

# RENEWABLE ENERGY REFRESHER

## BERGEN GROUP NEWSLETTER



## Setting up Solar Cell manufacturing lines in India Cherry Picking or Turn- Key

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Ministry of New and Renewable Energy (MNRE), Government India, recently announced that a Basic Custom Duty (BCD) will be imposed on imported solar cells and modules at the rate of 25% and 40% respectively from April 2022. This has triggered several announcements by Indian industrialists for setting up solar cell manufacturing lines mostly at Giga Watt (GW) scale in coming few years. It is, therefore, expected that in coming 2-3 years 5-10 GW solar cell manufacturing capacities will be built in India.

Major dilemma being faced by Indian investors is on two fronts- one on what technology to choose and on the other what approach to choose? On technology front there are two choices- one is the today's PV industry mainstay technology P-Mono Crystalline Silicon PERC and other is HJT. If one chooses P-Mono PERC, initial capital cost could be low, but danger of obsolescence will be there. Soon these lines will require upgradation to N-Mono PERT first and then to N-Mono TOPCON to compete with very fast emerging HJT. In the long run, it

is not sure whether TOPCON will be able to win on efficiency and COO fronts or HJT. If one chooses HJT, that company will leapfrog to highest efficiency and lowest COO club right from the start. Cost of capital, however, in HJT case would be higher initially compared to that for P-Mono PERC

With regard to choosing approach between cherry picking equipment and integrating the process by in-house process engineering team and turn-key solution, Indian investors still appear to be more inclined towards turn-key solution due to lack of strong in-house process and technology teams. In turn-key approach, disadvantage is that one cannot choose all best equipment available in the industry. This problem is eliminated in cherry picking (Pick and choose) approach. In this approach the investor is free to select all the best available equipment in the industry and can put the best processes with the help of either inhouse team or by hiring external process integrators from India and abroad. This approach is technologically strong, economically more prudent and builds the organisation for future competition. Both approaches, however, work and choice is of investor/industrialist.

## PEROVSKITE - HYPE AND REALITY

Renewable energy has promise to give humanity, an environmentally friendly and efficient energy system, which will enable it to abandon disastrous fossil fuel sources of energy. Among renewables, solar energy is the most powerful, hence researchers have been trying to harness it most efficiently at the lowest cost since long and as a result many technologies have evolved in last two decades mainly around the crystalline silicon substrate.

Recently a new class of solar cells based on Perovskite crystal structure material has shown remarkable results in a very short time, owing to very desirable photovoltaic-enabling properties for wider range of solar spectrum, ease of fabrication and lower cost. Perovskite solar cells have, therefore, emerged to be the front runners for low cost, high performance solar cells.

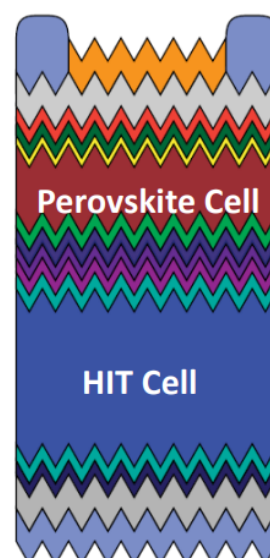
Despite being so promising and attractive, the Perovskite solar cell technology is presently facing two major challenges: one maintaining the high efficiencies achieved in research on very small sizes to larger sizes substrates and second is the durability and stability.

For example, efficiencies for cell sizes of 0.1-0.2 cm<sup>2</sup> have been obtained in the range of 20-23% but the same technologies when scaled to even modest sizes of 10-40 cm<sup>2</sup>, efficiency drops to 15-16% and for sizes above 100cm<sup>2</sup> it drops to 10-11%. It may be noted that crystalline silicon substrate being used today for solar cells are of the sizes of 256 cm<sup>2</sup>-441 cm<sup>2</sup> range and efficiencies are in the range of 22-25%. So, there is long way to go for Perovskite technology to compete with crystalline silicon solar cell technologies.

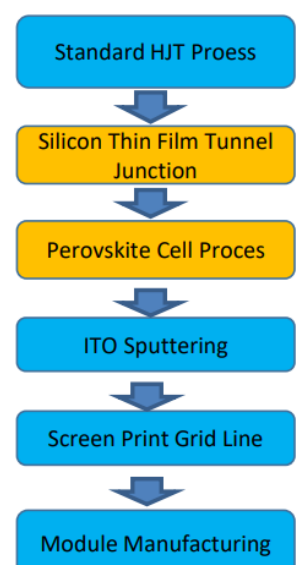
The biggest challenge of Perovskite cell is its instability when exposed to moisture under high temperature, under UV light and concentrated light and under electrical bias. Intense research is being carried out to improve the situation, but it is right now far away from being IEC certified as per the crystalline silicon solar cells standards.

In the meanwhile, effort is going on to build Tandem solar cells with perovskite top cells and crystalline silicon bottom solar cells. This approach has promise to take the combined efficiency of Tandem cells to 30-32%. Various technological difficulties with regard to assembly of such cells and stability issues of perovskites cells, however, remains to be solved.

This technology, therefore, is not even at horizon and will take minimum 4-5 years or even more to mature and become a serious challenger to crystalline silicon solar cell technology.



### Technology Map



Source : Maxwell

*Dr. D.N. Singh*  
CEO

*Bergen Solar Power & Energy Ltd.*

## NEWS UPDATE

### Gujarat's 500 MW solar auction sees aggressive tariff of INR 2.20/kWh despite BCD impact

JMK Research analysts attribute the comparatively lower tariffs to good ratings of the Gujarat State Discom Gujarat Urja Vikas Nigam Limited, choice of project location for developers, and anticipation that mono PERC module prices would fall 10-15% by 2022.

Sprng Ujjvala Energy, NTPC Renewable Energy, Coal India, and TP Saurya-a Tata Power subsidiary - were declared winners in the Gujarat Urja Vikas Nigam Limited's (GUVNL) auction to purchase power from 500 MW of grid-connected solar projects (Phase XII).

Sprng Ujjvala Energy won a capacity of 120 MW quoting ₹2.20 (~\$0.030)/kWh. Meanwhile, NTPC Renewable Energy, Coal India, and TP Saurya won 150 MW, 100 MW, and 60 MW, respectively, quoting ₹2.20 (~\$0.030)/kWh. SJVN had quoted 100 MW at ₹2.21 (~\$0.030)/kWh and won 70 MW capacity under the bucket filling method.

### Tigo launches optimizer for high-power modules

The IEC certified product has a maximum wattage of 700 W, a maximum current of 15 A, and a maximum voltage of 80 V.



It includes MC4 connectors, IP68 enclosure rating, and is claimed to be compatible with for use with older modules. The IEC certified product is claimed to show the highest per-module wattage of any commercially available optimizer on the market. "The new product retains the same form factor as the previous generation TS4-A-O and works with the same equipment that installers are familiar with," the manufacturers specified. "It will be rolled out internationally, beginning in Australia and South America initially, followed by Europe."

- Upgrading partnership with India: Italy joins International Solar Alliance

- India adds 9.7 GW of power generation capacity this fiscal till Feb 28

India added 9.7 GW of power generation capacity from April 2020 to February 2021 which includes 3.8 GW of conventional energy and 5.9 GW from renewable sources, Power and New & Renewable Energy Minister.

- IHS Markit forecasts 181 GW of new PV capacity for this year.

More than 180GW of solar will be deployed globally this year as the sector defies headwinds including higher module prices and supply chain constraints, IHS Markit has said.

## NEWS UPDATE

### BHEL issues RFP for Detailed Project Report on Manufacturing from Quartz to Solar Modules

Bharat Heavy Electricals Limited (BHEL), an Indian engineering and manufacturing enterprise has invited bids from consulting firms to prepare a detailed project report (DPR) on the solar photovoltaics (PV) manufacturing value chain.

The scope of work includes market research, sectoral assessment, market entry strategy, business modeling, and feasibility studies. Selected bidders must prepare a DPR for manufacturing in the entire solar PV value chain - quartz to MG-si mining, polysilicon, ingots, wafer, cells, and modules.

### India to launch supercharged push for global electric vehicle players.

The new automotive sector scheme, however, has been under discussion since mid-2020 to provide a more focused approach

India plans to offer fresh incentives to companies making electric vehicles (EVs) as part of a broad auto sector scheme it expects to attract \$14 billion of investment over five years, according to industry sources and a document seen by Reuters.

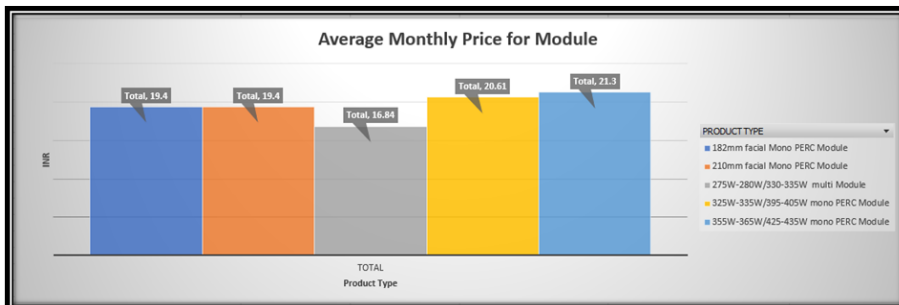
The country's efforts to promote EVs to reduce its oil dependence and cut pollution have been stymied so far by a lack of investment and weak demand, as well as the patchwork nature of existing incentives that vary from state to state. The new automotive sector scheme, however, has been under discussion since mid-2020 to provide a more focused approach, industry sources close to the matter told Reuters. The plans envisage \$8 billion of incentives for carmakers and suppliers over a five-year period to drive large investment in the sector.

- State discoms to get grants only if they meet previous year's targets'. Grant flow under the ₹3 lakh crore scheme is proposed to be 10% in first year, 20% in second year; 30% and 40% in third and fourth years, he said.
- Power tariff in Odisha to increase by 30 paise per unit from April 4
- U.S. researchers are using a data fusion approach to identify the most stable perovskites for PV cells. Their machine-learning method combines perovskite test results with first-principles physical modeling to identify the best candidates.

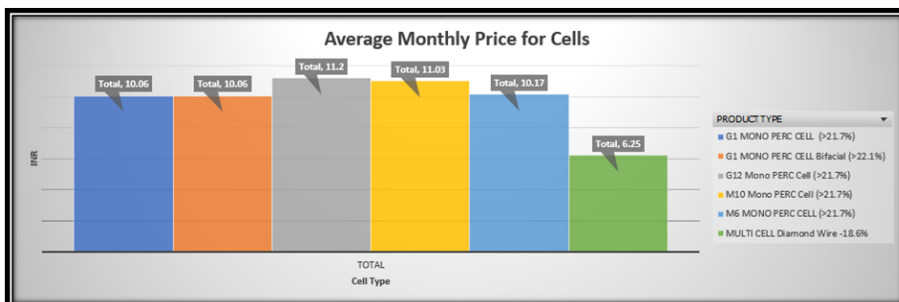
# MARKET ANALYSIS

## PRICE UPDATE

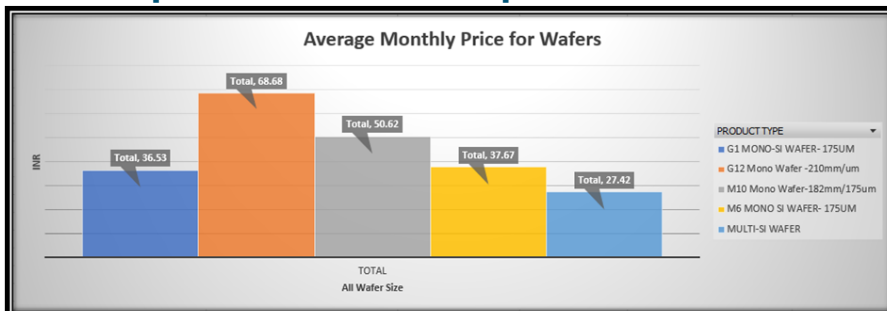
- **Module Spot Price Update- Multi/Mono**



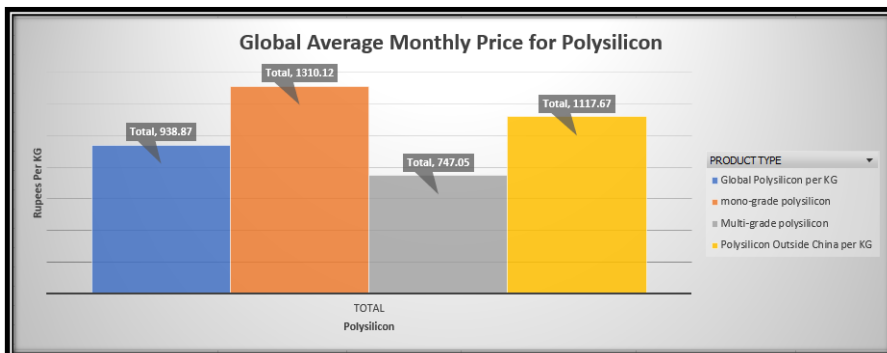
- **Cell Spot Price Update- Multi/Mono/PERC**



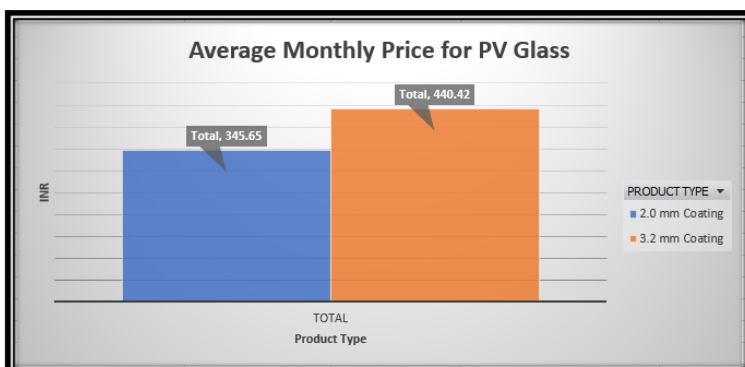
- **Wafer Spot Market Price Update- Multi SI/MonoG1M6**



- **Polysilicon Spot Price Update-Virgin poly (spot, contract)/Granular**



- **PV Glass Spot Price Update**



## TECHNOLOGY UPDATE

Source : ITRPV

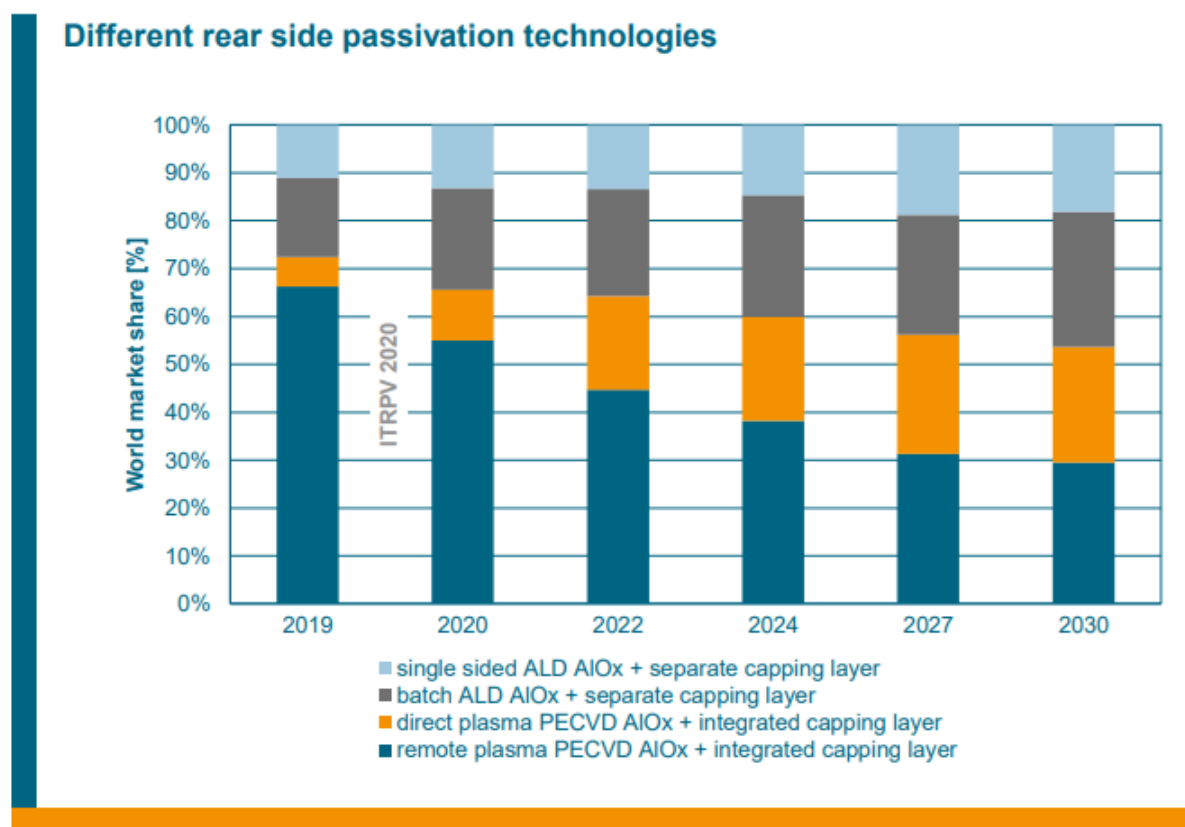


Fig. predicted market shares for AlOx-based rear side passivation technologies.

Since 2012, several cell concepts using rear side passivation with dielectric layer stacks have been in mass production (PERC/PERT/PERL technology). The above figure shows the expected market shares of different rear side passivation technologies suitable for n-type and p-type PERx cell concepts. Remote plasma PECVD  $\text{Al}_2\text{O}_3$  in combination with a capping layer has a market share of 55% in 2020-this former mainstream technology for PERC cell concepts will further lose market share. Newly built cell production capacities will use ALD  $\text{Al}_2\text{O}_3$  deposition in combination with separate capping layer deposition, and direct plasma PECVD  $\text{Al}_2\text{O}_3$  with integrated capping layer deposition. Tools combining ALD  $\text{Al}_2\text{O}_3$  and PECVD  $\text{SiNx}$  will also be available in the market. PECVD  $\text{SiONx/SiNx}$  is considered as niche process. A new method for rear side passivation uses a thin tunneling oxide layer with a conducting polysilicon cap layer. Instead of forming contacts to the bulk silicon the contacting is done via tunneling of electrons. This technique avoids the forming of undesired recombination centers.

## PRODUCT UPDATE


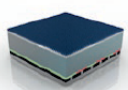
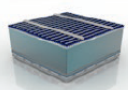
### WAFER COATING SYSTEM

#### *High Volume Mass Production for HJT, IBC & Passivated Contacts*

The XEA|nova L is an inline coating system based on our proprietary large-area coating technology. The system is wider than the XEA|nova and can process more substrates at the same time. Therefore it is especially suited for high productivity applications at very low costs. It is suited for silicon wafers or other small and even very thin substrates. Thanks to its modular design, the XEA|nova L can be equipped with rotatable magnetrons for the sputter deposition of high-performance TCO layers or several other materials, such as metals and metal oxides. It can also be adapted for other deposition technologies. The substrates can also be pre-treated by cleaning or etching, either under vacuum or before it enters the vacuum. VON ARDENNE is also working on introducing single-sided passivated contacts processed by means of high-rate soft sputtering into mass production. The necessary sputtering process technology will be designed to fit into the XEA|nova L platform.



### Application

<b>HJT</b>	High-performance TCO contact layers and metalization	
<b>IBC</b>	High-performance metalization layers and back side mirror combined with lowest cost of ownership	
<b>Passivated Contacts</b>	Single-sided deposition of in-situ doped amorphous silicon as well as SiN layer for hydrogenation	

#### OPTIONAL FEATURES

- Automated substrate loading & unloading
- Automated carrier return system
- Controlled heating and cooling unit (CHU)
- Dry air supply (CDA)
- Carrier storage racks
- Others on request

#### AUTOMATION OPTIONS

- Configuration single- or double-end
- Automation system fully automatic
- Substrate feeding cassette, box, other

#### HIGHEST ECONOMY OF SCALE

Due to its large width, the productivity of the tool is exceptionally high while the process utilization is brought to a maximum. Thus, the XEA|nova L offers best cost of ownership by providing applicable economy of scale.

#### PROVEN MAGNETRON TECHNOLOGY

Proven rotatable magnetron technology guarantees excellent target utilization. For more than 40 years, VON ARDENNE has been developing and manufacturing proprietary magnetrons for all kinds of applications.

#### PROCESS CHAMBER

The process chamber enables simultaneous processing of different material compositions, such as TCO's, TCO stack layers and/or combinations of TCO, metal oxides and metal stacks.

#### PRECISE TEMPERATURE CONTROL OF SUBSTRATES

For transparent conductive oxides like ITO or other special applications, the substrate temperature can be precisely controlled in order to achieve reproducible and ideal layer characteristics by optional active heating or cooling.

#### EDGE EXCLUSION, FULL AREA, ALL AROUND & BEVEL

The innovative VON ARDENNE carrier concept is very flexible and enables the deposition on substrates with full or partial edge exclusion. Furthermore, the substrate can be coated on the full area and all around, including the bevel.

#### CONVENIENT AND QUICK MAINTENANCE

The optimized machine design enables easy access to the process environment and the auxiliary chambers.

#### FLEXIBLE AND DYNAMIC IN PRODUCTION

The standardized subcomponents enable custom-made configurations with a high degree of flexibility. That means that the system can be adapted to changing processes or requirements. Therefore, our customers are able to act very dynamically and to keep their production in accordance with the evolution of their product.

## EDITORIAL TEAM



**Rajinder Kumar Kaura**  
CMD

With nearly 43 years of contributions in conventional and non conventional power & 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 State 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, US, 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 standard 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.



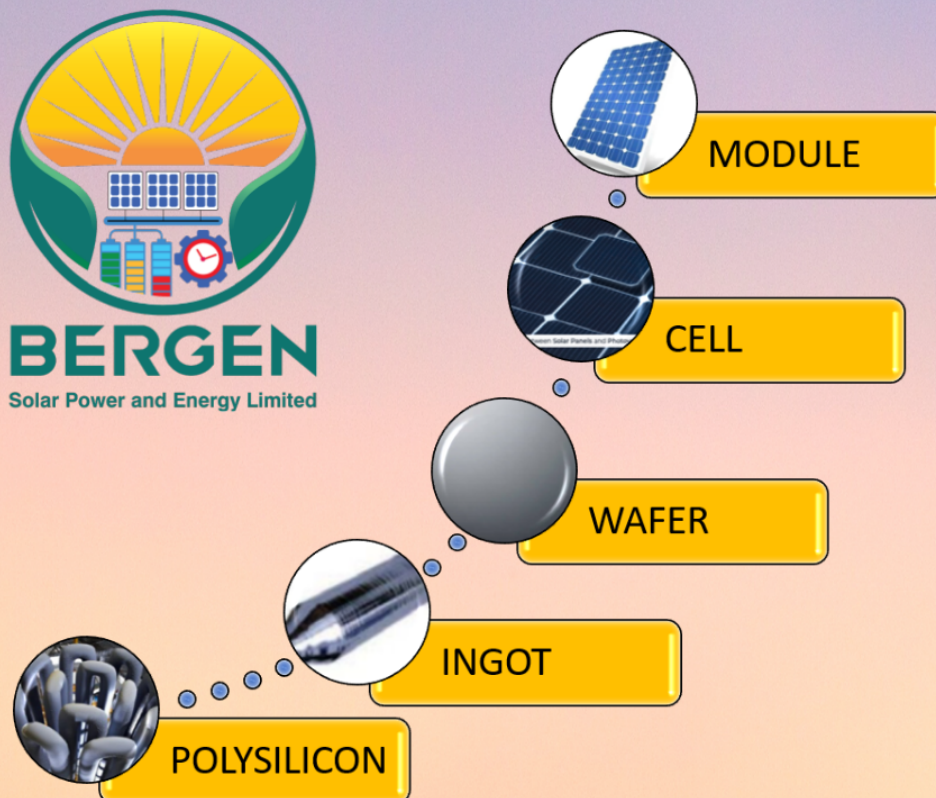
**S.K. Kaul**  
Vice President

Having more than 20 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 Cell & Photovoltaic Modules and undertaking the turnkey installation of the solar based power projects.



# PROVIDING TURNKEY SOLUTIONS FROM SAND TO ENERGY

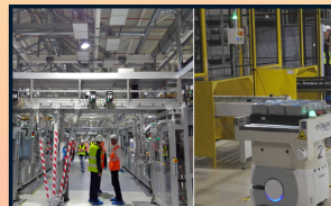
India's Most Experienced Fully Integrated, Technology, Application and Knowledge Engineering Group with end to end O & M Capabilities.



## POLYSILICON PLANT



## HJT CELL LINE



## MODULE LINE



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