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RENEWABLE ENERGY REFRESHER

BERGEN GROUP NEWS LETTER



Human resource crisis in upcoming Indian PV industry

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Indian PV industry is all set to take a big leap in building supply chain in this sector locally. Two big triggers, one the imposition of Basic Custom Duty of 25% on cell and 40 % on modules from April 2022, second the PLI scheme, have created an excitement in the sector and have attracted intensions for investment for building above 50 GW supply chain. So, it is expected that in coming three years minimum 40GW cell and module lines will be set up in India. It is also expected that 80-100K ton/ annum capacities for polysilicon and wafer production will be set up during this period. This is going to bring paradigm shift in PV ecosystem of India.

Building supply chain locally in PV sector was overdue and necessary, however, for this very ambitious plan to be successful, inter alia it is imperative to give attention to very critical element of Human resources required for running these enterprises.

As per thumb rule of 1.5 skilled (Engineers, diploma holders and technicians) manpower per MW of production across the value chain, around 60-70 thousand trained persons will be required. Presently in India cell production capacity is about 3 GW and module production capacity is about 12GW whereas polysilicon and wafer manufacturing capacities are zero. So, a rough estimate of total skilled manpower available in Indian PV sector would be not more than 4-5 thousand. Number of experienced engineers is not more than 3-4 hundred. For complete PV supply chain, we need engineers and scientists to run production, facilities, maintenance, process engineering, technology, and R&D.

It is, therefore, imperative to address this issue in advance and make plans to feed the upcoming PV manufacturing with appropriate skilled manpower on urgent basis. Academic institutions should be roped in for this and be actively involved, however, these institutions will first require having enough trained teachers for this, so there is also need to train the trainers.

Bergen associates, who have been pioneering the establishment of cell and module manufacturing lines in the country by bringing technologies and equipment from their principals from USA, Europe, and China since last two decades, can play an important role in this endeavour as they have acquired enough knowledge and experience across the PV value chain over this period.

Bergen can train the trainer, conduct in-house on-the floor training programmes in the factories, can provide course contents, and can bring awareness through in-house seminars.

Rajinder Kumar Kaura

Chairman and Managing Director

Technology Upgradation Issues

In coming 3-4 years India will be adding above 40GW of cell manufacturing capacities against its present capacity of about 3GW. Out of this present capacity of 3GW, only 250MW capacity is in P-Mono PERC - Selective Emitter- Bifacial technology, rest is all in P- Multi-crystalline AIBSF technology which will be obsolete in coming 1-2 years timeframe. The existing Multi lines could be upgraded to Mono- PERC lines by replacing texturing from Multi- to Mono and adding Aluminium Oxide (Alox) deposition equipment (PECVD) and Laser Contact Opening (LCO) equipment. Other equipment can be used but difficulties is all these lines are suitable for wafers only up to 158.75 square mm size which will also be obsolete in 1-2 years, so in all probability these existing Multi lines have to be discarded.

Now coming to new lines going to be set up, the technology choices are two:

- 1.P- MONO- PERC
- 2.HJT

P- Mono-PERC with Selective Emitter (SE) technology can take the average efficiency of cell maximum up to 23% and bifaciality up to 70% where as HJT can give average cell efficiency of 24% to start with and can go up to 27% with intensive process engineering on the same line without changing the line significantly. Bifaciality in this technology is >90%. It is, therefore, obvious that lines which will be set up with P- Mono- PERC technology will require upgradation to next generation Tunnel-Oxide- Passivated- Contact (TOPCon) technology to compete with HJT in future.

In HJT approach, initial cost of investment is higher compared to Mono- PERC technology by more than 60-70% and technology challenges are more as this technology is still not a large install base technology (current capacity in 9-10 GW but planned capacities are up to 132 GW mainly in China).

P- Mono- PERC technology can be upgraded to TOPCon by adding equipment for growing thermal thin silicon dioxide and amorphous/ polysilicon layer with p or n type doping provisions. These processes are currently being carried out by Low Pressure Chemical Vapour Deposition (LPCVD) furnaces. These could be also done by PECVD or PVD processes. Another major change in TOPCon process is that it is N-Type - Mono process compared P- Mono - PERC, so another set of diffusion furnaces to dope boron to make emitter will be required in addition to existing furnaces for doping phosphorus (LP POCAL). LP POCAL furnaces still could be used for doping polysilicon layer in TOPCon process or could be used for annealing process.

So, upgradation of PERC technology to TOPCon will require further investment and will bring similar process challenges as in HJT as installation base of TOPCon is similar to HJT. It may be noted that PERC lines can not be upgraded to HJT lines.

H2GEMINI and Bergen bring another solution to PERC technology by way of introducing In-Line PECVD for Silicon Nitride and Alox deposition. These in-line PECVD can have built in capability to upgrade PERC to TOPCon by adding few more process chambers for silicon dioxide and amorphous/polysilicon layers. This option is worth considering, as it will save investment and time for upgradation.

Dr. D.N. Singh
Chief Executive Officer

Government to enhance funding under PLI for solar manufacturing to ₹24,000 cr, says R.K. Singh

The government will soon enhance the funding under the production linked incentive (PLI) scheme for the domestic solar cells and module manufacturing to ₹24,000 crore from the existing ₹4,500 crore to make India an exporting nation.

"We brought the PLI scheme [for solar cells and modules] worth ₹4,500 crore. We invited bids and we got 54,500 MW manufacturing capacity of solar equipment. We asked the government to sanction ₹19,000 crore more under the PLI, which was approved [in-principle]. Now we would have a PLI of ₹24,000 crore. We would be exporting solar equipment," Power and New & Renewable Energy Minister R.K. Singh told PTI.

The minister also informed that at present solar module manufacturing capacity in the country is 8,800 MW while the solar cell manufacturing capacity is 2,500 MW.

Cabinet approves Programme for Development of Semiconductors and Display Manufacturing Ecosystem in India

Following broad incentives have been approved for the development of semiconductors and display manufacturing ecosystem in India: Semiconductor Fabs and Display Fabs: The Scheme for Setting up of Semiconductor Fabs and Display Fabs in India shall extend fiscal support of up to 50% of project cost on pari-passu basis to applicants who are found eligible and have the technology as well as capacity to execute such highly capital intensive and resource incentive projects. Government of India will work closely with the State Governments establish High-Tech Clusters with requisite infrastructure in terms of land, semiconductor grade water, high quality power, logistics and research ecosystem to approve applications for setting up at least two greenfield Semiconductor Fabs and two Display Fabs in the country.

Semi-conductor Laboratory (SCL): Union Cabinet has also approved that Ministry of Electronics and Information Technology will take requisite steps for modernization and commercialization of Semi-conductor Laboratory (SCL). MeitY will explore the possibility for the Joint Venture of SCL with a commercial fab partner to modernize the brownfield fab facility

Compound Semiconductors / Silicon Photonics / Sensors (including MEMS) Fabs and Semiconductor ATMP / OSAT Units: The Scheme for Setting up of Compound Semiconductors / Silicon Photonics / Sensors (including MEMS) Fabs and Semiconductor ATMP / OSAT facilities in India shall extend fiscal support of 30% of capital expenditure to approved units. At least 15 such units of Compound Semiconductors and Semiconductor Packaging are expected to be established with Government support under this scheme.

Semiconductor Design Companies: The Design Linked Incentive (DLI) Scheme shall extend product design linked incentive of up to 50% of eligible expenditure and product deployment linked incentive of 6% - 4% on net sales for five years. Support will be provided to 100 domestic companies of semiconductor design for Integrated Circuits (ICs), Chipsets, System on Chips (SoCs), Systems & IP Cores and semiconductor linked design and facilitating the growth of not less than 20 such companies which can achieve turnover of more than Rs.1500 crore in the coming five years.

India Semiconductor Mission: In order to drive the long-term strategies for developing a sustainable semiconductors and display ecosystem, a specialized and independent "India Semiconductor Mission (ISM)" will be set up. The India Semiconductor Mission will be led by global experts in semiconductor and display industry. It will act as the nodal agency for efficient and smooth implementation of the schemes on Semiconductors and Display ecosystem.

Bucket-Share of Beneficiaries and Waiting List

Sr No	Bidder's Name	Marks for 'Extent of Integration'	Marks for 'Manufacturing Capacity in MW'	Total Marks	Bidder's Manufacturing Capacity in MW	Eligible Capacity (for PLI) in MW	PLI for 1st Year (in Crores)	PLI for 2nd Year (in Crores)	PLI for 3rd Year (in Crores)	PLI for 4th Year (in Crores)	PLI for 5th Year (in Crores)	Total PLI for Five Years (in Crores)
1	Jindal India Solar Energy Limited	50	50	100	4000	2000	389.20	333.60	278.00	222.40	166.80	1390.00
2	SHIRDI SAI ELECTRICALS LIMITED	50	50	100	4000	2000	525.00	450.00	375.00	300.00	225.00	1875.00
3	Reliance New Energy Solar Limited	50	50	100	4000	2000	450.00	495.00	441.00	351.00	180.00	1917.00 (1190.00)
4	ADANI INFRASTRUCTURE PRIVATE LIMITED	50	50	100	4000	2000	1008.00	864.00	720.00	576.00	432.00	3600.00
5	FS INDIA SOLAR VENTURES PRIVATE LIMITED	50	40	90	3009	1504	467.90	413.30	345.70	284.70	241.00	1752.60
6	Coal India Limited	35	50	85	4000	2000	353.00	312.00	274.00	225.00	176.00	1340.00
7	Larsen & Toubro Limited	35	50	85	4000	2000	380.80	326.40	272.00	217.60	163.20	1360.00
8	Renew Solar (Shakti Four) Private Limited	35	50	85	4000	2000	404.00	505.00	421.00	355.00	265.00	1950.00
9	TATA power solar systems ltd	20	50	70	4000	2000	420.00	360.00	300.00	240.00	180.00	1500.00
10	Waaree Energies Ltd	20	50	70	4000	2000	630.00	540.00	487.50	390.00	292.50	2340.00
11	VIKRAM SOLAR LIMITED	20	45	65	3600	1800	270.00	265.00	275.00	275.00	200.00	1285.00
12	Avaada Ventures Private Limited	20	40	60	3000	1500	147.83	193.78	205.77	181.79	148.83	878.00
13	Megha Engineering and Infrastructures Limited	20	30	50	2000	1000	65.00	90.00	90.00	60.00	28.00	333.00
14	PREMIER ENERGIES LTD	20	30	50	2000	1000	140.00	120.00	100.00	80.00	59.00	499.00
15	ACME ECO CLEAN ENERGY PRIVATE LIMITED	20	30	50	2000	1000	175.00	150.00	125.00	100.00	75.00	625.00
16	EMMVEE PHOTOVOLTAIC POWER PRIVATE LIMITED	20	20	40	1000	500	98.00	84.00	70.00	56.00	41.00	349.00

India's Installed Renewable Energy Capacity Including Hydro Crosses 150 GW: MNRE

India has crossed the 150 GW milestone of installed renewable energy capacity, including hydro, the Ministry of New and Renewable Energy (MNRE) has said in a tweet.

In August this year, MNRE announced that the country's installed renewable energy capacity, including large hydro, had touched 146 GW, and 100 GW excluding large hydro.

Meanwhile, Minister of New and Renewable Energy (MNRE) RK Singh told Rajya Sabha that India had installed 46.25 GW of grid-connected solar energy as of October 31, 2021.

In addition, 36.65 GW of solar projects are under various stages of implementation, and another 24.56 GW of capacity has been tendered. So, 107.46 GW of solar capacity has been installed or under various stages of implementation or tendering.

Indian Railways to Develop 71 MW of Solar Projects on its Vacant Land

Indian Railways plans to develop around 71.7 MW of solar projects on its unused vacant land. Of this, 50 MW of solar projects will be developed at Bhilai, Chhattisgarh, and 15 MW in Nagpur, Maharashtra. It will develop a 3 MW solar project at Raebareli, Uttar Pradesh, and a 2 MW solar capacity at Diwana, Haryana. It also plans to develop a 1.7 MW solar project at Bina, Madhya Pradesh.

Reliance New Energy Solar Limited, a wholly-owned subsidiary of Reliance Industries Limited, has completed the acquisition of 100% shareholding of REC Group from China National Bluestar. In October 2021, the company announced that it would acquire REC Solar Holdings for \$771 million. The acquisition is expected to help Reliance expand globally in key green energy markets, including in the U.S., Australia, Europe, and elsewhere in Asia.

Shirdi Sai Electricals Limited and Viridis iQ GmbH have signed a memorandum of understanding to develop a 4 GW vertically integrated module manufacturing facility. Under the production-linked incentive (PLI) program, the Indian Renewable Energy Development Agency awarded Shirdi Sai a PLI of ₹18.75 billion (~\$252 million) for a 4 GW solar module manufacturing capacity.

Bids Invited for 15 MW of Grid-Connected Solar Projects in West Bengal

The Durgapur Projects Limited (DPL), a government of West Bengal enterprise, has floated two tenders for 15 MW of grid-connected ground-mounted solar projects in Durgapur, on a turnkey basis.

In the first tender, bids have been invited for the design, engineering, manufacturing, supply, erection, testing, and commissioning of 7 MW of grid-connected ground-mounted solar power projects in the premises of DPL on a turnkey basis. The successful bidder will also have to provide five years of comprehensive project maintenance.

The projects will be developed on 23.5 acres of land opposite the administrative building of DPL. The last date to submit the bids is January 24, 2022. Bids will be opened on January 28.

Feasibility of Domestic Solar Manufacturing Initiative and Demand Visibility

The government is pushing for solar manufacturing in India with restrictive and enabling policies.

In April this year, the Union Cabinet approved the production-linked incentive (PLI) program for the 'National Program on High-Efficiency Solar PV (Photovoltaic) Modules' to achieve gigawatt-scale manufacturing with an outlay of ₹45 billion (~\$605 million).



In July this year, First Solar announced that it would invest \$684 million to set up a new, vertically integrated photovoltaic (PV) thin-film solar module manufacturing facility in India. Emmvee plans to set up a 3 GW solar cell and module facility in Bangalore. Adani, First Solar, and Emmvee have submitted their bids in the PLI program.

APTEL Asks DISCOM to Consider Carrying Cost With Solar Safeguard Duty Refund

The Appellate Tribunal for Electricity (APTEL) recently set aside an order of the Maharashtra Electricity Regulatory Commission (MERC) restricting compensation to two solar developers under the 'Change in Law' clause due to the imposition of safeguard duty.

The Tribunal directed MERC to pass a fresh order regarding the compensation for the additional cost incurred due to the imposition of the safeguard duty within six weeks.

APTEL also directed the state Commission to decide on the issue of 'carrying cost.'

Juniper Green Energy and its fully-owned subsidiary Nisagra Renewable Energy had filed applications with the Tribunal challenging the order passed by MERC on July 23, 2020.

The Commission had restricted the compensation claims of the developers for the increase in cost due to the imposition of safeguard duty for a limited capacity of solar modules as against the total direct current capacity.

Jinko Solar's Revenue Down Marginally Due to Drop in Solar Module Shipments

Chinese solar cell and module manufacturer Jinko Solar has reported a 2.3% year-over-year (YoY) decline in its total revenue for the third quarter (Q3) of 2021.

The total revenue declined to RMB 8.57 billion (~\$1.33 billion) from RMB 8.77 billion (~\$1.37 billion) in the same period last year. The revenues were reportedly affected by the decrease in the shipment of solar modules.

However, in Q3 2021, the company's revenue increased 8.1% quarter-over-quarter (QoQ) compared to RMB 7.93 billion (~1.24 billion) in the previous quarter.



Tender Floated for 200,000 Mono or Multicrystalline Solar Cells

The Rajasthan Electronics and Instruments Limited (REIL) has invited bids to supply 200,000 monocrystalline or multicrystalline silicon solar cells of 4.57 W.

The last date to submit the bids is December 23, 2021. Bids will be opened on the next day.

The tender is to supply five busbar monocrystalline or multicrystalline silicon solar cells. The cells must be in the dimension of $156 \times 156 \pm 1.0$ mm or $156.75 \times 156.75 \pm 1.0$ mm. The thickness of the solar cells must be 200 ± 20 μ m.

Bidders are not required to furnish any earnest money deposit (EMD) for this tender.



Growth of Domestic Solar Manufacturing Hindered by Global Supply Chain Disruptions



The Indian government has come up with several initiatives to encourage domestic solar manufacturing. In April this year, the Union Cabinet approved the production-linked incentive (PLI) program to push gigawatt-scale manufacturing of high-efficiency solar photovoltaic (PV) modules with an outlay of ₹45 billion (~\$605 million). The general perception is that this program is meant for the larger investors and will not help smaller manufacturers.

The program started off as a move to mitigate future global supply chain disruptions by establishing a robust domestic ecosystem for solar manufacturing. But now, the same supply chain disruptions are cramping the growth of the domestic industry.

BHEL Invites Bids to Procure Monocrystalline Modules for a Solar Project in Mauritius

Bharat Heavy Electricals Limited (BHEL) has issued an expression of interest (EoI) for the supply of monocrystalline solar photovoltaic (PV) modules under the domestic content requirement (DCR) category for an 8 MW solar project in Ebene, Mauritius.

The modules should have a power output between 360 W and 545 W in the 5 W band. Modules must be made from 72 cells in a 12*6 configuration or 144-cell (half-cut) in a 24*6 configuration.

The last date to submit bids is December 28, 2021. Bids will be opened on the same day.

Bidders do not have to furnish any earnest money deposit for this tender.

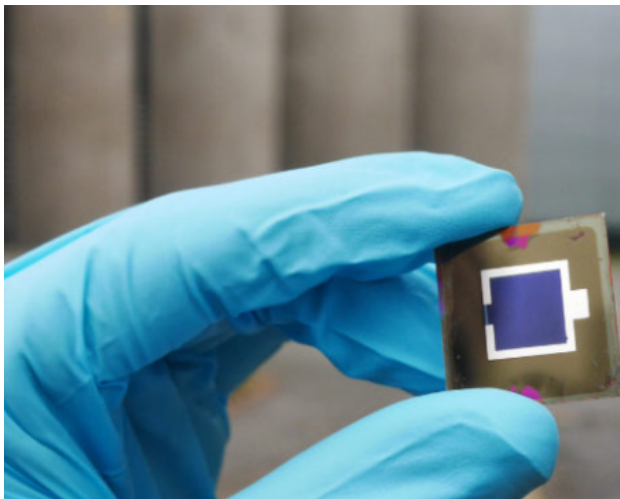
Germany to Phase out Coal, Boost Share of Renewable Energy to 80% by 2030

Two months after the general election in Germany, the Social Democrats (SPD), Alliance 90 (The Greens), and Free Democrats (FDP) have agreed on a coalition treaty that pledges that Germany will phase out coal-fired power generation by 2030.

The coalition partners also plan to increase the share of renewable energy to 80% by 2030. The coalition plans to introduce a program that will ensure that 2% of the country's land area is available to expand onshore wind energy and increase the capacities for offshore wind energy to at least 30 GW by 2030.

The coalition also said that it will ensure that the CO2 price in industrial production and electricity generation does not fall below €60 (~\$67.60) per ton of CO2. In addition, 50% of the heat will be generated in a climate-neutral manner by 2030. The coalition plans to roll out comprehensive municipal heating and expand heating networks with renewables.

Researchers Claim 29.8% Conversion Efficiency in Perovskite Silicon Tandem Solar Cell



Researchers from Helmholtz-Zentrum Berlin (HZB) have claimed to have set a new conversion efficiency record of 29.80% in a tandem solar cell made of perovskite and silicon. The result was certified by Fraunhofer ISE CaLab.

The researchers improved upon their earlier conversion efficiency record of 29.15%. They claim the results suggest that the conversion efficiency of perovskite silicon tandem solar cells could be increased to over 30% by nanostructuring the absorber layers on both sides.

"An efficiency of 30% is like a psychological limit for this fascinating new technology. That could revolutionize the photovoltaic industry soon," said Steve Albrecht, who examines the perovskite thin films in the HySPRINT innovation lab at HZB.

Solar Module Maker Central Electronics Sold to Nandal Finance for ₹2.10 Billion

The Union Government has approved the sale of the government-owned solar cell and module manufacturer Central Electronics Limited (CEL) to Nandal Finance and Leasing Private Limited for ₹2.10 billion (~\$28.02 million).

The Cabinet Committee on Economic Affairs (CCEA) approved Nandal Finance's highest bid of ₹2.10 billion (~\$28.02 million) for 100% sale of the Government of India's shareholding in CEL.

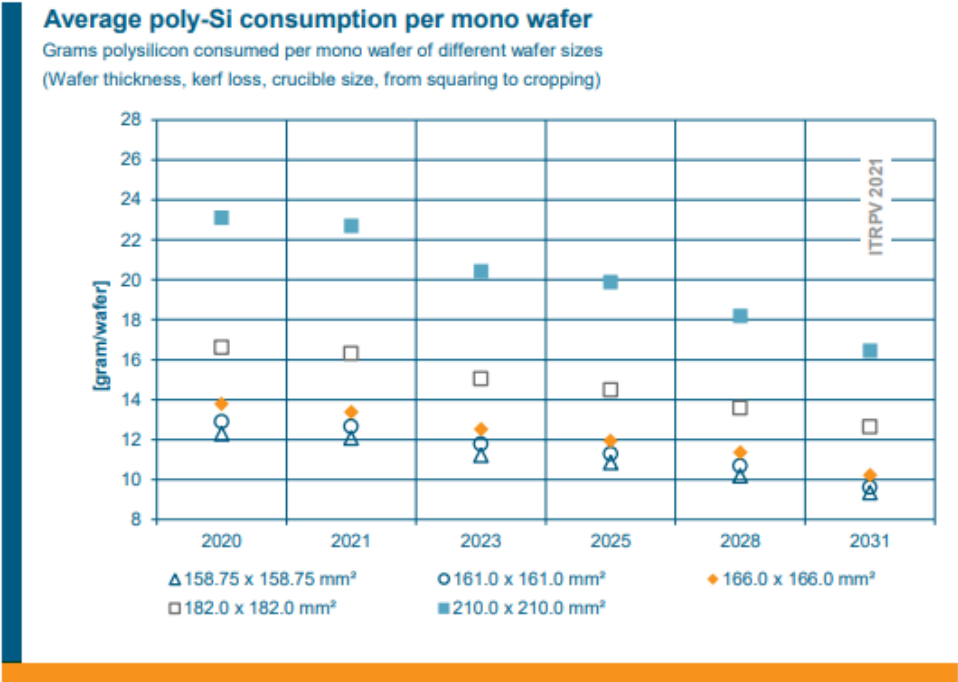
CEL is a central public sector enterprise under the administrative control of the Department of Scientific and Industrial Research, Ministry of Science and Technology. The company has a solar cell and module manufacturing capacity of 10 MW and 38 MW, respectively.

The process of disinvestment of CEL started in 2016. Bids were invited for its sale in May 2019. However, no financial bids were received.

TECHNOLOGY UPDATE

POLYSILICON

With close to 20% price share, poly-Si remains the most expensive material of a c-Si solar cells. Siemens and FBR (Fluidized Bed Reactor) processes remain the main technologies to produce poly-Si. Today, FBR processing has about 5% market share and we expect that its share will increase to 12% within the next 10 years against the well matured and further optimized Siemens process. Other technologies like umg-Si (upgraded metallurgical grade-Si) are not expected to yield significant cost advantages compared to matured poly-Si technologies over the coming years but are expected to stay available in the market.



The average utilization of poly-Si to produce silicon wafers. The weight of a 180 um 158.75 mm x 158.75 mm mono Si or mc-Si wafer is about 9.7 g. 12g or close to 125% of remaining Si was used in 2020 to produce a standard moni-Si wafers. We conclude that larger formats consume to a relatively lesser extend poly-Si per wafer. We expect that the poly-Si usage will be improved further during the next years.

PRODUCT UPDATE

PV Module Automatic Production Line



Stringer



Auto Layup Machine



Auto Bussing Machine



Auto Template Placing Machine



Auto Trimming Machine



EVA/TPT Cutting and Layup Machine



Auto Manipulator for Curing Line



Auto Framing and Glue Dispensing Machine



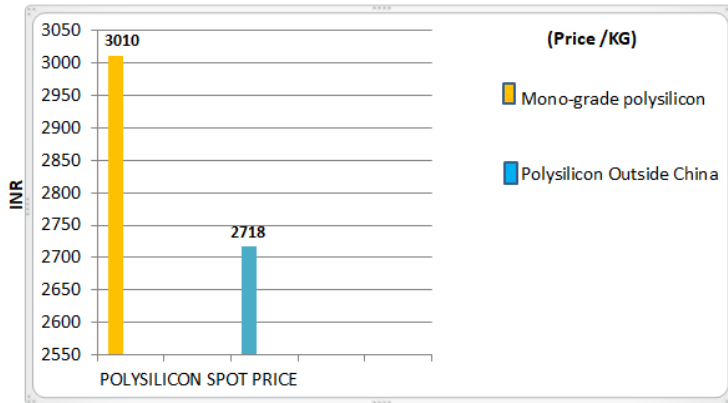
Auto Glass Loader

- ◆ High stability
- ◆ Online control
- ◆ Intelligent detection
- ◆ Quick response

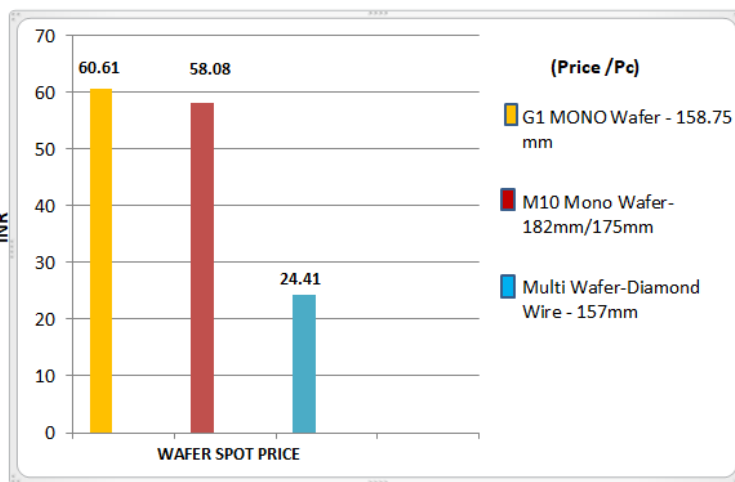
CONFIRMWARE
康奋威科技

Price update

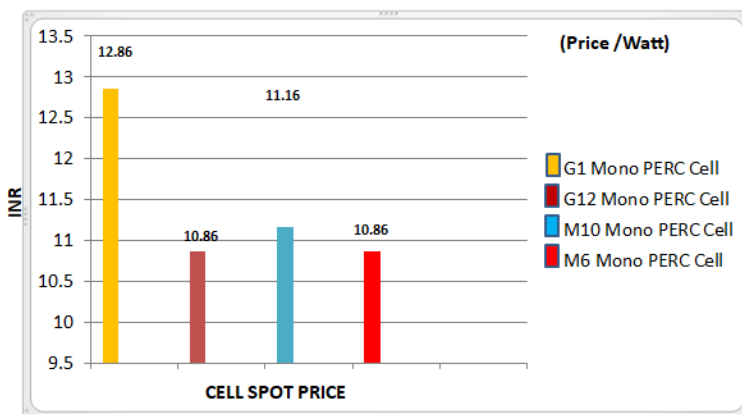
Polysilicon Spot Price Update



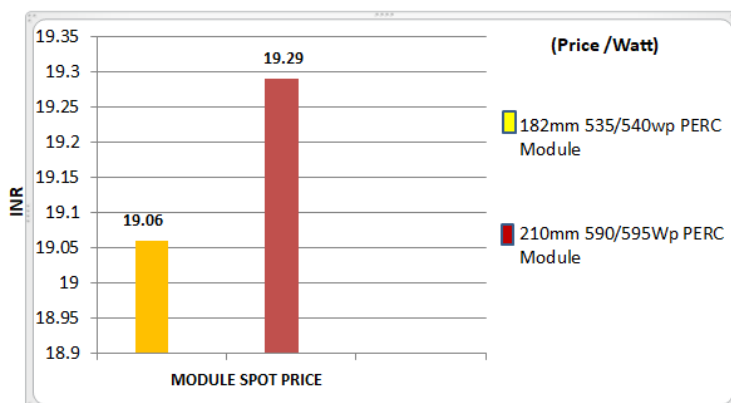
Wafer Spot Market Price Update - Multi SI/Mono G1M6



Cell Spot Market Price Update - Multi/Mono/PERC



Module Spot Price Update - Multi/Mono



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 the 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.