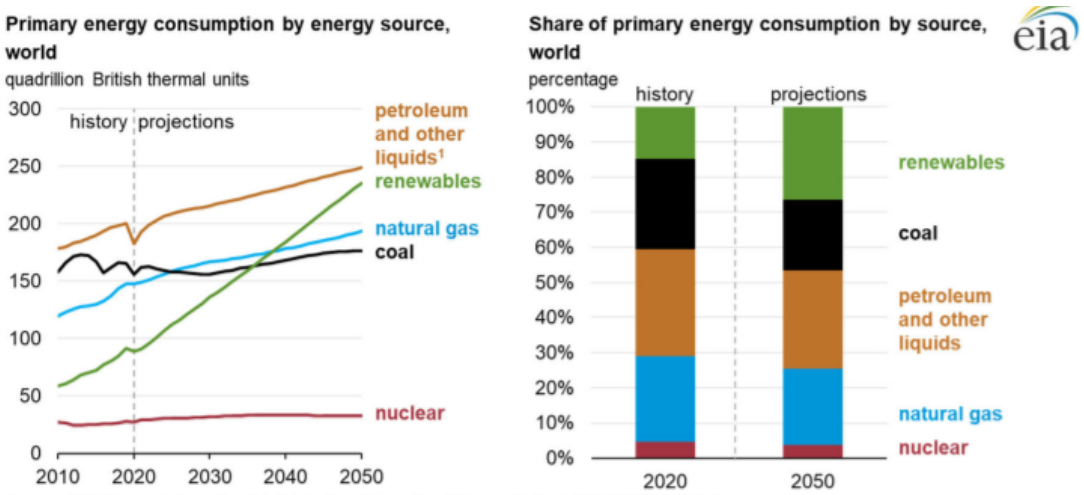
The West Bengal Electricity Regulatory Commission (WBERC) has set a feed-in tariff of ₹3.20 (~$0.042)/kWh for solar projects below 5 MW capacity. The feed-in tariff will be reviewed annually.

In another order, the Commission extended the date for the net metering arrangement for projects up to 5 kW until December 31, 2021. Earlier, the Commission had ruled that consumers who installed solar photovoltaic systems before June 30, 2021, would be eligible for the net metering facility.

Renewables to Be the Primary Source for New Electricity Generation in 2050

The U.S. Energy Information Administration's (EIA) latest International Energy Outlook 2021 report suggests that if current policy and technology trends continue, global energy consumption and energy-related carbon dioxide emissions will increase through 2050 due to population and economic growth.

The report finds that renewables will be the primary source for new electricity generation in 2050. However, natural gas, coal, and batteries will meet load and support grid reliability. Oil and natural gas production will continue to grow, mainly to support increasing energy consumption in developing Asian economies.



Source: U.S. Energy Information Administration, *International Energy Outlook 2021* (IEO2021) Reference case

¹ includes biofuels

Reliance's REC Acquisition Could Reduce Indian Solar Developers' Dependence on Imports

Solar developers and module manufacturers believe Reliance Group's recent solar acquisitions will help India provide an alternative to Chinese products.

In June 2021, Mukesh Ambani, Chairman of Reliance Industries, announced that Reliance Industries would invest ₹750 billion (~$10 billion) in clean energy. The company said it would build an integrated solar photovoltaic (PV) factory, advanced energy storage battery manufacturing unit, green hydrogen, and fuel cell facility in Jamnagar, Gujarat.

Mercom spoke with solar developers and module manufacturers to understand the strategic importance of Reliance's recent acquisitions and their impact on the Indian solar market.

MNRE Brings Down Benchmark Costs for Off-grid Solar Systems for FY 2021-22

The Ministry of New and Renewable Energy (MNRE) has issued a downward revision of benchmark costs excluding taxes for decentralized and off-grid solar systems for the financial year (FY) 2021-22.

In August this year, MNRE issued the benchmark costs for FY 2021-22. Subsequently, the Goods and Services Tax (GST) Council revised the GST for solar energy applications and projects. The revision necessitated the change in benchmark costs for decentralized solar applications.

MNRE has stated that the applicable GST rates may be added to the benchmark costs for the purpose of central financial assistance (CFA).

The revised benchmark costs will be applicable from August 18, 2021 (date of the original order of the benchmark costs for FY 2021-22). The amended benchmark costs include the total cost of the system and its installations, commissioning, transportation, insurance, warranty, monitoring, and maintenance for five years.

Reliance Makes Open Offer for a 25.9% Public Shareholding in Sterling and Wilson Solar

Reliance New Energy Solar, the green energy arm of Reliance Industries Limited (RIL), has offered ₹375 (~$5)/share to acquire 49.14 million equity shares of Sterling and Wilson Solar for around ₹18.42 billion (~$245.58 million).

Sterling and Wilson Solar is a Mumbai-based solar engineering, procurement, and construction company and has a presence across 24 countries.

The 49.14 million shares account for a 25.9% equity stake or the entire public shareholding of Sterling and Wilson Solar.

MSEDCL Invites Bids to Procure Power from 1,250 MW of Solar Projects

The Maharashtra State Electricity Distribution Company Limited (MSEDCL) has invited bids to procure 1,250 MW of solar power from projects developed in various districts of Maharashtra.

The last date to submit the bids is November 25, 2021. The bids will be opened on the same day. The pre-bid meeting will take place on November 11.

The ceiling tariff for the tender has been set at ₹3.10 (~$0.041)/kWh.

Bidders will have to submit an amount of ₹100,000 (~$1,334)/MW of the quoted capacity as an earnest money deposit. The successful bidder will have to furnish an amount of ₹500,000 (~$6,672)/MW of the quoted capacity as a performance bank guarantee within 30 days from the issuance of the letter of award.

Energy Procured from a Captive Solar Project in West Bengal Allowed to Offset RPO in Odisha

The Odisha Electricity Regulatory Commission (OERC), in a recent order, ruled that the power generated from a 5 MW captive solar power project in West Bengal should be accounted and used for renewable purchase obligation (RPO) compliance for the petitioner's cement plant at Rajgangpur in Odisha starting from financial year (FY) 2019-20.

It also said that after accounting the generation for every year, the remaining RPO should be met by the surplus renewable energy certificates (RECs) available to the petitioner.

The Commission directed the Odisha Renewable Energy Development Agency (OREDA) to calculate the RPO compliance target of the petitioner's cement plant in Rajgangpur and verify the validity of the RECs. Only those RECS within the validity period would be allowed to carry forward to subsequent years.

Dalmia Cement (Bharat) had filed a petition seeking directions from OREDA regarding the carry forward of RECs and utilization of the solar power generated at the West Medinipur captive power project in West Bengal for RPO compliance of the cement plant at Rajgangpur in Odisha.

Energy Procured from a Captive Solar Project in West Bengal Allowed to Offset RPO in Odisha

Toyota Kirloskar Motor has achieved 100% renewable energy use from June 2021 at its manufacturing facility and eight on-site supplier companies. As a result, the company reduced 16,635 tons of carbon dioxide emissions. It gradually increased green energy procurement to meet its energy needs. It installed a rooftop solar system and ground-mount solar project at its manufacturing facility with a combined capacity of 8.2 MW and installations of an 18 MW solar park outside the company.

Union Minister of Power and New and Renewable Energy R K Singh launched a new market segment, Green Day Ahead Market (GDAM), for renewable energy. The minister said the launch of the green day-ahead market would provide competitive price signals, besides offering an opportunity to market participants to trade in green energy in a transparent, flexible, competitive, and efficient manner. The introduction of GDAM is expected to create a domino effect that will lead to a gradual shift from power purchase agreement-based contracts to market-based models.

Amp Energy announced that it is on track to install 100 MW of community solar projects across its northeastern territory by the end of this year, including wholly-owned community solar projects in New York state and its Massachusetts portfolio. The New York portfolio includes 11 solar projects with 75 MWdc and 27 MWh of battery storage capacity.

TECHNOLOGY UPDATE

BERGEN

BIFACIAL HETROJUNCTION

Characteristics: A crsytalline silicon wafer is sandwiched between doped and intrinsic amorphous silicon layers

	Topics	Status	Comments
Process	Influence on process sequence	✓✓✓	Though the process sequence is simple it deviates completely from the standard
	Additional process tools required	✓✓✓	Requires a completely different set of process tools
	Influence on passivation configuration	✓✓✓	A totally different passivation scheme is applied; HJT is in principle a passivated contacts approach
	Influence on metallization	✓✓✓	Requires a special metallization process that can support low temperature process
Production	Status of commercialization	✓✓	More than a dozen companies are evaluating the process at least in pilot stage and few are offering commercial products
	Avalability of production equipment	✓✓	The production solutions are available from turnkey to individual processing tools
	Additional costs	✓✓	Several solution providers are showing that the LCOE is much lower compared to PERC; the conversion costs are high due to high capex and opex
	Challenges	✓	Supply chain is not robust yet; requires completely optimized metallization; high temperature sensitivity
Performance	Highest cell efficiency	24.90%	Hanergy attained 25.11% efficiency end of 2019
	Average cell efficiency in production	24.0%	Several manufacturers incl. REC, GS-Solar, Jinergy and several other claim to have attained 24% efficiency in production
	Bifaciality today / potential	80%	Several companies have attained bifaciality above 90%
	Top commercial bifacial solar module power	615 W	Jinergy, among the first to upgrade to larger wafer size with HJT, in this case to M6, is currently offering the most powerful HJT module

Note: All comparisions are referred to PERC as base line.

Source: © TaiyangNews 2021

Legend: ✓ Low negative impact; ✓ Medium negative impact; ✓✓✓ High negative impact; ✓ Low positive impact; ✓✓ Medium Positive impact; ✓✓✓ High positive impact; ✗ No impact;

Highest bifaciality: Like other n-type technologies, HJT is naturally bifacial, but its bifaciality of about 90% scores higher than its peers, in fact it is the highest among all cell technologies.

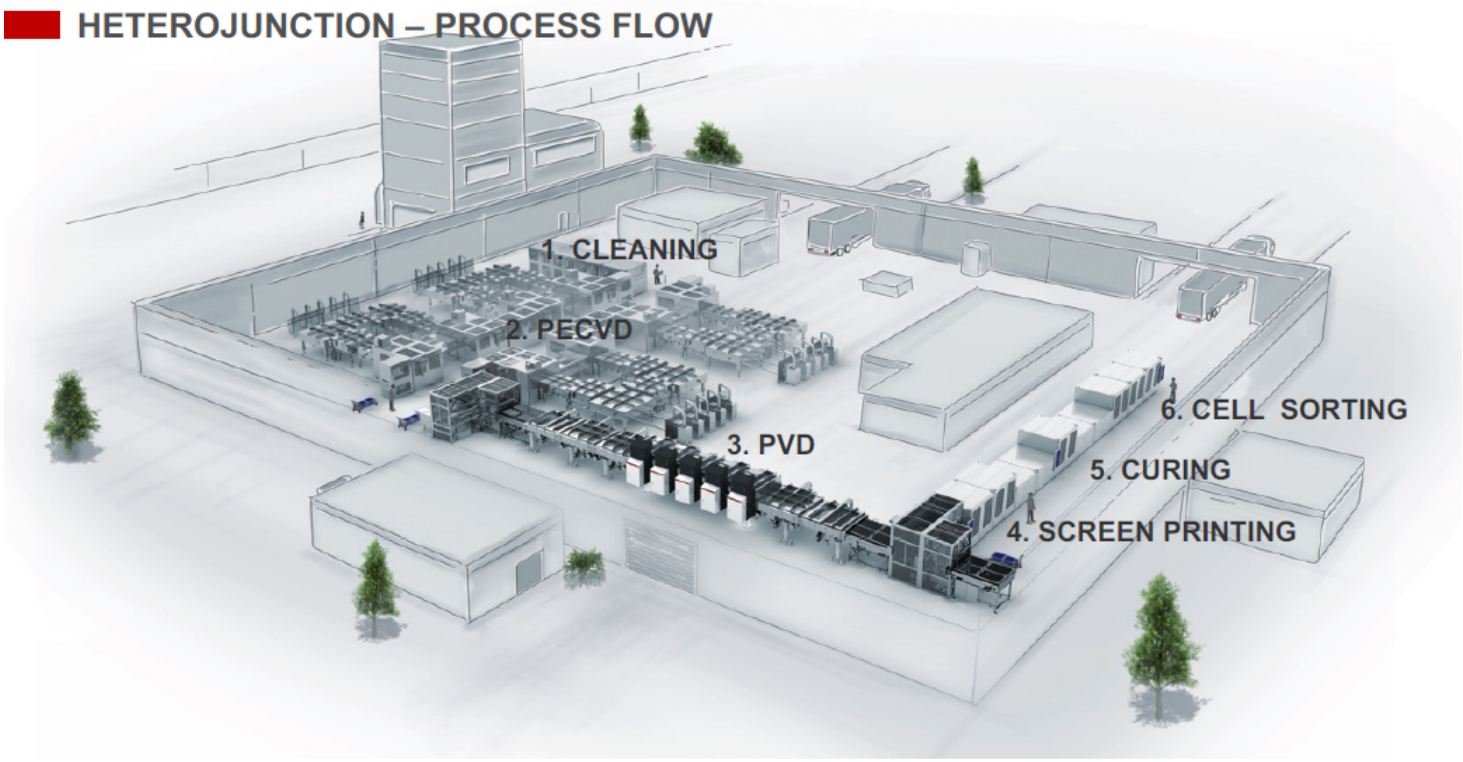
Sourve: ITRPV, 2021

PRODUCT UPDATE

BERGEN

Hetro Junction Technology

Advantages



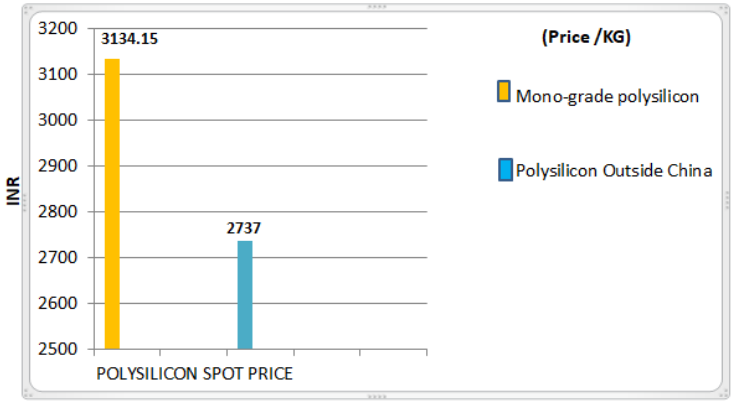
- ☐ **TARGET TO INCREASE THE OFF-THE-SHELF MODULES TO MORE THAN 24 PER CENT**
- ☐ **EXTREMELY THIN = HIGHLY FLEXIBLE + LOWER COSTS @ HIGHER EFFICIENCIES**
  - High efficiency is possible even with a thickness of just 100 micrometres,
  - high flexibility also means they can withstand snow loads better and are less susceptible to microcracks during transport
- ☐ **NO LIGHT-INDUCED DEGRADATION (LID) AND NO POTENTIAL-INDUCED DEGRADATION (PID)**
  - The LID effect, which can lead to a loss of efficiency of up to 3%, is minimised because n-type wafers are used for heterojunction cells,
  - The PID effect is minimised, because the cell is electrically protected like in a Faraday cage and efficiency losses of up to 2% are prevented
- ☐ **SIGNIFICANTLY LOWER TEMPERATURE COEFFICIENT (-0,25%/K)**
  - HJT cells achieve 8% higher efficiency at high temperatures than conventional silicon solar cells

MARKET ANALYSIS

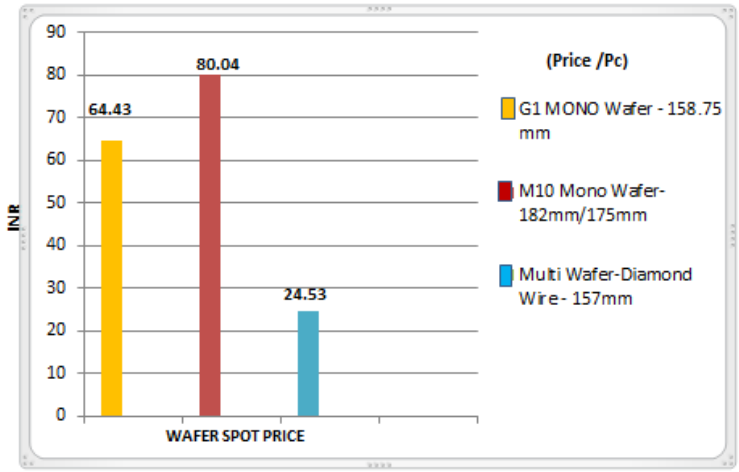
BERGEN

Price update

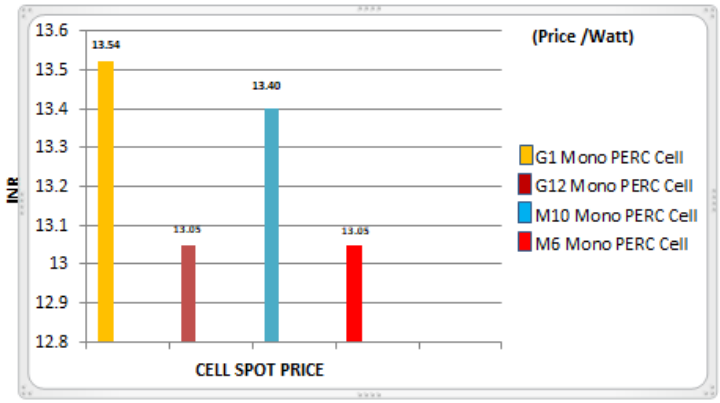
Polysilicon Spot Price Update



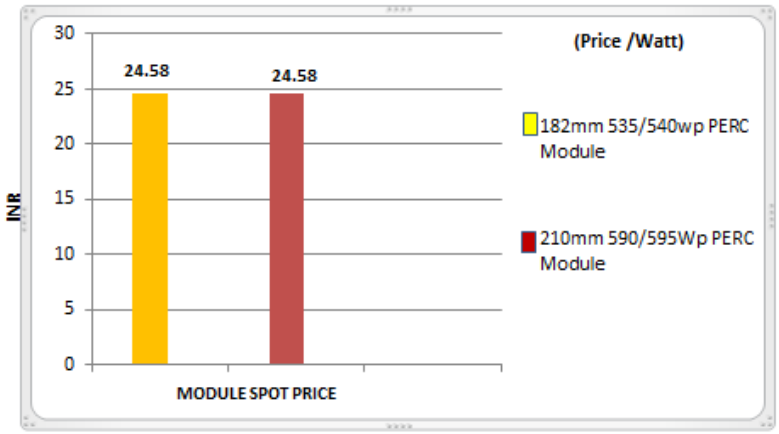
Wafer Spot Market Price Update - Multi SI/Mono G1M6



Cell Spot Market Price Update - Multi/Mono/PERC



Module Spot Price Update - Multi/Mono



Source: Energy Trend

EDITORIAL TEAM

Rajinder Kumar Kaura
CMD

With nearly 43 years of contributions in conventional and non conventional power and electronics field, he is pioneer and pathfinder in developing solar & electronic industry in India. His contributions in bridging he gap in standards of living between rural and urban population through generation of solar power and skill development has earned him tremendous respect and recognition by countries like Norway, Japan, Germany, etc. besides States and Central Organizations.

Dr. D.N. Singh
CEO

Dr. D.N. Singh is a one of the most prominent leaders in Solar PV and Semiconductor technology and widely known professional in India and abroad. He has a total of 46 years of experience in Industries, research and academia. He has published over 40 research papers in International and National journals. He has been invited speaker at PV Cell Tech and PV Module Tech international conferences. Dr. Singh is Vice President of Microelectronic Society of India, Member IEEE and Member of National Nano-Technology working group.

Dronveer Kaura
Director

After completion of academics from the Ohio State University, USA, he returned to India to share the knowledge gained in his academic and serve the nation. He founded and engaged himself and his team in Industrial Automation Projects to follow industry 4.0 standards and keep India intact and way forward in the state of art technology of Automation. Under his guidance and knowledge sharing, we could develop a efficient solution for Robot Automation in the field of automobile to boost per day production. He is currently pursuing PhD in Hydrogen Fuels & Technology.

S.K. Kaul
Vice President

Having more than 38 years of experience in the field of Manufacturing, Operation, Material Management & Factory Administration and looking after complete solutions & supply of Capital Equipment technology for the manufacturing of Printed Circuit Boards, Electronic Assemblies, Photovoltaic Cells & Photovoltaic Modules and undertaking the turnkey installation of the solar based power projects.