Annexure

Annexure 1

Domestic Solar Cell manufacturing capacity for different solar manufacturers as of November 2025

Company Name	State	Total Solar Cell Manufacturing Capacity (GW)	BSF (GW)	PERC (GW)	TOPCon (GW)	HJT (GW)	Thin-film/ Cd-Te (GW)	Not specified (GW)
Adani Solar	Gujarat	4	0	2	2	0	0	0
Central Electronics	Uttar Pradesh	0.1	0	0	0	0	0	0.1
Evervolt Green Energy	Andhra Pradesh	1	0	1	0	0	0	0
IndoSolar	Gujarat	0.5	0	0	0	0	0	0.5
Jupiter	Himachal Pradesh	0.8	0.3	0.5	0	0	0	0
KL Solar	Tamil Nadu	0.3	0	0	0	0	0	0.3
Premier Energies Photovoltaic	Telangana	2	0	2	0	0	0	0
ReNew Power	Gujarat	2.5	0	2.5	0	0	0	0

RenewSys India	Telangana	0.13	0.13	0	0	0	0	0
Tata Power Solar	Karnataka	2.53	0.53	1	1	0	0	0
Websol	West Bengal	0.6	0	0.6	0	0	0	0
Waaree	Gujarat	5.4	0	1.4	4	0	0	0
First Solar	Tamil Nadu	3.3	0	0	0	0	3.3	0
Emmvee	Karnataka	2.5	0	0	2.5	0	0	0
Reliance	Gujarat	1.72	0	0	0	1.72	0	0
Total		27.38	0.96	11	9.5	1.72	3.3	0.9

Source: Authors' analysis from company announcements, (Sinovoltaics 2025), (Waaree Energies 2025), (ETEnergyWorld 2024)

Annexure 2

Announced TOPCon manufacturing expansion

Date	Company	Capacity	By When
22-Feb-24	RenewSys	3	Dec-26
10-Sep-24	Jackson	2.5	Dec-25
8-Oct-24	Avaada	5	Oct-25

14-Feb-25	Premier Energies	1	Mar-26
14-Feb-25	Premier Energies	4	Mar-27
7-Feb-25	Waaree	4	Apr-25
17-Sep-24	Emmvee	2.5	Sep-24

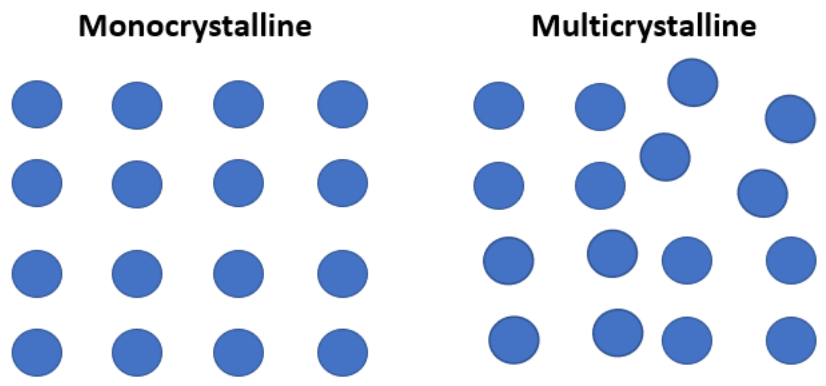
Source: PV Magazine 2024c, EnergyTrend 2024, Taiyang News 2024a, Energetica India 2025, Saur Energy 2025, EQ International 2024

Annexure 3

Silicon-based solar cells utilise the photovoltaic effect to generate electricity. Through the photovoltaic effect, incident radiation, having energy equal to or greater than the energy bandgap of silicon, excites electrons through the bulk of the solar cell and causes a flow of electrons, leading to electric current and power generation. The dislocation of electrons causes the creation of "electron-holes" which act as positive charge carriers that flow in the opposite direction to the electrons and contribute to power generation. The primary photovoltaic loss occurs through the phenomenon of recombination, where an electron and an electron-hole recombine with each other, leading to a loss of energy in the form of heat or radiation (Leu and Sontag 2020c).

Silicon-based solar cells can be broadly classified under two umbrellas based on the wafers they utilise: multi-crystalline (also known as polycrystalline) solar cells and monocrystalline solar cells. Monocrystalline silicon wafers have longer order periodic properties whereas multi-crystalline silicon wafers have their periodic order interrupted. The difference in the crystalline structure between the two is illustrated in Figure 1.

Figure 1: Difference in monocrystalline and multi-crystalline silicon wafers



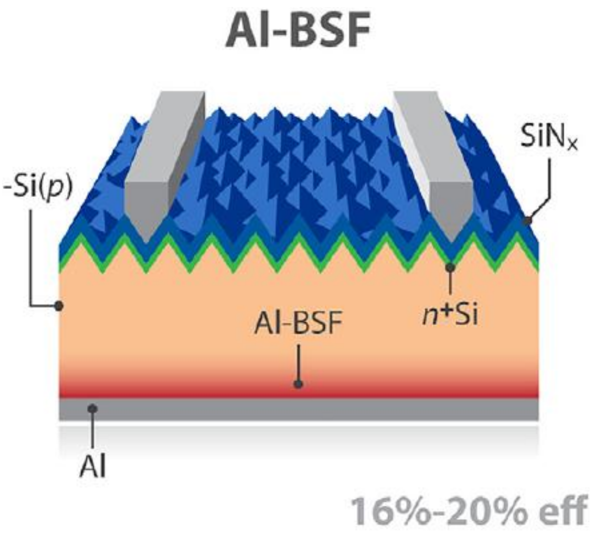
Source: Authors' interpretation

The presence of multiple crystalline orders in multi-crystalline wafers leads to an interruption in the periodic properties. Such interruptions act as defects, where electron-hole pairs recombine, resulting in photovoltaic losses. Cells utilising monocrystalline wafers thus have higher efficiencies than those using multi-crystalline wafers. The higher efficiencies of monocrystalline solar cells have led to them having a market share of 97 per cent, while multi-crystalline silicon technology has a market share of 0.5 per cent (Rethink Energy 2024b).

Within monocrystalline solar cells, the different kinds of solar cell technologies that have been commercialised are Back Surface field technology (BSF), Passivated Emitter and Rear Contact (PERC), Tunnel Oxide Passivated Contact (TOPCon), Heterojunction (HJT), and Back Contact technology utilising either TOPCon or HJT cell architecture (XBC). The evolution of each silicon-based solar cell technology has been a targeted attempt to improve the photovoltaic conversion efficiency.

Back Surface Field (BSF) solar cell was introduced in the 1960's, with the cell architecture comprised of an aluminium back surface field that would help reduce recombination at the metal current collectors or contacts in the back (Pastuszak and Wegierek 2022). The presence of aluminium on the backside creates a minor backside electric field, which reduces the effective surface recombination velocity of the electrons at the rear contacts, by redirecting the electrons back towards the bulk surface (Leu and Sontag 2020b). Back surface field solar cells used p-type wafers as the base and an n-type thin layer of crystalline silicon as the emitter[1].

Figure 2: Schematic diagram of the Al-BSF solar cell



Source: Verlinden et al. 2023

However, the large area of contact between the silicon layers and the metal contact causes high surface recombination, leading to photovoltaic losses and limiting conversion efficiency. BSF cell technology was eventually replaced by PERC cell technologies, with market shares of BSF falling from 75 per cent to 10 per cent from 2018 to 2021 and the market share of PERC rising from 35 per cent to 80 per cent in 2021 (Stefani et al. 2023).

Passivated Emitter Rear Contact (PERC) cell technology was developed by a group of scientists led by Dr Martin Green in 1983 at the University of New South Wales (Blakers et al. 1989). Like the BSF solar cell, PERC cell technology uses a p-type monocrystalline wafer as the base and an n-type thin layer of crystalline silicon as the emitter. The front side of PERC cells has an anti-reflection coating and metal

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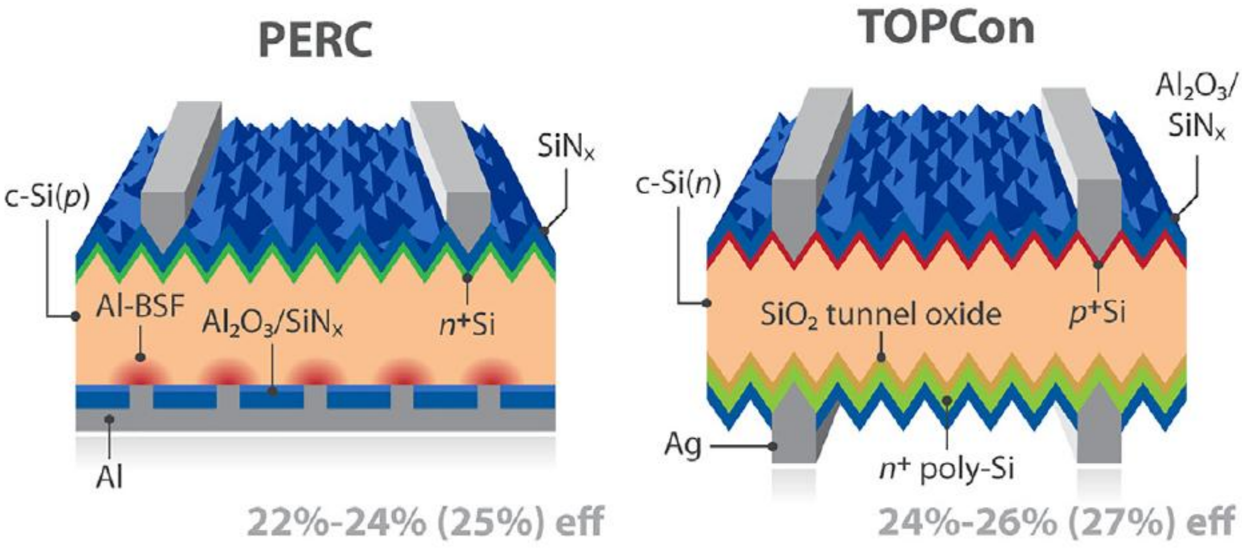
[1] P-type and n-type refer to the kind of doping performed on semiconductors like silicon wafers. P-type semiconductors are those where the semiconductors are doped with elements which have lesser electrons than the substrate and n-type wafers are where the semiconductors are doped with elements with more electrons than the substrate. Thus, p-type semiconductors are positively doped with electron-holes as the majority charge carriers while n-type semiconductors are negatively doped with electrons as the majority charge carriers.

contacts. The rear side of PERC cells has aluminium oxide deposition which form a layer between the silicon layers and the metal contacts, providing surface passivation and reducing surface recombination (Leu and Sontag 2020b). This Aluminium oxide layer is very thin; a "capping" layer of silicon nitride is deposited to protect it. Metal contacts made of aluminium-silver paste are further deposited on the rear side through screen-printing. Aluminium oxide and silver nitride as a rear passivation film enhance the passivation effect through field and chemical passivation, thus differentiating PERC cell technology from BSF cell technology.

Figure 3: Schematic diagram of PERC and TOPCon cell technology.



Source: Verlinden et al. 2023

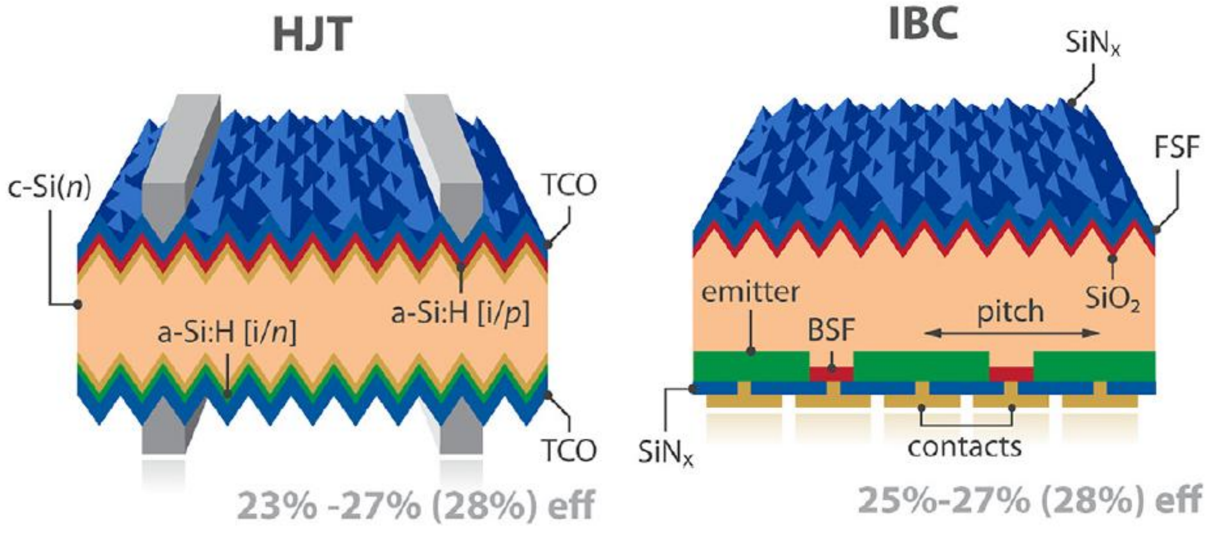
PERC cell technology has stagnated photovoltaic efficiency, with commercial modules using PERC cells not showing an efficiency increase beyond 21.7 per cent (Taiyang News 2024b).

Tunnel Oxide Passivated Contact (TOPCon) cell was developed by Fraunhofer ISE in 2013, with a record efficiency of 25.3 per cent on a $20 * 20\ mm^2$ wafer (Fraunhofer ISE 2024). TOPCon uses n-type wafers as the base layer in contrast to PERC, which uses p-type wafers as the base layer. N-type wafers have electrons as the charge carriers which provide higher mobility than electron holes, which are the majority charge carriers in p-type wafers (Leu and Sontag 2020a). As of 2024, Tunnel Oxide Passivated Contact (**TOPCon)** cell technology has replaced PERC as the mainstream solar cell technology. In TOPCon cell technology, the direct contact between silicon and metal on the rear side is avoided. A sandwich structure of silicon oxide layer, around 2 nanometre (nm) thickness, and a strongly doped n-type polycrystalline layer (n^+-poly-Si) is used as a "tunnelling oxide" between the silicon and metal contacts(Leu and Sontag 2020b). The charge carriers, which are either electrons or electron-holes, tunnel through this layer and reach the metal contacts. Due to the presence of the sandwich structure, the recombination of electrons and electron holes are reduced drastically as the metal contacts are not directly in contact with the silicon layers anymore. Additionally, the tunnelling phenomenon leads to "charge carrier selectivity" which ensures that electrons and electron-holes flow in separate directions and reduce recombination (Leu and Sontag 2020b).

The highest efficiency recorded by a commercially available module using TOPCon cells was 23 per cent in 2024, 6 per cent more than the previously mentioned PERC module efficiency (Taiyang News 2024b). From 2023 to 2024, the efficiencies of commercial TOPCon cells made by Chinese manufacturers like Astronergy, DAS Solar, JA Solar, Tongwei reached an average of 26.8 per cent, exceeding the average laboratory scale efficiency of TOPCon cells of 26.3 per cent, which highlights the importance placed by Chinese manufacturers on R&D (Taiyang News 2025).

Heterojunction (HJT) was first commercially developed by Sanyo in Japan in the 1980's (Chuchvaga et al. 2023). HJT cells use both crystalline and amorphous silicon in a symmetric structure. The crystalline silicon layer is sandwiched between amorphous silicon layers, with each layer comprising of one intrinsic and one doped layer (positively doped on one side and negatively doped on the other). Charge carriers' tunnel through the amorphous and crystalline silicon interface, ensuring charge carrier selection (Leu and Sontag 2020a). Amorphous silicon layers on one side allow only one type of charge carrier to pass through, reducing surface recombination at contacts and thereby maintaining high efficiencies. Due to the presence of amorphous silicon layers where hydrogen has to be used to passivate certain dangling bonds, low temperature silver pastes have to be utilised, as at high temperatures the hydrogen escapes from the amorphous silicon layers. A higher amount of silver paste is required for such lower temperature metallisation leading to higher operational expenditure (Taiyang News 2023a).

Figure 4: Schematic diagram of HJT and IBC cell technology



Source: Verlinden et al. 2023

In 2024, the highest efficiency recorded by a commercially available module using HJT cells was 23.18 per cent (Taiyang News 2024) marginally higher than the previously mentioned TOPCon module efficiency and nearly 7 per cent more than the PERC module efficiency levels. At the cell level, efficiencies for HJT reached around 25.7 per cent in 2025, rising by 0.3 per cent from 2024 (Taiyang News 2024b). HJT cells are costlier to produce due to higher capital and operational expenditure. Chinese manufacturers have been working on reducing costs for HJT cell manufacturing through various methods like reducing wafer thickness and reducing silver paste consumption through usage of silver-copper pastes. (Taiyang News 2023a).

Back Contact cell technology was invented in the 1970s, and the recent rise of high-efficiency n-type cell technologies like TOPCon and HJT has led manufacturers to use Back contact cell architectures in conjunction with them, improving their efficiency gains (Aiko Solar 2024). Due to its possibility of implementation with either TOPCon or HJT, Back Contact is abbreviated as XBC. XBC cells feature metal contacts on the rear side, thus preventing losses from being shaded by front contacts. This contrasts with non-back-contact cell architectures, where the cells must be interconnected using front-to-back ribbons. The resulting close packing allows superior power density and higher module efficiencies. (Aiko Solar 2024)

As a result of these unique advantages, modules using back contact cell technology have the highest efficiency ceiling. In 2024, commercially available modules using back contact cells had the highest efficiency ceiling, with modules using XBC cells showcasing 24.2 per cent efficiency (Taiyang News 2025a). Overall, the highest recorded photovoltaic efficiencies achieved in laboratory settings for multi-crystalline and monocrystalline solar cell technology are 24.4 and 27.8 per cent, respectively (PV Magazine 2025; Fraunhofer ISE 2024). The table below summarises all the facets of the cell technologies described below.

Key features of the commercially available silicon-based solar cell technologies.

Attribute	**PERC**	**TOPCon**	**HJT**	**Back Contact (XBC)**
First developed	1983 (UNSW)	2013 (Fraunhofer ISE)	1980s (Sanyo)	1970s (modern rise post-2020s)
Base wafer type	p-type	n-type	n-type wafer with a-Si layers	n-type, used with either TOPCon or HJT (TOPCon/HJT)
Structure / Features	AlOx + SiNx rear passivation; screen-printed Al-Ag contacts	Tunnel oxide + n+-poly-Si; no direct Si-metal contact	Crystalline Si between doped a-Si; requires hydrogen passivation	Rear-side metal contacts; no shading losses; tight cell packing

Passivation mechanism	Field + chemical passivation via AlOx/SiNx	Carrier-selective tunnel oxide layer	a-Si layers for carrier selectivity; hydrogenated passivation	Full rear passivation; depends on TOPCon/HJT stack
Efficiency (module)	Up to 21.7%	Up to 23%	23.18% (2024)	24.2% (2024)
Efficiency (cell)	-	Avg. 26.8% (2024)	25.7% (2025)	Max efficiency potential
Limitations	Efficiency plateaued; being phased out	Longer commissioning; higher complexity	High capex/opex; needs low-temp silver paste	Complex manufacturing; higher cost
Commercial status	Peaked in 2021; declining	Mainstream by 2024	High efficiency; cost reduction in progress	High-efficiency segment; rising adoption with HJT/TOPCon

Source: Authors' analysis

The commercialised solar cell technologies share similarities in manufacturing processes, with there being five key steps in the production process (SolarPower Europe 2025):

1. Surface Preparation
2. Diffusion or doping
3. Passivation
4. Metallisation
5. Testing

All silicon-based solar cell technologies share five key manufacturing steps, differing mainly in execution. Manufacturing processes for PERC, TOPCon and HJT are described in the table below.

PERC and TOPCon cells share similar manufacturing processes, while HJT has a different manufacturing process with fewer steps.

Key Step	**PERC Manufacturing process**	**TOPCon Manufacturing Process**	**HJT Manufacturing process**
Surface Preparation	Surface damage removal	Texturing	Incoming wafer supply
Surface Preparation	Texturing on the front side	Low pressure Boron deposition	Wet-chemical processing
Diffusion or doping	Phosphorous diffusion using Phosphorous Oxychloride	Annealing (drive-in)	Core layer deposition
Diffusion or doping	Laser doping for selective emitter	Etching and Backside Polishing	Transparent Conducting Oxides (TCO) deposition: Indium-Tin-Oxide used primarily as TCO layer
Passivation	Phosphorus Silicate Glass (PSG) removal, edge isolation and rear polish	PECVD based SiO2/ Polysilicon deposition and in-situ Phosphorous doping.	Click or tap here to enter text.
Passivation	Anti-Potential Induced Degradation (PID) SiO2 process	Annealing	
Passivation	Rear-side Aluminium oxide deposition	RCA cleaning for Wrap Around	
Passivation	Rear-side silicon nitride deposition	Front side ALO (Al2O3) deposition	

Passivation	Front-side silicon nitride deposition	Si3N4 front side passivation	
Passivation	Laser opening of the dielectric stack on the rear side for contact	Si3N4 rear side passivation	
Metallisation	Metallisation at temperatures of nearly 700 degrees Celsius.	Metallisation	Metallisation through dual screen printing at temperatures of 200 degrees Celsius.
Metallisation	Light Induced Degradation regeneration	LECO – Laser Enhanced Contact Optimisation	
Cell testing	Cell testing and sorting	Edge passivation	I-V characterisation or cell testing
		Cell testing and sorting	Light Soaking

Source: Taiyang News 2022, 2023b, 2023a

Alternatives to these commercialised technologies are in development too. One such example is tandem-perovskite, an alternate solar cell technology that has not yet reached commercial scale, but possesses unique properties that make it a contender for the future. The next subsection shall explore the history, technical details, and pathways for mainstream production of this technology.

Tandem-perovskites

Perovskite materials are thin film materials of half a micrometre to one-micrometre thickness, composed of metal halides with a particular crystalline chemical structure. Due to their composition, perovskite materials have photovoltaic properties, which make them useful for constructing thin-film solar cells (Miyasaka and Jena 2021). The first perovskite solar cell was invented in 2009 in Japan (Kojima et al. 2009).

Perovskite cells promise higher photovoltaic conversion efficiencies, especially when used with silicon solar cells to make tandem perovskite cells. The theoretical efficiency limit of a silicon solar cell is 29 per cent, also known as the Shockley-Quisser limit, and tandem perovskites promise efficiencies higher than this. For example, Chinese manufacturer LONGi unveiled a perovskite solar cell in December 2023, certified to have an efficiency of 33.9 per cent (PV Magazine 2024a). Perovskites can have a lower cost of production than silicon-based solar cells. Estimates suggest that the capital expenditure for setting up a perovskite manufacturing plant can be one-fifth of the capital expenditure required for a silicon solar manufacturing plant (Rethink Energy 2024a). Further, perovskite manufacturing processes operate at much lower temperatures than conventional silicon solar manufacturing, meaning lower energy consumption and operating costs (Mitsui & Co Global Strategic Studies Institute 2024). The lower energy consumption also entails a lower emission profile associated with perovskite manufacturing.

In addition to these benefits, perovskite solar cells are thin-film, which makes perovskite-based solar modules lighter in weight and more flexible than conventional solar modules. This enables perovskite-based modules to be utilised in various niche applications, such as Building Integrated Photovoltaics or non-load-bearing roof structures. The lightweight and flexible nature also reduces installation costs, reducing the electricity costs produced by such photovoltaic systems (Rethink Energy 2024a). An overall comparison between silicon-based and tandem perovskite cells has been showcased below.

Comparison of Silicon-based, Perovskites, and Tandem-Perovskites solar cell technologies

Cell technology	**Monocrystalline Silicon Solar cells (PERC, TOPCon)**	**Perovskite**	**Tandem-perovskites**
Cell level efficiency (recorded)	27.10%	26.10%	34.60%
Capex (USD million per GW)	250 (for the entire supply chain, from polysilicon to modules)	50	Combination of silicon and perovskite
Operating Temperatures (Degrees Celsius)	1400	100	Combination of silicon and perovskite
Absorption Wavelength range (nanometre)	300 to 1200	300 to 800	300 to 1200

Light absorption coefficient (cm^-1)	10^4	10^5	10^5
Photoelectric conversion layer thickness (micrometre)	50 to 300	1	Combination of silicon and perovskite
Manufacturing process (time)	3 days or longer	one-tenth of crystalline silicon	Combination of silicon and perovskite
Existing Manufacturing capacity (worldwide) (GW)	476	0.8	0
Major countries with Manufacturing base	China	China, Japan, USA, Europe	Europe

Source: Rethink Energy 2024a, 2024b, Mitsui & Co Global Strategic Studies Institute 2024

Due to these advantages, efforts are being made across countries to commercialise perovskite solar cell technology. Perovskite market share is projected to increase in the future, with forecasts predicting that perovskite manufacturing will hit the gigawatt scale from 2028 and will rise rapidly to 56 GW in 2030, capturing 6 per cent of the solar cell technology market share (Rethink Energy 2024a).

In 2024, multiple companies released trial commercial modules of perovskite and tandem perovskite cell technology. In September 2024, Oxford PV shipped commercial modules utilising tandem-perovskite technology to US customers with an efficiency of 24.5 per cent and unveiled residential rooftop models with a record 26.9 per cent efficiency (PV Magazine 2024b). These efficiencies may not seem higher, given that silicon-based modules have also reached module efficiencies as high as 24 per cent (Taiyang News 2024b). However, tandem-perovskites promise to deliver efficiencies higher than 33 per cent. Already, tandem perovskite cell prototypes have been certified to exceed this efficiency limit, with Chinese solar manufacturer LONGi's "two-terminal tandem perovskite" cell prototype showing a 34.6 per cent photovoltaic efficiency (PV Magazine 2024a).

As of December 2024, Chinese manufacturers and technology start-ups have established 0.8 GW of perovskite manufacturing capacity. Further, about 4.3 GW of plants are under construction, most coming online by the end of 2025. Chinese manufacturers benefit from policies such as the 14th Five-Year Plan for National Economic and Social Development, which boosts materials development, manufacturing equipment, mass production and industrialisation techniques for perovskite and tandem cells (Mitsui & Co Global Strategic Studies Institute 2024). In Japan, perovskites have been designated to be subjected to the Green Innovation Fund, which provides long-term support for research, development and commercialisation of technologies (Mitsui & Co Global Strategic Studies Institute 2024). Due to this favourable environment, Japanese firms like Sekisui Chemical lead the perovskite patent filing trends, having both high number and high quality of patents, which target the manufacturing processes of perovskites (Patseer 2024). Sekisui Chemical also target niche demands for perovskite deployment, such as deployment along metro rail and rooftop buildings. Non-Chinese thin film solar manufacturers like First Solar and Q Cells have invested at scale in the research and development of Perovskite cells, along with start-ups like Oxford PV and Caelux PV. While the latter start-ups have unveiled products with "only" 24.5 to 25 per cent efficiency, the potential efficiency increase is high.

Tandem-perovskites are yet to reach maturity, which makes them attractive for new players to enter perovskite development.

Annexure 4

Analysis carried out by Shrishti Projects Private Limited for Vikram Solar, as mentioned in the DHRP document by Vikram Solar.

Particulars	Total estimated cost for 3000 MW solar module facility (INR million)	Total estimated cost for 3000 MW solar cell facility (INR million)
Capacity (MW)	3000	3000
Land and site development	244.98	205.83
Building and civil works	1700.27	1349.13
Plant, machinery, equipment and utilities	4419.42	15248.81
Miscellaneous fixed assets	248.39	90.29
Pre-operative expenses and other miscellaneous expenses	189	375.4
Interest during construction	114.55	514.07
Contingency cost	138.33	355.67
Total	7054.93	18139.2

Source: Vikram Solar 2024

Analysis carried out by RCT Solutions GmbH for Premier Energies, as mentioned in the DHRP document by Premier Energies.

Particulars	Estimated cost for 4 GW Cell Facility (INR million)	Estimated cost for 4 GW Module Facility (INR million)	Total estimated cost (INR million)
Land and site development		1293.6	1293.6
Buildings and civil works	1383.84	996.17	2380.01
Plant and machinery	12202.96	3399.91	15602.87
Utilities	6706.15	1192.99	7899.14
Design, engineering and project management	252.8	108.4	361.2
Miscellaneous	660.5	348.19	1008.69
Contingency	478.6	175.89	654.49
Interest during construction, security margin and debt service reserve account	2117	2102	5442.75

Total	23801.85		34642.75

Source: Premier Energies 2024

Analysis carried out by Waaree Energies with respect to estimated cost for setting up 6 GW of integrated ingot to module plant.

Particular	Total Estimated Cost (INR million)
Land	1385.8
Engineering consultancy- total plant design	275.52
Engineering consultancy- detailed engineering design for the plants, engineering design for mechanical, electrical and public works and project management consultancy	530.15
Civil Infrastructure and development works	10856.06
Ingot and wafer manufacturing machinery: manufacturing plant, automation system, recoating and regrooving tool, laboratory equipment and recycle silicon cleaner and jaw crusher	18748.52
Cell manufacturing machinery: main plant, installation and commissioning, automated guiding vehicle system and automatic packaging line, manufacturing execution system, turnkey service and laboratory equipment	20041.54
Module manufacturing machinery: main plant, multi bus bar photovoltaic cell soldering stringer machine, sun simulator, laboratory	4655.3

equipment and balance module laboratory equipment	
Utilities for ingot and wafer plant, cell manufacturing plant and module manufacturing plant as well as common utilities	29318.82
IT Infrastructure	929.96
Freight charges	1285.97
Miscellaneous expense	874.98
Contingencies	1596.97
Total	90499.59

Source: (Waaree Energies 2024)

Annexure 5

Calculating Depreciation from Capital Expenditure

In general, depreciation from capital expenditure is calculated by dividing the total capital expenditure per production unit by the asset's useful life. From the literature, the useful life of the machinery and building facility required for cell manufacturing are 5 years and 20 years, respectively (APVI 2023). The depreciation arising from the capital expenditure for machinery and buildings for in India is calculated as follows.

Table 1: Calculation of depreciation using straight line depreciation method

Capital Asset	Useful life	Average Indian Capital Expenditure (USD per Wp)	Straight Line Depreciation (USD per Wp)
Buildings and civil works	20	0.00468	0.000234
Plant, Machinery, Equipment and Utilities	5	0.0577	0.01154
Total	-	0.06238	0.011774

Source: APVI 2024, Vikram Solar 2024, Premier Energies 2024, Waaree Energies 2024

Thus, the total depreciation of capital expenditures, when calculated through a straight-line method for Indian manufacturers, is USD 0.011 per Wp. Combining this depreciation with the other manufacturing costs allows us to compare the cost of manufacturing in India and China more comprehensively.

Annexure 6

Table 2: TOPCon patent infringement lawsuits

Date	Patent infringement lawsuit filed by	Patent infringement lawsuit filed against	Technology on which lawsuit has been filed	Region in which it has been filed	Patent number
February 2025	First Solar	JinkoSolar	TOPCon	USA	US9130074
February 2025	JinkoSolar	Waaree	TOPCon	USA	US11824136B2
February 2025	Trina Solar	Canadian Solar	TOPCon	China	ZL201710975923.2
February 2025	Trina Solar	Canadian Solar	TOPCon	China	ZL201510892086.8
February 2025	JinkoSolar	LONGi	TOPCon	Australia	
January 2025	JinkoSolar	LONGi	TOPCon	China	

January 2025	Qcells	Multiple unknown	LECO for TOPCon		
December 2024	JinkoSolar	VSUN	TOPCon	USA	US11581454
December 2024	JinkoSolar	Toyo	TOPCon	USA	US11824136B2
November 2024	First Solar	Canadian Solar	TOPCon	not filed,	
November 2024	First Solar	LONGi	TOPCon		
November 2024	First Solar	JA Solar	TOPCon		
November 2024	First Solar	Trina Solar	TOPCon		
October 2024	Trina Solar	Canadian Solar	TOPCon	USA	US9722104
October 2024	Trina Solar	Canadian Solar	TOPCon	USA	US10230009

October 2024	Trina Solar	Runergy	TOPCon	USA	US9,722,104
October 2024	Trina Solar	Runergy	TOPCon	USA	US10,230,009
October 2024	Trina Solar	Adani	TOPCon	USA	US9,722,104
October 2024	Trina Solar	Adani	TOPCon	USA	US10,230,009
August 2024	JA Solar	Astronergy	TOPCon	Germany	EP2787541B1
August 2024	JA Solar	Astronergy	TOPCon	Germany	EP4092759B1
April 2024	Maxeon	REC	TOPCon	USA	
April 2024	Maxeon	HanWha	TOPCon	USA	

Source: Various Magazine articles

Annexure 7

Calculation of disbursed PLI amount

PLI formula as of tranche II is Sum of (Base PLI rate * Local Value Addition Factor* Tapering Factor * Sales). The Base PLI rate across the three baskets of vertical integration (Polysilicon to module, wafer to module and cell to module), are given in the Table 3.

Table 3: Base PLI rates across three baskets of vertical integration in tranche-II of PLI.

Base PLI rate (for the P+W+C+M bracket) in INR per Wp						
Module's temperature coefficent	20.5 - 21	21 - 21.5	21.5 - 22.00	22 -22.5	22.5- 23	>23
(-0.4, -0.3)	0	1.45	1.65	1.85	2	2.2
>-0.3	1.45	1.65	1.85	2	2.2	2.2

Base PLI rate (INR/Wp) (W+C+M) in INR per Wp						
Module's temperature coefficent	20.5 - 21	21 - 21.5	21.5 - 22.00	22 -22.5	22.5- 23	>23
(-0.4, -0.3)	0	0.9	1.05	1.25	1.4	1.55
>-0.3	0.9	1.05	1.25	1.4	1.55	1.55

Base PLI rate (INR/Wp) (C+M) in INR per WP						
Module's temperature coefficent	20.5 - 21	21 - 21.5	21.5 - 22.00	22 -22.5	22.5- 23	>23
(-0.4, -0.3)	0	0.5	0.65	0.85	1	1.15
>-0.3	0.5	0.65	0.85	1	1.15	1.15

Source: MNRE PLI tranche-II announcement, (MNRE 2022)

The following assumptions are taken for calculation.

Assumptions	Description	Value
Sales (GW)	30% utilisation of a 2 GW facility are sold per year	0.6
Efficiencies of module sold	>21.5%	
Temperature coefficient	Can be either (-0.4, -0.3) or >-0.3	
Base PLI rate(INR per Wp)	Assuming firm can be in P+W+C+M, W+C+M, or C+M bracket	1.44791667

Local Value Addition factor	>90 per cent	1
Tapering factor	Tapering factor average over 5 years will be 1	1

From this, the PLI disbursed is calculated using the formula mentioned as following:

Calculation of PLI disbursed per year (USD million)	PLI disbursed at the end of five years (USD million)	Total Capital Expenditure by manufacturer (USD million)
10.22058824	51.10294118	140

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