

JANUARY 2022, VOL 1

RENEWABLE ENERGY & SEMICONDUCTOR REFRESHER

BERGEN GROUP NEWS LETTER

CONTENTS

- Article by CMD
- Article By CEO
- News Update.
- Price Update
- Technology Update
- Product Update.

**HAPPY
New Year
2022**

Missing link in PV sector PLI scheme

THE CAPITAL EQUIPMENT

Year 2021 has been the happening year for PV sector in India. The most coveted scheme of Government of India (GOI) Production Linked Incentive (PLI) to make India "ATAM NIRBHAR" like other sectors has concluded with a bang attracting investment proposals for 54.8 GW manufacturing across the PV value chain against the invitation of 10 GW for Rs.4800 crore incentive. Proposals for 10GW have been selected for award of PLI, however, all proposals have been graded from L1 to L16 and there is good hope that all remaining qualified proposals will also be awarded as the news is that GOI has already approved additional Rs.19000 crore for the scheme.

As the PLI is to be given on the production of solar panels (modules), the final product of the PV value chain, so, to achieve this level of production, all the capital machinery have to be imported as there is zero production base in the country for the equipment required for manufacturing right from Polysilicon (Stage1) to Ingot/Wafer(Stage2) to Cell (Stage3) to Modules (Stage4).

Out of 54.8 GW production proposals, 16 GW is for all 4 stages which will require approximately Rs.40,000 crore of equipment. Another 15 GW is for from stage 2 to stage 4 which will cost capital machinery of about Rs.20,000 crore and remaining qualified proposals for 19 GW are for stage 2 and stage 3 which will require capital machinery of Rs.10,000crore. So, to set up the 50GW production facilities under the PLI scheme, Rs.70,000 crore worth capital machinery will require to be imported.

It can be expected that this production capacity will easily double in coming 10 years given the target of 500 GW of production of power form renewable by 2030. **It is, therefore, prudent to plan to build the production base of capital machinery as well in the country in coming 2-3 year.** GOI is pursuing very hard to build Semiconductor Chip manufacturing facilities in the country. Recently Ministry of Electronics and Information Technology (MEITY) announced 10 billion USD package for this sector. It may be noted that capital machinery for this sector also require to be imported at much higher cost than PV sector but is quite similar to those used for PV sector.

The subject of manufacturing capital machinery for high tech PV and Semiconductor sectors should, therefore, be given urgent attention. This segment should be heavily incentivised for setting up initial base by imported technologies and then should be supported by strong R&D. This is very appropriate time to do so as now our indigenous market itself is quite significant and there is no reason to believe that the capital machineries built in India will not be able to compete in the world market, once it is tried and tested in Indian market.

Rajinder Kumar Kaura

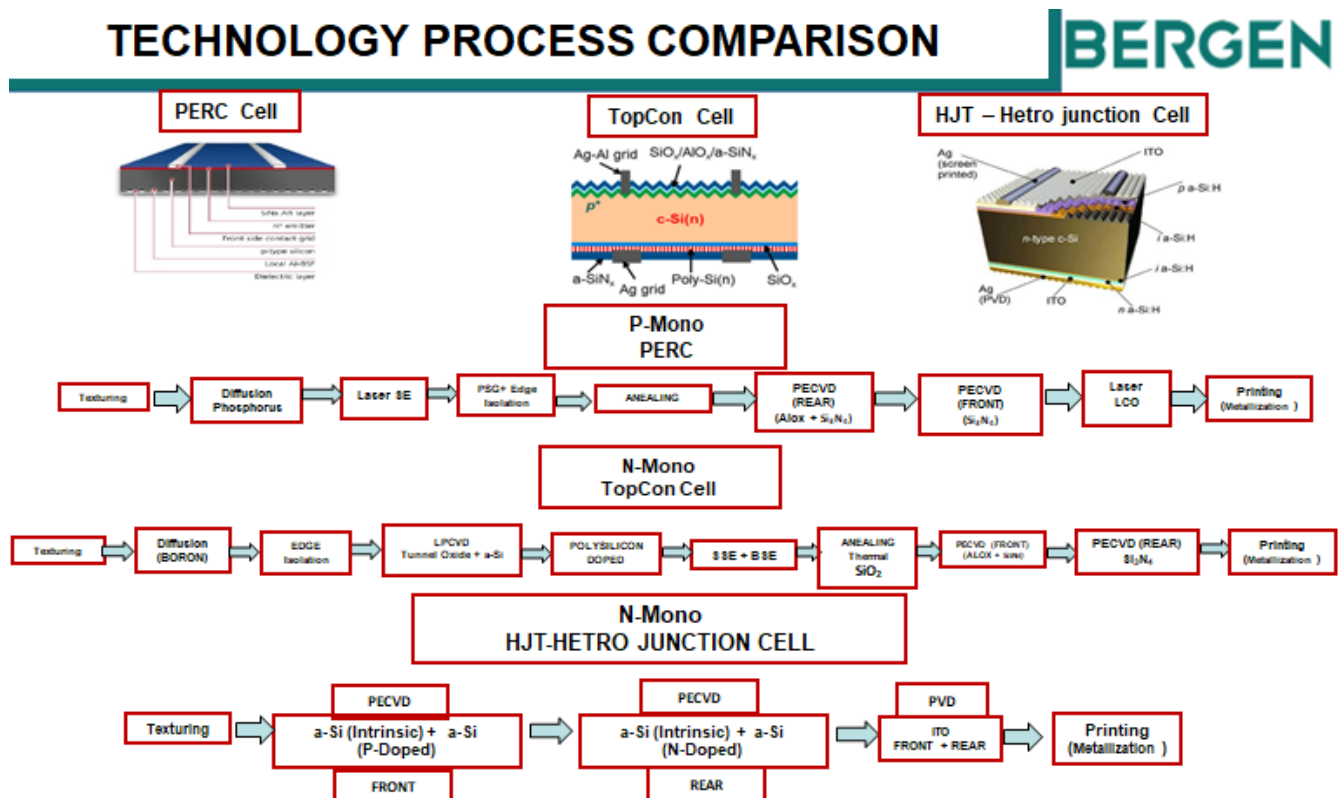
Chairman and Managing Director

Strategy for building Technology agnostic PV crystalline silicon solar cell manufacturing line

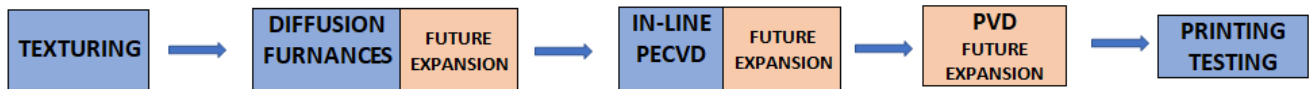
Today a new investor who wants to set up GW scale solar cell manufacturing facility, he has to first choose the technology which is less costly but at the same time should be such that it does not become obsolete in coming 2-3 years. As well known by now that choice for a mature technology at low investment is P-Mono PERC, however, this technology faces the risk of being obsolete in coming 2-3 years unless upgraded to N-Mono TOPCon technology sooner than later. Another choice is HJT for which initial investment for the same capacity as PERC is almost 1.6-1.8 times, but this is latest technology, though not as mature as PERC, and can not be obsolete for coming 6-8 years minimum.

So, a serious dilemma in front of the investors and technologists. Technologists will always try to opt for the latest whereas investors will prefer low investment upfront specifically the newcomers as is the case in India.

Under these circumstances a strategy can be built to configure the lines in such a way that initially it works for PERC, then gets upgraded to TOPCon and finally to HJT with minimum changes/ additions.



Taking into the account the process flows for all three technologies, the PERC line can be built with in-line PECVD which will be upgradable to TOPCon & HJT as follows:



PERC in-line PECVD will be initially configured for Rear Alox and Si₃N₄ and front Si₃N₄ with provision to add few additional process chambers. For TOPCon, addition will be one more furnace set for boron diffusion and one PECVD chamber for SiO₂ and a-Silicon. Rear Alox and Si₃N₄ will be used for front passivation and front Si₃N₄ will be used for Rear cap over polysilicon.

The same line can be upgraded to HJT by adding one more PECVD chamber for additional layer of a-Silicon and one PVD system for TCO. Diffusion furnaces could be used for annealing or curing purposes.

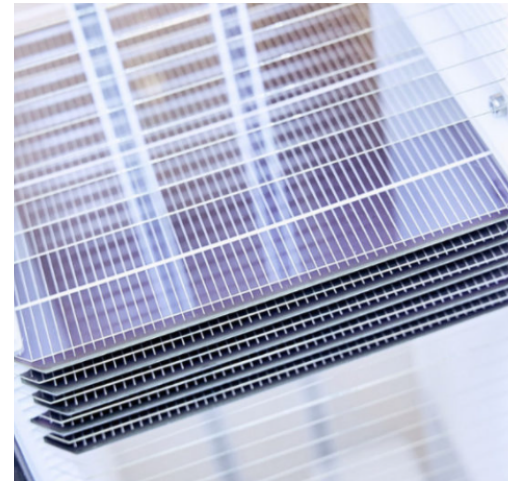
This concept is quite novel and being currently being developed by H2GEMINI and BERGEN. Details can be shared on request.

Dr. D.N Singh
Chief Executive Officer

Pairing Metal Halide Perovskites with Silicon Solar Cell Could Enhance Cell's Efficiency

Researchers at Oxford PV, an Oxford University spin-off company, have asserted that combining metal halide perovskites with conventional silicon could overcome the 26% efficiency limit of solar cells made with only silicon.

The researchers said that the addition of perovskites onto existing silicon photovoltaics is the fastest way to enhance the performance of silicon. Perovskites satisfied all optoelectronic requirements for a solar cell and could be manufactured with existing processes. These properties make perovskite perfect plug-and-play as it could be deposited as a layer onto a traditional silicon solar cell.



The auction discovered the second-lowest tariff in 2021. The previous low tariff in 2021 was ₹2.14 (~\$0.028)/kWh at the auction for 500 MW of projects at the Neemuch Solar Park in Madhya Pradesh.

Budget 2021 Allocates ₹45 Billion For High-Efficiency Solar Modules Manufacturing

The Union Budget 2021 has allocated exclusive funds to expand renewables, especially solar and green hydrogen. The Budget has elaborated on the production-linked incentive program to help the solar manufacturing sector grow over 10% on a sustainable basis.

The government has committed to providing about ₹1.97 trillion (~\$27.03 billion) over the next five years from the financial year 2021-22 to help bring scale and size to the solar photovoltaic (PV) manufacturing sector and generate new job opportunities. As a part of the commitment, ₹45 billion (~\$617 million) would be provided for high-efficiency solar PV modules manufacturing.

Under the program, integrated solar manufacturing facilities (from the manufacturing of wafer-ingot to high-efficiency modules) with a total capacity of 10 GW, with direct investments of around ₹140 billion (~\$1.92 billion), will be set up by the fourth quarter of 2022-23.

Power banking restrictions will curb open-access solar

New restrictions on the banking of power will inhibit the growth of the rooftop and open-access solar market, and potentially slow progress towards India's national target of 450 GW of installed renewable capacity by 2030, according to a new briefing note by the Institute for Energy Economics and Financial Analysis (IEEFA) and JMK Research.

Banking allows renewable energy generators to deposit surplus power into the grid and withdraw it later when needed – much like putting money into a savings account at a bank.

“Solar and wind projects are likely to produce excess energy during peak summer or windy seasons,” says co-author Jyoti Gulia, Founder of JMK Research. “Without a banking facility or with banking restricted to monthly rather than annual periods that excess generation is lost.”

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.

SECI's 1,785 MW Solar Auction Gets Lowest Tariff of ₹2.17/kWh



NTPC, Sprng Energy, UPC Renewables, Metka EGN Singapore Pte, ReNew Power, and ACME Solar were declared winners in the Solar Energy Corporation of India's (SECI) auction for 1,785 MW of solar power projects (Tranche IV) in Rajasthan.

NTPC Renewable Energy (NTPC Limited subsidiary) won a capacity of 500 MW, Sprng Energy Natural Power Source (a special purpose vehicle (SPV) of Sprng Energy) won 200 MW, Calpine Subsico Solar Energy (an SPV of UPC Renewables) 90 MW, and Metka EGN Singapore Pte 20 MW, each quoting ₹2.17 (~\$0.0289)/kWh. ReNew Solar Power won 600 MW, while ACME Solar, which had bid for the entire 1,785 MW of capacity, was allotted 375 MW. Both the companies quoted ₹2.18 (~\$0.02904)/kWh.

The auction discovered the second-lowest tariff in 2021. The previous low tariff in 2021 was ₹2.14 (~\$0.028)/kWh at the auction for 500 MW of projects at the Neemuch Solar Park in Madhya Pradesh.

Coal India Forms Subsidiaries for Solar Manufacturing and Renewable Energy Projects

Coal India Limited (CIL) has recently announced forming two wholly-owned subsidiaries for undertaking solar photovoltaic manufacturing and renewable energy projects.

While CIL Solar PV Limited has been incorporated for manufacturing in the solar value chain (ingot-wafer-cell-module), CIL Navikarniya Urja Limited has been formed for renewable energy projects, CIL said in a BSE filing.

In a green push, the state-owned company had earlier announced that it would invest ₹56.50 billion (\$763 million) by March 2024 to develop 14 solar projects to help power its mining operations.

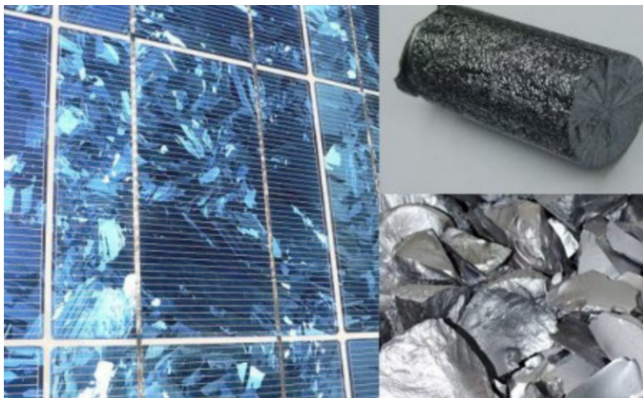
Facebook to Buy 5 MW Power from Sunseap Group's Offshore Solar Floating Project

Singapore-based solar energy company Sunseap Group has signed a multi-year virtual power purchase agreement (VPPA) with Facebook for solar energy from Singapore's largest offshore floating solar farm in the Straits of Johor.

Power from a 5 MW offshore floating photovoltaic (PV) project will be exported to the national grid. All renewable energy credits (RECs) from the project will be transferred to Facebook under the VPPA, which will support the company's operations in Singapore, including Facebook's first custom-built data center in Asia.



Explosion at Hoshine Silicon's Polysilicon Plant in China Threatens Supply



A massive explosion was reported at a polysilicon factory in the city of Shihezi in China's Xinjiang region. The plant produces raw materials for polysilicon used in the production of solar modules.

The factory belongs to the Hoshine Silicon Industry, which stated that the fire broke out at the second phase trial production line at the finished product packaging workshop of the sealing plant.

In a notification to the Shanghai Stock Exchange, the company stated that the gutted portion did not house the raw material production unit, which goes into making polysilicon. The company has claimed that the mishap has had no major impact on the company's production and operation.

Nanoparticle Paste to Maximize Perovskite Solar Cells' Efficiency Developed

Researchers at the ITMO University's School of Physics and Engineering have developed a paste of titanium dioxide and resonant silicon nanoparticles to maximize perovskite solar cells' efficiency. The paste increases the generation of photocurrent in perovskite solar cells, maximizing efficiency.

The researchers said halide perovskite solar cell's efficiency of over 25% with its low cost makes it one of the most promising devices. They need to improve perovskite solar cells' charge collection or light absorption by the charge generation layer. However, they would have to introduce other substances or 2D structures into perovskite cells, which is expensive.

The researchers used Mie-resonant silicon nanoparticles, as silicon is one of the most accessible elements in nature. They utilized colloid chemistry methods to develop a silicon-based nanoparticle paste that accurately controls the light scattering inside a perovskite solar cell.

Modules Manufactured in Europe Emit 40% Less CO₂ than the Chinese: Fraunhofer ISE

Researchers at the Fraunhofer Institute for Solar Energy have claimed that solar modules manufactured in the European Union produce 40% less carbon dioxide than modules manufactured in China.

China dominates the solar module market. In 2019, it produced 68% of polysilicon, 96% of all wafers, 76% of all solar cells, and 71% of all solar modules.

The researchers used a life cycle analysis and compared the CO₂ footprint of monocrystalline solar modules manufactured in Germany, Europe, and China. The study also found that glass-glass modules enabled an additional emission reduction between 7.5% and 12.5% compared to solar modules with backsheet films, regardless of their production location.

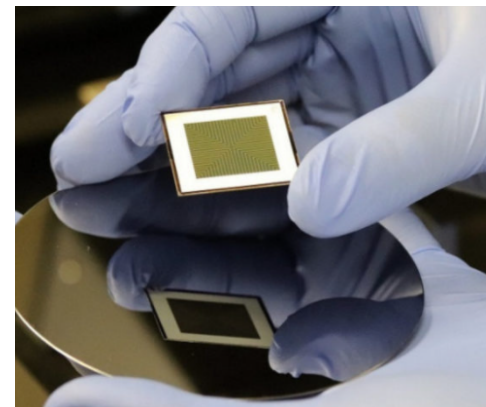
In its study, the researchers said that glass-glass modules do not require an aluminum frame that is very energy-intensive to produce. In addition, glass-glass modules also have a longer lifetime and lower annual degradation than modules with a film. Therefore, glass-glass modules produce 22%-27% less carbon dioxide emission than glass-foil modules.

Bifacial Solar Cell Using Laser Processing Claims Record Power Output of 29%

Researchers at Australian National University claim to have produced a more efficient type of solar cell using laser processing. The cell produced is supposedly a true bifacial solar cell with a nearly symmetrical power generation capacity on both surfaces of the device.

The research team claims to have set a new world record in the process by achieving a power output of approximately 29%, exceeding the performance of single-sided silicon solar cells. Laser-doping allowed the research team to achieve a front conversion efficiency of 24.3% and a rear conversion efficiency of 23.4%, representing a bifacial factor of 96.3%.

The Commonwealth Scientific and Industrial Research Organization has independently verified the results. Principal Investigator Dr. Kean Chern Fong said the so-called bifacial solar cells easily beat the performance of single-sided silicon solar cells.



Solar for Railways

Photovoltaic projects developed along railways to feed electricity directly into the traction current network are not new. German solar project developer Enerparc has built the first photovoltaic power plants in Northern Germany for this purpose. However, such projects are by no means a sure-fire success, as some technical and legal peculiarities have to be observed.

The German Center for Rail Transport Research (DZSF) at the German Federal Railway Authority has, therefore, tasked TÜV Rheinland to investigate the potential for such photovoltaic applications on and in the rail infrastructure through a 14-month research project. An interdisciplinary team of rail and solar specialists will investigate which photovoltaic applications are compatible with the rail infrastructure in order to feed solar power directly into the rail power network. In addition, it should be determined how much photovoltaics could increase the share of renewables in traction current.

Draft of National Green Hydrogen Mission under inter-ministerial consultations



Power minister RK Singh said recently the draft document of the National Green Hydrogen Mission is under inter-ministerial consultations.

The mission envisages commercial production of green hydrogen production in the nation from the financial year 2025-26 onwards. The draft proposes to undertake hydrogen production projects through a competitive bidding mode which would be open to participation from both private and public entities.

Further, the Mission includes frameworks for indigenous manufacturing and research & development aimed at improving the efficiency of electrolyzers—systems that use electricity to break water into hydrogen and oxygen in a process called electrolysis.

Among other provisions, the Mission includes a framework for demand creation of green hydrogen through mandates in identified sectors.

Iran brings 150MW solar cell factory online

An announcement from the government's Renewable Energy and Energy Efficiency Organization (SATBA) states that the factory was inaugurated in a ceremony attended by Iran's Minister of Energy Ali Akbar Mehrabian, and other officials.

Mehrabian stated that with this factory and cooperation from others in the renewable energy sector, Iran would be able to set higher targets for renewable energy in its development plans. "Today, in response to questions related to the effects of fossil energy use, including water and fuel consumption, pollution,... it can be noted that the development of renewable energy is the answer to all these questions," the minister said at the event.

The factory is operated by Tehran-headquartered company Mana Energy Pak. The company's website states that it has additionally purchased a factory able to produce 1.2 GW of multi- and monocrystalline wafers per year, and that it has operated a 250 MW production line for PV modules at the site since early 2020.

Perovskite solar cell retains 99% of initial efficiency after 1,450 hours

A group of researchers from Germany's Forschungszentrum Jülich has developed a planar perovskite solar cell that is claimed to reach over 1,400 hours of operational stability at elevated temperatures.

Before choosing the perovskite material for the cell, the scientists tested hundreds of different perovskite mixtures and investigated, in particular, their thermal stability using a self-constructed, high-throughput screening platform.

The 20.9% efficient device was built without the ionic dopants or metal oxide nanoparticles that are commonly used to contact the cell, as these can be subject to secondary reactions at higher temperatures, they further explained.

Sungrow to supply inverters to ‘largest solar project in Bangladesh’



The Chinese inverter maker has signed a contract with India-based Rays Power Infra to supply 1,500V, 3.125 MW central inverters to the 280 MW solar project, set to be installed in the Rangpur district of Bangladesh.

Sungrow shall provide its central inverter solution as well as comprehensive on-site and post-sale service to the 280 MW solar power plant, located in the Rangpur District, on the banks of the river Teesta.

A consortium comprising Rays Power Infra and Zetwerk Manufacturing Businesses has been tasked with the engineering, procurement, construction, commissioning, and operation and maintenance of the solar plant, while Switzerland-based ABB Ltd has been awarded the switchyard and substation contract.

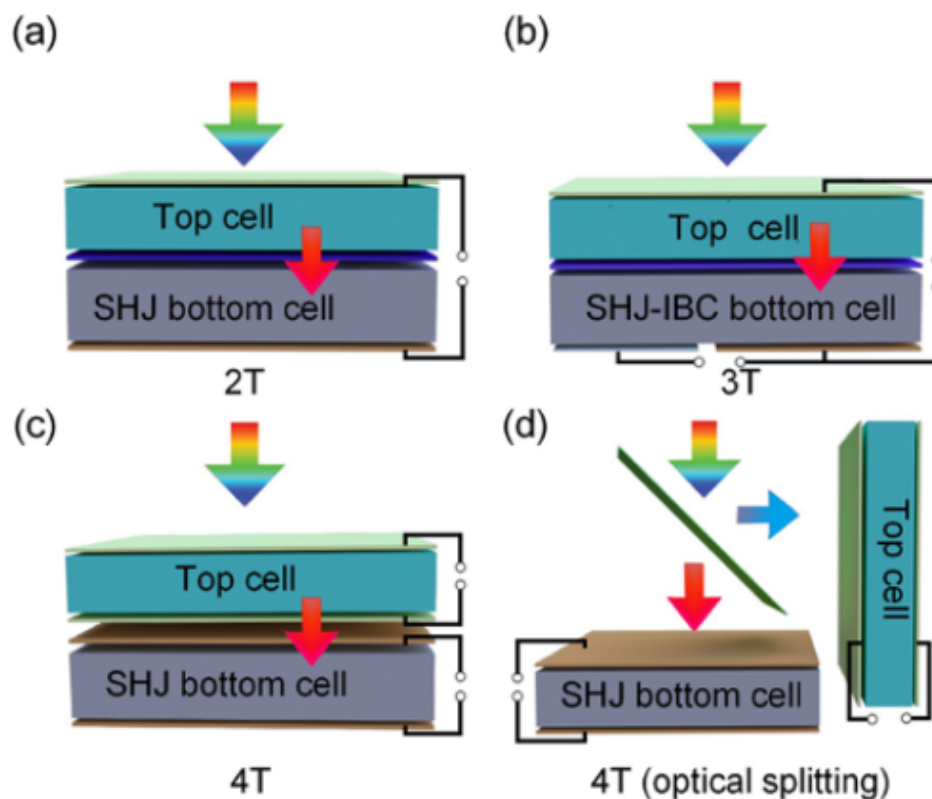
Renewable energy project acquisitions jumped by more than 300% in value terms in 2021

The total value of acquisitions in India's renewable energy sector surged by more than 300% to US\$ 6 billion in the first ten months of 2021 (till October) from less than US\$ 1.5 billion reported in 2020, according to an independent study released by the CEEW Centre for Energy Finance (CEEW-CEF) and the International Energy Agency (IEA). This signals enhanced appetite from companies to invest in climate-friendly technologies, and opportunities for investors to book profits and re-invest proceeds in new projects, or even exit completely.

The growth in acquisitions was supported by conducive global financial conditions and accommodative monetary policy maintained by the Reserve Bank of India. Adani Green's takeover of SB Energy India, in October, at a reported enterprise value of US\$ 3.5 billion was the biggest deal in the sector.

However, the 'Clean Energy Investment Trends 2021' study highlighted that solar PV capacity awarded in the first six months of 2021 fell sharply to just 2.6 GW from 15.3 GW (including 1.6 GW solar-wind hybrid capacity) reported in the corresponding period in 2020. This was largely as a result of a backlog of unsigned power sales agreements (PSAs) amounting to around 20 GW with the Solar Energy Corporation of India (SECI) at the end of 2020.

An overview of heterojunction solar cell technologies

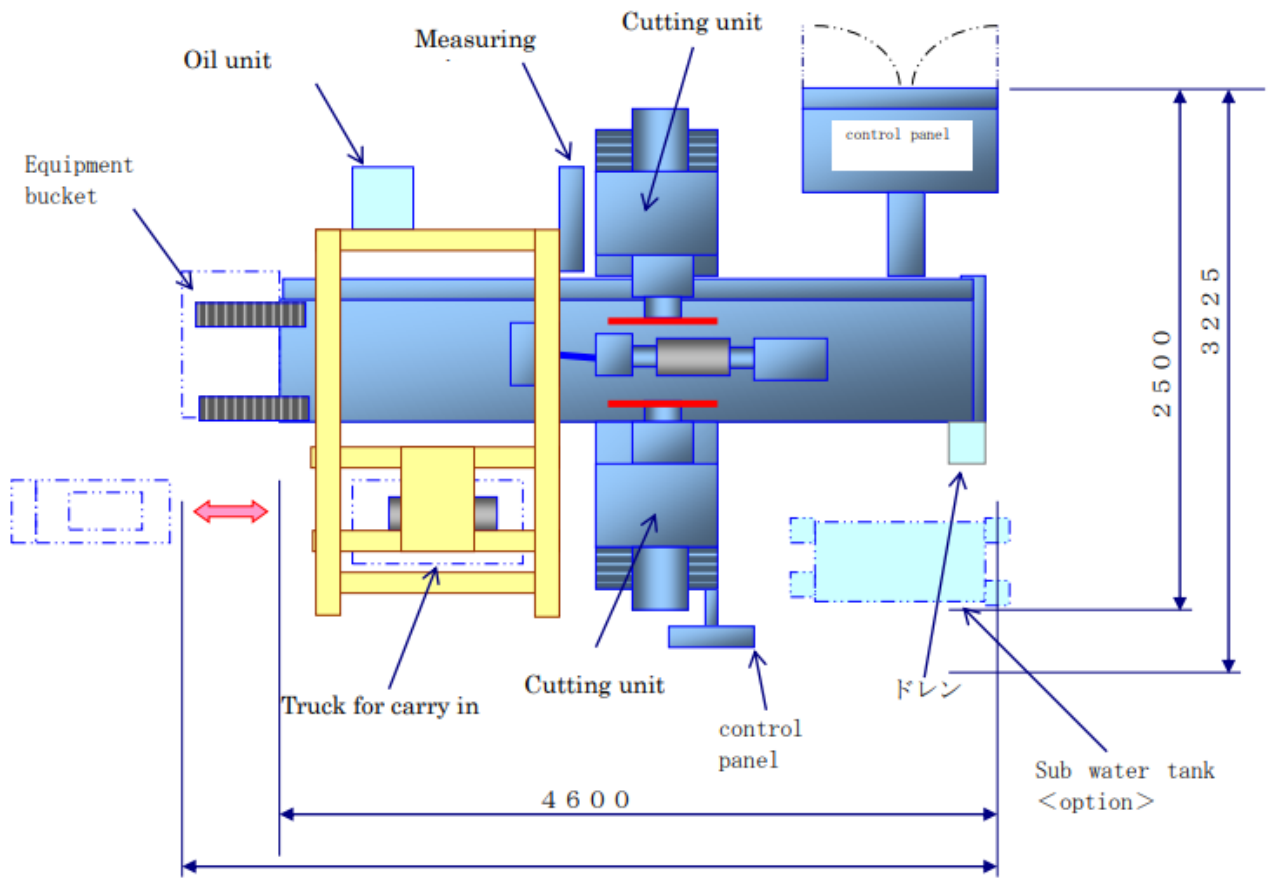


In a paper published in the journal *Nanophotonics*, scientists at Nankai University provide an overview of current research on silicon heterojunction tandem solar cells (SHJ-TSCs), including perovskite/SHJ TSCs and III-V/SHJ TSCs, and highlight the opportunities and challenges of this technology.

According to their analysis, the big challenge for perovskite/SHJ TSCs is the open-circuit voltage (V_{oc}) loss, which is mainly caused by nonradiative recombination at the grain boundary and interface. To address this issue, a range of strategies have been applied to date including increasing grain size, surface passivation, 2D/3D heterojunction engineering, and ion compensation.

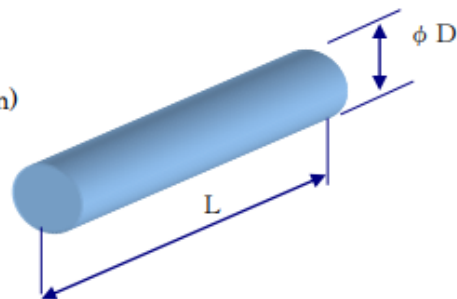
However, defects passivation has emerged as the most powerful means to improve V_{oc} . A lot of research effort is currently focused on Lewis bases/acids, alkali metal ions (Na, K, Ru, Cs), ligand passivation, halogen ion (Cl, Br), PbI_2 , 2D perovskite, insulating polymers, and guanidinium-based additives, the review finds.

Double-Head Squaring Machine for Mono-Si

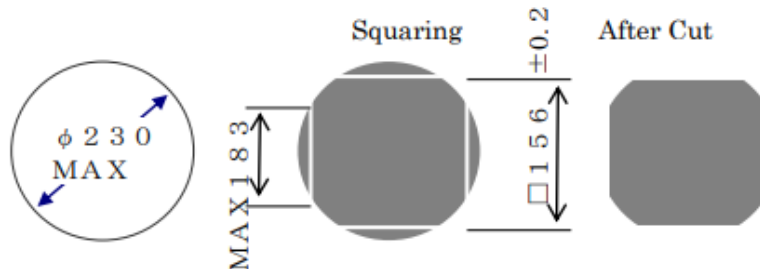


Workpiece

- Description : Si Ingot
- Materials : Monocrystal Si (Both side cut)
- Shape : Outside diameter (D) = ϕ 8 inches (As grown)
- Maximum O Diameter ϕ 230 mm
- Length L = 200mm to 650mm
- TOP, TAIL parallel cut



- Weight : Maximum kg
- Processed part : Dicing 4 sides
- Process method Dicing : Blade cutting (simultaneous processing on two sides)

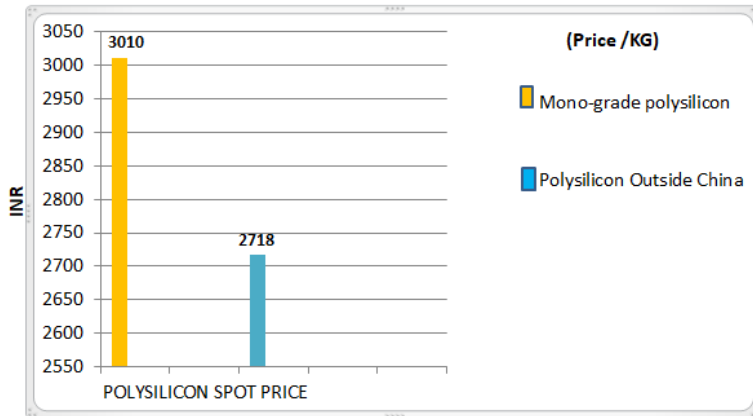


Machining accuracy

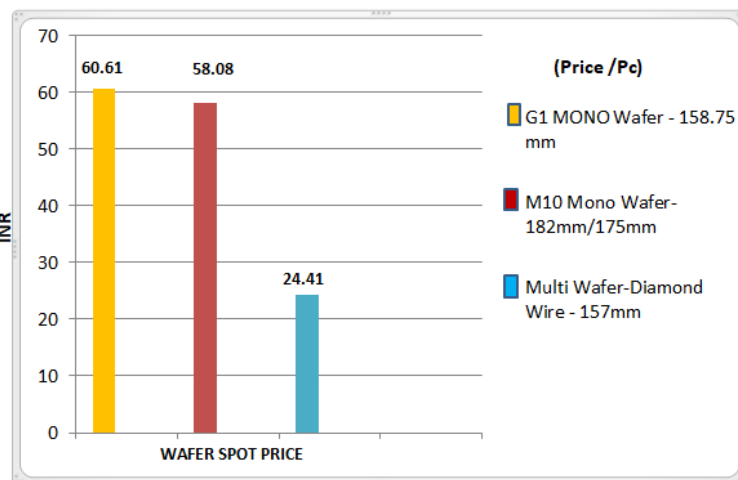
- ① Dicing width dimension: 156 ± 0.2 mm
- ② Squareness: $90^\circ \pm 0.1^\circ$
- ③ Mark position detection: Mark reference position $\pm 0.05^\circ$

Price update

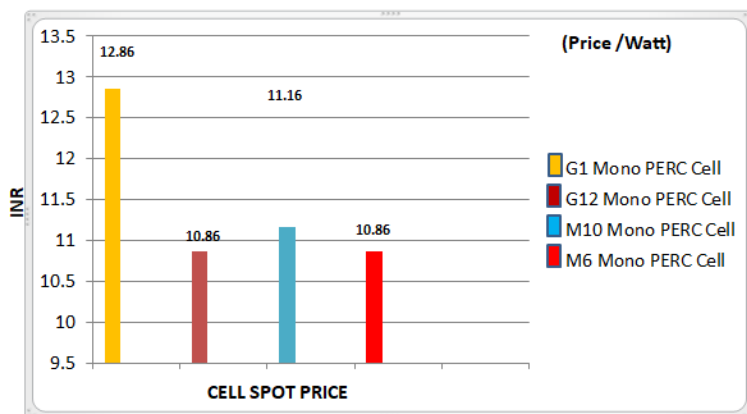
Polysilicon Spot Price Update



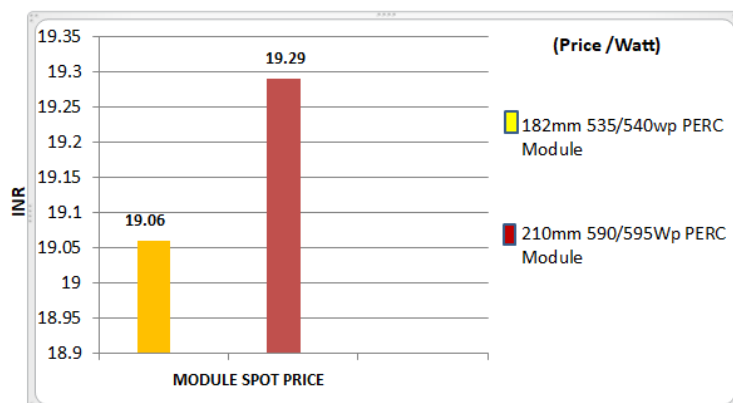
Wafer Spot Market Price Update - Multi SI/Mono G1M6



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.