Crisil
Intelligence

Industry research report on solar equipment and renewable energy

GK Energy Limited

Review and outlook | August 2025

by S&P Global

Crisil Intelligence

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Module 1: Global macroeconomic view

India to outpace major economies amid subdued global growth prospects

Global economic performance has been mixed, with growth rates varying significantly across countries.

The additional tariffs the United States (US) imposed on most countries have led to trade tensions. The US has imposed an additional 25% tariff on Indian goods, effective 21 days from August 6th, 2025, in response to India's continued purchase of Russian crude oil. This new tariff brings the total additional duty on Indian products to 50%, on top of a previous 25% tariff announced on July 31st, 2025.

According to the International Monetary Fund (IMF), global growth is projected to drop to 3.0% in calendar year 2025, down from 3.3% in the previous year. The IMF expects US growth to fall sharply to 1.9% in 2025 (2.8% in 2024) on account of greater policy uncertainty, trade tensions and softer demand momentum. At the same time, euro area growth is estimated to remain subdued at 1%.

Within emerging markets and developing economies, China's growth is likely to decline to 4.8% (5% in 2024). India, however, is expected to maintain its 6.5% pace, albeit with downside risk from external headwinds.

Table 1: Real GDP growth

YoY (%)	CY18	CY19	CY20	CY21	CY22	CY23	CY24P	CY25P	CY26P
World	3.7	2.9	-2.7	6.6	3.6	3.5	3.3	3.0	3.1
Advanced economies	2.3	1.9	-4.0	6.0	2.9	1.7	1.8	1.5	1.6
- Euro area	1.8	1.6	-6.0	6.3	3.5	0.4	0.9	1.0	1.2
- Germany	1.1	1.0	-4.1	3.7	1.4	-0.3	–0.2	0.1	0.9
- United States	3.0	2.6	-2.2	6.1	2.5	2.9	2.8	1.9	2.0
- United Kingdom	1.4	1.6	-10.3	8.6	4.8	0.4	1.1	1.2	1.4
- Japan	0.6	-0.4	-4.2	2.7	0.9	1.5	0.2	0.7	0.5
Emerging & developing economies	4.7	3.7	-1.7	7.0	4.1	4.7	4.3	4.1	4.0
- China	6.8	6.1	2.3	8.6	3.1	5.4	5.0	4.8	4.2
- India*^	6.5	3.9	-5.8	9.7	7.6	9.2	6.5	6.5	6.7#

**India numbers are on a fiscal year basis (Apr-Mar), where calendar year (CY) 2025 would correspond to fiscal 2026; other countries are on calendar year basis. #Indicates CAGR for fiscal 2027P- fiscal 2030P ^ Estimates for India as per MOSPI, Crisil Intelligence; E – estimated; P – projected; Euro area includes Germany, France, Italy and Spain; Source: IMF World Economic Outlook, July 2025, Crisil Intelligence*

Monetary cycles to ease in the medium term, tariff actions monitorable

The Monetary Policy Committee (MPC) of the Reserve Bank of India (RBI) cut the repo rate by 50 basis points (bps) in June, following a 25-bps cut in February and April each. It also announced the cash reserve ratio (CRR) would be cut by 100 bps in four tranches between September and November 2025.

The MPC began its rate-cutting cycle later than the central banks of advanced economies. The US Federal Reserve (Fed) had cut rates 100 bps between September and December 2024. That said, the MPC has a neutral stance, which provides the flexibility to vary rate actions based on incoming data.

Crisil Intelligence expects the RBI to remain proactive in using its liquidity and forex tools to support domestic financial conditions. Easier liquidity conditions are needed to transmit the MPC's rate cuts to broader market interest rates.

The Trump administration's tariff hikes have disrupted the Fed's monetary-easing journey. Higher tariffs are likely to add to US inflation in the short term due to higher cost of imported goods. While the timing and extent of tariff hikes are uncertain, the Fed is likely to err on the side of caution and watch how inflationary pressures evolve. It had already hit pause on its rate-cutting cycle in January.

The European Central Bank, Bank of England and Bank Indonesia cut rates between January and February 2025 despite the Fed's pause.

Table 2: Inflation movement across key economies

YoY (%)	CY22	CY23	CY24E	CY25P
Advanced economies				
- Euro area	8.4	5.4	2.4	2.1
- US	8.0	4.1	3.0	3.0
- UK	9.1	7.3	2.5	3.1
- Germany	8.7	6.0	2.5	2.1
- Japan	2.5	3.3	2.7	2.4
Emerging market and developing economies				
- China	2.0	0.2	0.2	0.0
- India	6.7	5.4	4.6	4.0

E – estimated; P – projected

Note: The above table is on calendar year basis; for India, data is based on fiscal year, with fiscal 2025 shown in 2024

Source: IMF World Outlook, July 2025, Crisil Intelligence for India

Module 2: Indian macroeconomic view

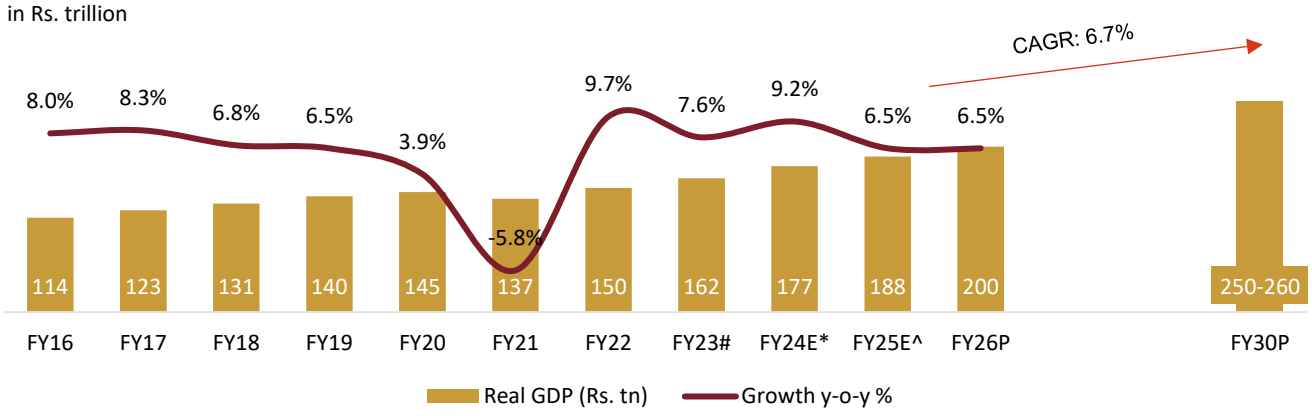
GDP review and outlook

Despite ongoing global geopolitical instability, India has maintained its position as one of the fastest-growing major economies globally. The country's real GDP is estimated to have grown at 6.5% on-year in fiscal 2025, according to the National Statistical Office's (NSO) second advance estimate of national income.

Crisil Intelligence expects India to maintain its GDP growth at 6.5% this fiscal with downside risks. The combination of easing inflation, the RBI rate cuts, and the personal income-tax cuts announced in the fiscal 2026 budget are expected to benefit households and boost consumption.

That said, tariff-related and geopolitical uncertainties have made the global environment uncertain and raised downside risks to global as well as India's growth.

Figure 1: Historical GDP growth and outlook



*Note: E = Estimated, P = Projected; GDP growth till fiscal 2022 is actual, FY23 is Final Estimate *FY24E is First Revised Estimate, ^FY25E is Second Advance Estimate, FY26 is projected based on Crisil Intelligence estimates and that for fiscals 2026-2030 is based on IMF estimates*

Source: NSO, Crisil Intelligence

Over fiscals 2022 to 2025, the Indian economy has outperformed its global counterparts. Going forward as well, the Indian economy will remain strong and would continue to be one of the fastest-growing economies.

Table 3: India's GDP and macroeconomic outlook

Macro variable	FY23	FY24	FY25	FY26P	Rationale for outlook
Real GDP (%, y-o-y)	7.2	9.2	6.5	6.5*	Lower inflation and the RBI's rate cuts are expected to maintain growth this fiscal, assuming a normal monsoon and lower crude prices. The budget will be mildly supportive of growth, though the fiscal impulse will moderate with fiscal consolidation. Any substantial pick-up in investment growth will hinge on accelerating private capex. Exports face headwinds from tariff hikes initiated by the US

Macro variable	FY23	FY24	FY25	FY26P	Rationale for outlook
Consumer price Index (CPI) inflation (%, y-o-y)	6.7	5.4	4.6	4.0	Inflation is likely to move closer to the RBI's target of 4% on expectations of a normal monsoon, high base effect in food inflation and softer global commodity prices. Some uptick is expected in non-food inflation due to an adverse base
Current account balance/GDP (%)	-2.0	-0.7	-0.6	-1.3	The current account deficit (CAD) is expected to increase owing to headwinds to exports from US tariff policies. Lower crude oil prices, healthy services trade balance and robust remittances growth will prevent the CAD from widening too much
₹/US$ (March end)	82.3	83.0	86.6	87.5	A manageable CAD would mean not much pressure on the rupee, but geopolitical shocks could keep the rupee volatile

P: Projected
*Note: * with downside risk*
Source: RBI, NSO, Crisil Intelligence

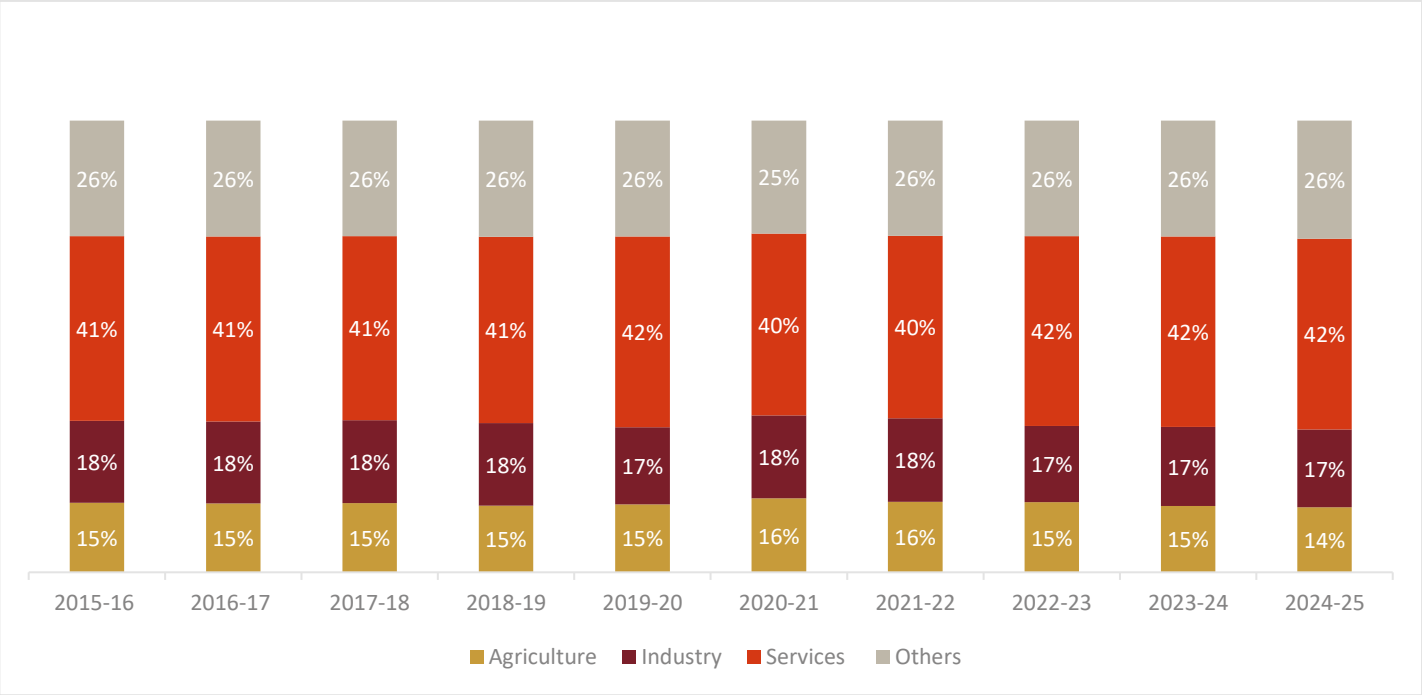
Contribution of key sectors to gross value added

India's gross value added (GVA) has grown consistently over the years except in fiscal 2021, when it was impacted by the pandemic-induced lockdown. The services sector has remained a significant contributor. Growth in services exports, accounting for half of the country's overall exports, has continued to outpace the economic growth.

The growth in the manufacturing GVA, which clocked a compound annual growth rate (CAGR) of 4.7% between fiscals 2016 and 2024, is attributable to government initiatives such as Atmanirbhar Bharat campaign, Make in India initiative and the production-linked incentive (PLI) scheme. Although the share of industry in the GVA has remained constant at 18%, a large percentage of PLI capex that is yet to be commissioned is expected to boost the share of both manufacturing and exports.

The agriculture sector's GVA clocked a CAGR of 4.5% between fiscals 2016 and 2024, driven by the subsidy support to farmers and other government initiatives such as the Pradhan Mantri Krishi Sinchayee Yojana. Normal monsoon rainfall, various government schemes and favourable agricultural commodity prices over the past two fiscals have aided the growth.

Figure 2: Contribution of key sectors (industry, agriculture and services) to GVA



Source: MoSPI, Crisil Intelligence

Multi-pronged policy focus helps prop up rural segment

The rural economy has benefitted from two consecutive years of good monsoon and increased spending under the Mahatma Gandhi National Rural Employment Guarantee Act, irrigation programmes and schemes such as Direct Benefit Transfer, PM Kisan, PM KUSUM, PM Ujjwala Yojana for cooking gas, PM Awas Yojana for housing and Ayushman Bharat Yojana for healthcare. To supplement this, there has been a continuous improvement in electricity and road infrastructure in rural areas. In addition, the Reserve Bank of India mandates priority sector lending to specific sectors, such as agriculture and allied activities, education, housing and food for the poorer population. Out of the overall target of 75% of total outstanding towards priority sector lending by regional rural banks, the agriculture sector is allotted 18%. The lending is categorised as (i) farm credit (short-term crop loans and medium/long-term credit to farmers) (ii) agriculture infrastructure and (iii) ancillary activities. Such initiatives have led to reduced leakages and higher incomes for the rural populace, thereby enhancing their ability and willingness to spend on discretionary products and services. To boost agriculture growth and developing the product dynamics in the country, the government also established Agriculture infrastructure fund of ₹ 1 trillion at farm-gate and aggregation points aimed at making the sector affordable and financially viable. The rural economy accounts for almost half of India's gross domestic product and has recorded a better performance in last decade, compared with its urban counterpart in the aftermath of the pandemic.

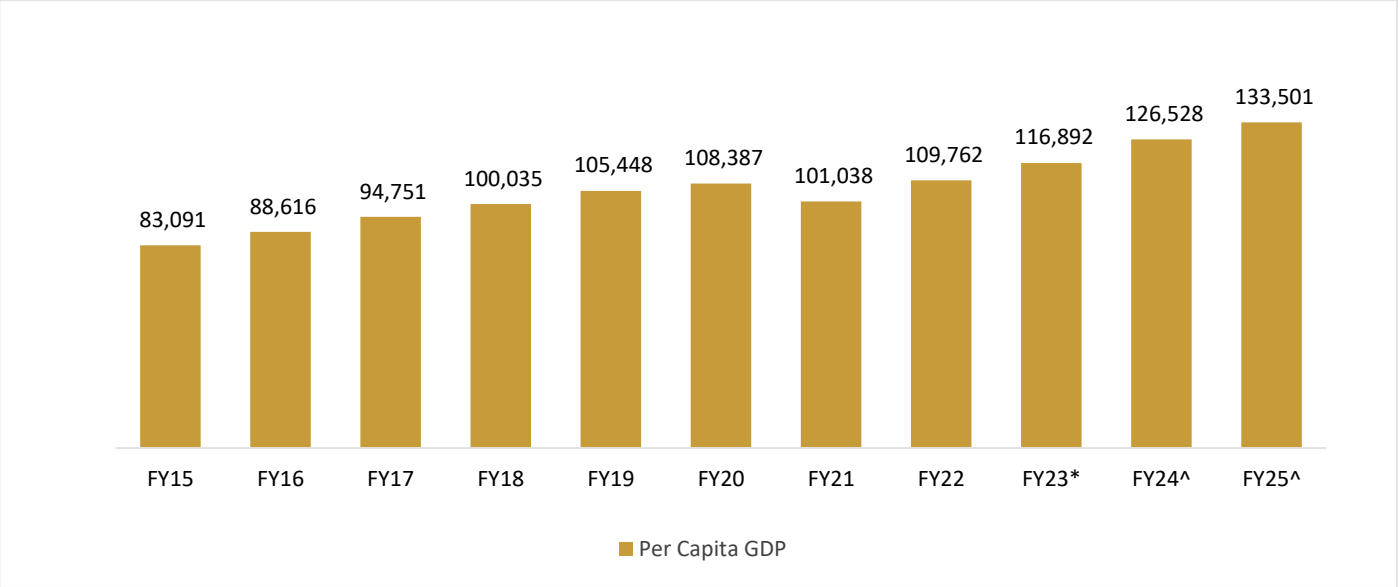
In addition to the budgetary support, favourable monsoon has supported farm prospects in FY25. In terms of rural incomes, stable agricultural output is expected to provide some relief. Rural India remains largely agrarian, with 86% of land holdings belonging to small and marginal farmers, who dominate the Indian agricultural landscape. These farmers rely heavily on the monsoon for irrigation, making its timely arrival and adequacy crucial for a good crop. Any negative impact on crop supply due to low rainfall has a cascading effect on the rural economy, leading to reduced earnings and lower spending. Over the last five years, the performance of the agriculture sector has been encouraging in contrast to the CAGR of (3.7) % from FY13 to FY18, the sector has witnessed a healthy pace of growth, with the Agri Gross Value Added (GVA) growing at a CAGR of 4.2% during the FY19-24 period.

Although the growth slowed to 2.7% in FY24 due to an unfavourable monsoon, the sector is expected to rebound, with Agri GVA projected to grow at a healthy pace of 4.6% in FY25. Given the significant role of the rural economy in driving demand for the automotive industry, particularly for two-wheelers, three-wheelers, and tractors, which source large share of their demand from rural areas, demand for these segments is expected to remain robust.

GDP per capita trends

India's GDP per capita in real terms logged CAGR of 4.86% between Fiscals 2015 and 2025, rising from ~₹ 83,091 to ~₹133,501.

Figure 3: India's GDP per capita (₹)



Note: Data is based on constant prices, 2011-12 base

*Note: * indicates final estimates, ^ indicates first revised estimates, & indicates provisional estimates*

Source: National Accounts Statistics, Crisil Intelligence

Crop cycles, pricing and production are major factors towards influencing farmer incomes and hence largely rural growth. For instance, farmer income would be largely impacted by the monsoon quality, the crop chosen for sowing and the market pricing policy for the crop.

Consequently, to mitigate the volatility related to agricultural income, the government through various schemes has tried to improve income levels for this segment of the economy. Some of them are:

- Direct financial assistance to 118 million farmers under the PM Kisan scheme, crop insurance to 40 million farmers under the PM Fasal Bima Yojana scheme.
- PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) Scheme is aimed at ensuring energy security for farmers in India, along with increasing the renewable energy share in India.
- Introduced PM Surya Ghar Muft Bijli Yojana. Under this scheme, the government aims to make 10 million households self-sufficient in generating up to 300 units of electricity per month.
- The PM Kisan Sampada Yojana scheme has benefitted 3.8 million farmers and generated 1 million employments. The PM Formalisation of Micro Food Processing Enterprises Yojana scheme has assisted 0.24 million self-help groups and 0.06 million individuals with credit linkages.

Global focus increases on energy transition and power decarbonization

The urgent need to address climate change is driving the shift towards renewable energy, with international initiatives like the Paris Agreement and RE 100 promoting its adoption. To limit global warming, a transition to renewable energy is critical. The global clean energy transition has been boosted by solar power, which has experienced remarkable growth, with installed capacity almost tripling since 2018 to reach 1,418 gigawatts by 2023, accounting for 37% of the world's total renewable energy capacity. Governments have supported the solar industry through policies like feed-in tariffs, tax incentives, and subsidies, accelerating global growth in solar photovoltaics and driving the sector's expansion.

The 2021 United Nations COP26 was the 26th United Nations Climate Change conference, held at Glasgow, Scotland during October-November 2021 and a draft agreement was circulated with respect to climate change action. The proposal aims at updating the time frame for revised targets NDCs to next year — much sooner than the requirement of every five years as laid out in the 2015 Paris Climate Accord. India updated its NDCs as follows:

- To reduce emissions intensity of its GDP by 45% by 2030, from 2005 level
- To achieve about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030
- By the year 2070, India will achieve the target of Net Zero

The Indian government has initiated efforts to combat climate change through multiple programmes and schemes, such as the National Action Plan on Climate Change (NAPCC), which comprises missions in specific areas of solar energy, energy efficiency, water, sustainable agriculture, Himalayan ecosystem, sustainable habitat, health, Green India and strategic knowledge for climate change. The National Solar Mission under NAPCC is one of the key initiatives to promote sustainable growth while addressing India’s energy security with the total solar energy potential estimated at 748 GW peak by the National Institute of Solar Energy. Some of the measures undertaken by the Centre to promote renewable power in India are as follows:

Table 4: Policy drivers

Policy initiatives launched by the Indian government	
1. Allowing foreign direct investment up to 100% under the automatic route	2. Extension of waiver of inter-state transmission system charges for inter-state sale of solar and wind power for projects to be commissioned by June 30, 2025
3. Declaration of trajectory for RPOs until 2030. according to which the obligated entities, mainly DISCOMs, in each state, are required to meet their minimum share (24.3% in 2023 to 43.3% in 2030) of electricity purchase from Renewable Energy (RE) sources.	4. Setting up of Ultra Mega Renewable Energy Parks to provide land and transmission to renewable energy developers for installation of related projects on a large scale
5. Introduction of schemes such as PM-KUSUM, PM-Surya Ghar Yojana, Solar Rooftop Phase II, 12,000 MW Central Public Sector Undertaking Phase II, among others	6. Laying of new transmission lines and creating new sub-station capacity under the Green Energy Corridor Scheme for evacuation of renewable power

7. Setting up of a project development cell for attracting and facilitating investments	8. Standard bidding guidelines for tariff-based competitive bidding process for procurement of power from grid-connected solar PV system, wind and hybrid projects
9. Notification of promoting renewable energy through Green Energy Open Access Rules, 2022	10. Notification of The Electricity (Late Payment Surcharge and related matters) Rules, 2022
11. Mandates that power shall be dispatched against Letter of Credit or advance payment to ensure timely payment by distribution licensees to renewable energy generators	12. PM Surya Ghar Muft Bijli Yojana mandates all government rooftops under the administrative control of Central Government Ministries/Departments, shall be saturated with rooftop solar to the extent that is technically feasible by 31st December 2025.

Source: Crisil Intelligence, MoP, MNRE, GoI

The Indian government has implemented several initiatives to promote the use of renewable energy. One such initiative is the Renewable Purchase Obligations (RPOs), which requires distribution licensees to purchase a percentage of electricity from renewable sources. Additionally, the Domestic Content Requirement (DCR) mandates the use of domestically manufactured solar cells and modules in government schemes, such as the CPSU scheme, PM-KUSUM scheme, and grid-connected rooftop solar programs.

The Pradhan Mantri Kisan Urja Suraksha and Utthaan Mahabhiyan Yojana (PM-KUSUM) scheme, launched in 2019, aims to set up 10,000 MW of decentralised grid-connected renewable energy power plants. The scheme also aims to install 1.4 million standalone solar-powered pump systems, and 3.5 million grid connected solar-powered pump systems including feeder level solarisation in off-grid areas to provide energy and water security for farmers. The Production Linked Incentive (PLI) scheme, introduced in 2021 with outlay of Rs 240 billion, aims to boost the manufacturing of high-efficiency solar PV modules and reduce import dependence for solar energy. Overall, the scheme has allocated 21.4 GW of polysilicon, 32.9 GW of wafers, 48.3 GW of cells and module capacity each between two tranches.

The government has also launched the PM Surya Ghar Muft Bijli Yojana, which provides up to 300 units of free electricity to 10 million households with rooftop solar systems. Furthermore, India has contributed to the setting up of the International Solar Alliance (ISA), a global coalition of solar-resource-rich countries that aims to promote the use of solar energy and provide a platform for cooperation among member countries. These initiatives demonstrate India's commitment to increasing the use of renewable energy and reducing its dependence on fossil fuels.

Even in its National Electricity Plan for the generation segment as released on March 2023, the government projects solar and wind resources alone to form 54% of installed base of ~900 gigawatt (GW) as expected by Fiscal 2032. This is going to be driven by the robust pipeline created by government-led tenders as well as the support to the rooftop segment along with other policy pillars provided to the clean energy sector.

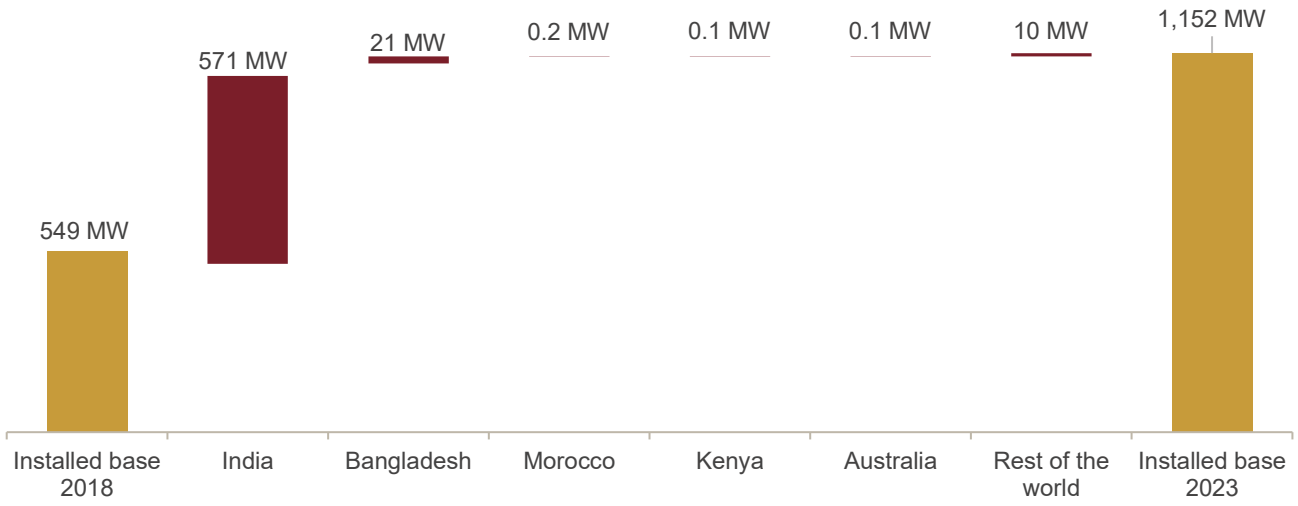
Module 3: Domestic solar-powered pump systems market

Growth drivers for global solar-powered pump systems market

The solar-powered pump systems market has witnessed significant growth globally over the past five years from the beginning of CY2018 to CY2023. These pumps are increasingly seen as a sustainable and economically viable alternative to traditional diesel-powered irrigation systems, especially in rural areas with limited access to electricity. To respond to growing concerns over climate change, energy access, and rising fuel prices, governments and international organizations are providing incentives to encourage the adoption of solar-powered pump systems.

The agriculture solar-powered pump systems installed capacity has grown nearly 2 times between 2018 and 2023. The total additions from the beginning of CY2019 till the end of CY2023 touched 603 MW with India accounting for 95% of the additions.

Figure 4: India added 571 MW of agricultural solar-powered pump systems from CY2019 till CY2023

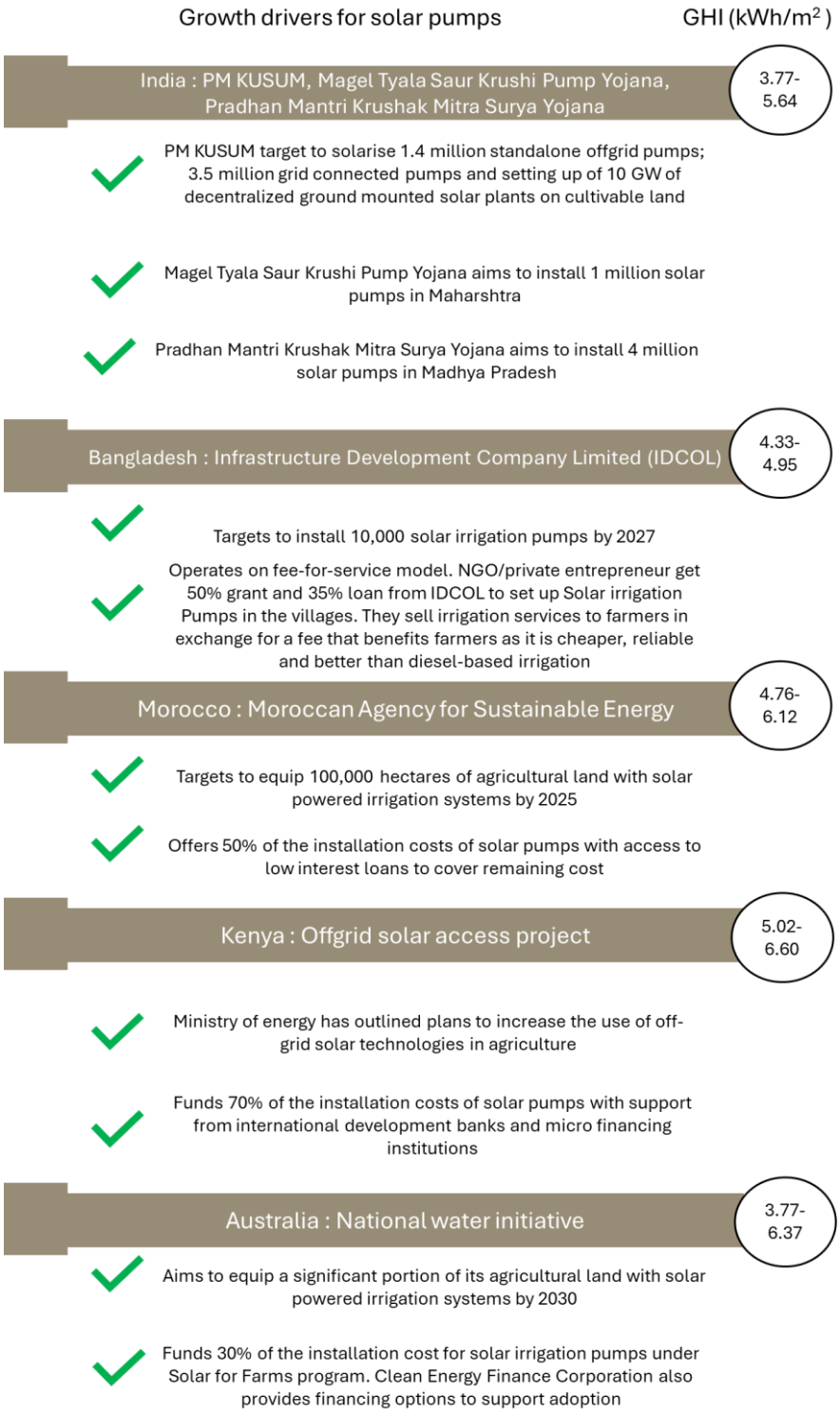


Source: Industry Reports, Crisil Intelligence

Estimates suggest that 1 MW of power output would translate to 250-450 solar-powered pump systems in India, basis the average power output of solar-powered pump systems installed in the country.

India's agriculture land as share of land area was 60% while that of Bangladesh was 77%. These economies also benefit from a good global horizontal irradiance and have policies/incentives in place to promote installations of solar-powered pump systems.

Figure 5: Policy measures in place to boost solar adoption



Note: GHI stands for global horizontal irradiance.

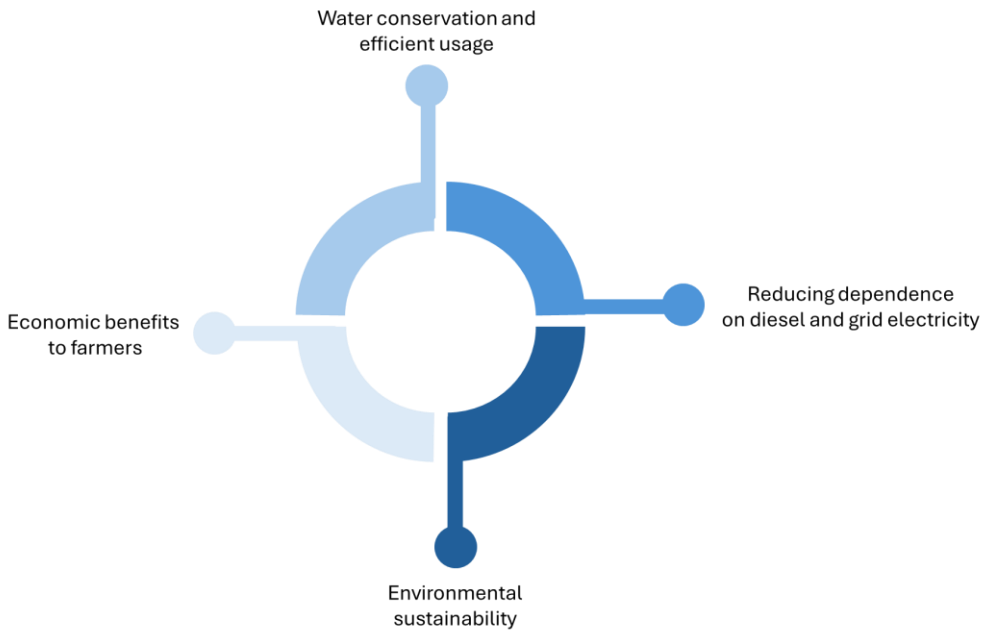
Source: Global Solar Atlas, Asian Development Bank, Government websites, Crisil Intelligence

Need for solar-powered pump systems in India

India as a country has a large agricultural base with more than 46.1% of its population depending on agriculture for their livelihood, as per Economic Survey 2024-25. In fact, as per the PM-KISAN, the number of farmer beneficiaries reached nearly 118 million. Indian farmers are heavily dependent on erratic monsoons and groundwater extraction for irrigation, both of which face significant challenges. As per government report on PM-KUSUM, as of 2022, 8 million pumps out of approximately 30 million agriculture pumps installed in India were diesel based. Furthermore, the total diesel consumption of these pumps in a year was 5.52 billion litre per annum along with equivalent CO_2 emissions of 15.4 million tonnes. The balance 22 million pumps largely relied on grid electricity where challenges such as limited supply of electricity (many regions provided electricity primarily at night forcing farmers to irrigate under unsafe conditions, risking accidents from wildlife and adverse weather) and frequent power cuts (extending up to 12 hours in some regions) impede the irrigation process thereby impacting agricultural productivity. Hence, the reliance on diesel pumps poses economic and environmental challenges, reliance on electricity grids poses operational issues to tackle.

In this context, the solar-powered pump systems industry looks at the robust prospect going ahead as it presents a transformative solution, offering an environmentally sustainable cost effective and reliable alternative to traditional irrigation methods. Some of the incentives a solar-powered pump systems offers are it reduces dependency on diesel and grid electricity, saves costs and increases revenue with multiple crops over the years for farmers and also conserves water. The standalone solar-powered pump systems offer a viable solution for irrigation in remote locations, hilly terrains etc. where grid connectivity is a challenge.

Figure 6: Reduction in grid dependence and improvement in farmers' income key objectives of PM KUSUM



Source: Crisil Intelligence

1. Reducing dependence on diesel and grid electricity

Diesel powered pumps are widely used in Indian agriculture due to limited access to grid electricity, especially in remote and rural areas. However, they come with high operational costs, particularly due to the volatile prices of diesel. Furthermore, access to grid electricity is inconsistent, especially in remote agricultural areas. Even in

regions where electricity is available, the supply is often unreliable, with frequent power cuts. As per government released data disclosures, rural power supply over the past five years witnessed power cuts of an average of ~3.5 hours at least per day. Farmers in many parts of India receive electricity for limited hours a day, which often forces them to irrigate during odd hours, impacting farm productivity. Solar-powered pump systems provide an irrigation solution without reliance on either diesel or grid electricity.

Table 5: A shift from is diesel/grid to solar powered pump systems enables farmers to save ₹0.8-1.4 million

3 and 5 HP	Units	Diesel	Grid	PM-KUSUM	
				Non-special category states	Special category states
Cost of ownership to farmer	₹ million	1 - 2	0.19 - 0.2	0.07 - 0.11	0.04 - 0.06
Cost of ownership to government		0	0.23 - 0.24	0.1 - 0.15	0.14 - 0.22
Cost of ownership to farmers and government		1 - 2	0.41 - 0.42	0.17 - 0.26	0.18 - 0.28
Savings to farmer from shifting to solar pump		0.8 - 1.4	0.09 - 0.12		
Savings to farmers and government from shifting to solar pump		0.7 - 1.3	0.16 - 0.24		

Note: Operational expenses considered have been for a 10-year period. Excludes replacement cost of pumps.

Source: Crisil Intelligence

The shift from diesel/grid to solar powered pump systems also helps the government to save money which was otherwise required to invest in meeting renewable purchase obligations. The funding for this is primarily coming from “Tax on Sale of Electricity” in Maharashtra and similar levies in other states.

2. **Environmental sustainability**

Reduction in carbon emissions: India has set ambitious targets to reduce carbon emissions and transition toward renewable energy. Diesel pumps contribute significantly to carbon emissions in the agriculture sector. On an average, a 3 horsepower (HP), 5 HP, 7.5 HP and 10 HP diesel pump emit 2-3, 3-4, 4-6 and 5-7 tonnes respectively of CO_2 annually assuming 5 to 6 operational hours per day with 200 days of operations. Solar-powered pump systems, on the other hand, are a zero-emission technology once deployed. The widespread adoption of solar-powered pump systems could replace India’s agricultural carbon footprint by millions of tons annually, supporting the country's commitment to the Paris agreement and its goal of achieving net zero emissions by 2070.

3. **Economic benefits to farmers**

   a. Reduction in operational cost: Solar-powered pump systems, while having a higher initial installation cost, results in substantial long-term savings for farmers. Under the PM-KUSUM scheme, launched in 2019, the central and state governments provide subsidy making solar power pump systems more affordable for small and marginal farmers. Under this scheme, depending on state subsidy contribution and actual discovered price of the pump systems, farmers are required to pay anywhere between 5-69% of the total cost upfront, with options for financing via loans.

   b. Additional income through solar power sale: An additional economic benefit of solar-powered pump systems is the ability to sell surplus electricity back to the grid. Under Component C of the PM-KUSUM scheme, farmers with solar-powered pump systems can generate more electricity than they need for irrigation and sell the excess to the grid. This provides an additional income stream.

4. **Water conservation and efficient usage:** As per The Energy and Resource Institute (TERI), India is one of the world’s largest consumers of groundwater, with more than 60% of irrigated agriculture and 85% of drinking

water supplies dependent on it. This has led to over-extraction of groundwater in many states such as Punjab, Haryana, and Uttar Pradesh, where the water table is depleting at an alarming rate. Solar-powered pump systems when combined with technologies like drip irrigation and micro irrigation can help farmers use water more efficiently. Since solar-powered pump systems operate during the day, farmers are encouraged to adopt water efficient practices. They can run their pumps in shorter, more controlled bursts rather than keeping them running continuously, which is common with diesel pumps.

Market size of agriculture solar-powered pump systems in India

The Indian solar-powered pump systems market has experienced remarkable growth, especially driven by the PM-KUSUM initiative launched by the central government in 2019. Fresh installations of solar-powered pump systems under PM KUSUM from the beginning of Fiscal 2019 to July 2025 scaled up to approximately 0.85 million.

Within PM-KUSUM, the installed base by July 2025 was largely driven under component B to the extent of ~99%. States like Maharashtra, Haryana, Rajasthan have shown high policy focus on enhancing deployment. They collectively accounted for 72% of the sanctions under component B by July 2025.

Table 6: Top three states comprise 72% of sanctions under component B of PM KUSUM

States	Sanctioned as of July 31, 2025	Share in total (%)
Maharashtra	555,000	44%
Rajasthan	162,914	13%
Haryana	197,655	16%
Uttar Pradesh	107,266	8%
Madhya Pradesh	59,400	5%
Others	190,523	15%

Note: The above data is as per dashboard accessed on 18th August 2025 on PM KUSUM portal.

The data in third column has been rounded off and may not add to 100%

Source: MNRE

Table 7: PM-KUSUM state wise installations under component B

States	Installed base till July 31, 2025	Share (%)
Maharashtra	423,379	50%
Haryana	161,073	19%
Rajasthan	106,831	13%
Uttar Pradesh	64,468	8%
Jharkhand	33,346	4%
Others	59,233	7%

Note: The above data is as per dashboard accessed on 18th August 2025 on PM KUSUM portal

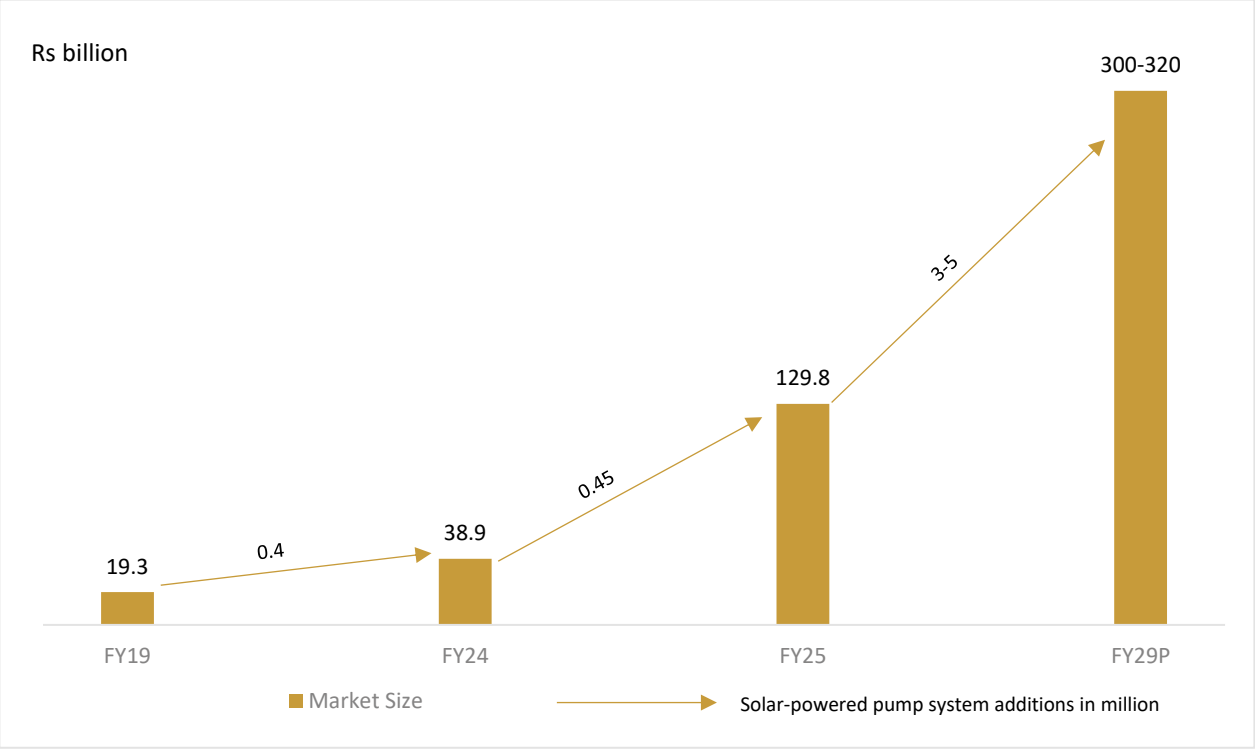
The data in third column has been rounded off and may not add to 100%

Source: MNRE

The top three states of Maharashtra (50%), Haryana (19%) and Rajasthan (13%) were cumulatively responsible for 81% of all installations in PM-KUSUM component B from the beginning of Fiscal 2019 to July 31, 2025.

The market size of domestic solar-powered pump systems logged a 15% CAGR from ₹19.3 billion in Fiscal 2019 to ~₹39 billion in Fiscal 2024. A key driver for the market has been the inclusion of other categories of players, especially EPC participants, post November 2020. This has led to a rapid rise in installation rate since the beginning of Fiscal 2022.

Figure 7: Indian solar-powered pump systems market to grow ~8 times between Fiscals 2024 and 2029



Note: The above market estimation is based on solar power pump system additions within and outside of PM KUSUM purview coupled with view on solar-powered pump system prices.

Source: Crisil Intelligence

Going ahead, installations are expected to be driven by policy, increased consumer awareness and player proliferation. The segment is expected to witness a multi-fold growth under the PM KUSUM initiative.

PM-KUSUM witnessed a capacity addition of ~0.5 million solar pumps between March 2024 and July 2025, indicating faster implementation, complemented by higher demand. This is expected to drive expansion in the coming period. Crisil Intelligence expects the installed base under PM-KUSUM to increase from 0.85 million (as per "List of beneficiaries" details from PM KUSUM portal as accessed on 18th August 2025) at the end of July 31, 2025, to ~4.0 million by the end of fiscal 2029. With this, nearly 77-82% of the sanctioned base under PM-KUSUM components B and C would have been installed by fiscal 2029. The improvement will be further supported by state-driven initiatives such as Maharashtra's Magel Tyala Saur Krushi Pump Yojana, with a similar completion rate expected against a sanction of 1 million pumps by fiscal 2029 and Madhya Pradesh's Pradhan Mantri Krishak Mitra Surya Yojana, was approved on January 24, 2025. According to secondary domain reporting, discussions are on to extend the tenure of PM-KUSUM scheme beyond its current end date of March 31, 2026. This provides an upside to the above outlook. Furthermore, the price of domestically manufactured modules (module cost accounts for 40% of the total bill of materials) is expected to fall by Fiscal 2029 owing to expansion in upstream manufacturing capacity.

Thus, Crisil Intelligence expects the market size to reach ₹300-320 billion by Fiscal 2029, witnessing a significant CAGR of ~52% between Fiscals 2024 and 2029. Close to 84% of the additions will be under the PM-KUSUM components B and C. The balance additions are expected to be driven by state government schemes like Magel Tyala Saur Krushi Pump Yojana and Pradhan Mantri Krishak Mitra Surya Yojana.

Overall, the sector presents a market potential of at least ₹2.6 trillion since the beginning of Fiscal 2019 until over the course of the scheme implementation, which is expected to extend beyond Fiscal 2029. While prior to government efforts to popularise and subsidise solar-powered pump systems, farmers were hesitant to move away from AC-based power systems and diesel-powered pumps because of the high initial costs and unfamiliarity with the technology, the market's growth now can be attributed to several factors, including supportive policies, escalating diesel costs and improved affordability. The key driver are the distinct advantages solar-powered pump systems enjoy over diesel/grid pumps. These advantages include reduced dependency of the user on electricity supply and protection against motor damage caused by voltage fluctuations. These and the continuous rise in diesel prices are compelling farmers to shift to more viable solar-powered pump systems alternatives to irrigate their fields. Further, solar-powered pump systems are easily available now as there are multiple vendors in the market and their information is available on a central portal. Going forward, technological innovations, such as Internet of Things (“IoT”) and Artificial Intelligence (“AI”) applications, will further drive growth. IoT enables real-time monitoring and remote control, while AI-driven predictive maintenance and smart irrigation optimise efficiency and reduce costs

Apart from this, MNRE has also proposed an update to standards and specifications for solar-powered pump systems with micro pumps. Module capacity in the range of 200 watt-peak (Wp) to 500 Wp with a motor pump capacity of 0.2 HP to 0.5 HP are expected to be deployed. The micro solar-powered pump systems are beneficial to micro, small and marginal farmers as they enable benefits of a large solar-powered pump systems at low cost suitable for their small land holdings. With over 100 million small farmers in India, the potential for micro solar-powered pump systems is also high.

Policy supports at multiple levels to help improve access to solar powered pump systems for farmers

PM – KUSUM

In March 2019, the Government of India launched the Pradhan Mantri Kisan Urja Suraksha evan Utthaan Mahabhivan Scheme (PM-Kusum Scheme), with an outlay of ₹344 billion as central financial support. The objective is to install 10 GW of solar capacity under component A, 1.4 million standalone solar-powered pump systems under component B and 3.5 million grid connected solar-powered pump systems including feeder level solarisation under component C in off-grid areas to provide energy and water security for farmers, reduce the consumption of diesel, promote the use of renewable energy in the agricultural sector and reduce environmental pollution. The PM-KUSUM Scheme also focuses on the solarisation of pumps in India for agriculture. The scheme consists of three components.

Figure 8: PM KUSUM consists of three components

Component A	Component B	Component C
Set up 10 GW of decentralized ground or still mounted grid connected solar/renewable power plant on barren or cultivable land Solar power generated will be purchased by DISCOMs at a feed-in-tariff determined by SERC	Target to install 1.4 million standalone off-grid solar water pumps in off-grid areas to replace diesel pumps Individual farmers will be supported to install standalone solar agriculture pumps of capacity up to 7.5 HP in off-grid areas	Solarise 3.5 million existing grid connected agriculture pumps, reducing dependence on grid power and providing reliable, sustainable energy for irrigation

Source: PM-KUSUM, Crisil Intelligence

For the pump cost, under component B, the central government offers financial assistance to special and non-special states.

1. Special states: North-eastern states, Sikkim, Jammu & Kashmir, Himachal Pradesh and Uttarakhand, Lakshadweep and A&N Islands benefit from central financial assistance (CFA) of 50% of the benchmark cost.
2. Nonspecial states: Remaining states benefit from a CFA of 30% of the benchmark cost

The farmers' contribution for solar-powered pump systems is determined by two factors: the state subsidy contribution and the actual pump rates discovered during the empanelment process. Some states may offer subsidies over and above the standard 30% (non-special category states) as per the central PM KUSUM policy, and the discovered pump rates may exceed the benchmark costs set by the central nodal agency.

As a result, farmers' contribution for solar-powered pump systems can vary widely, ranging from 5% to 69%.

Table 8: Farmer's contribution ranges from 5-69% across states

State	Central share	State share	Farmer's share	State	Central share	State share	Farmer's share
Maharashtra	22-24%	68-73%	5-10%	Karnataka	29-31%	48-51%	18-24%
Haryana	23%	35%	42%	Manipur	23-26%	23-26%	49-53%
Rajasthan	19-25%	19-25%	49-61%	Nagaland	25-27%	25-27%	47-50%
Uttar Pradesh	22-24%	22-24%	53-57%	Odisha	18-20%	18-20%	61-64%
Gujarat	23-26%	23-26%	48-55%	Jammu and Kashmir	38-45%	23-27%	28-39%
Tamil Nadu	23-25%	23-25%	50-53%	Jharkhand	21-24%	47-53%	22-32%
Punjab	19-26%	19-26%	48-62%	Uttarakhand	47-52%	28-31%	16-25%
Himachal Pradesh	19-52%	12-31%	16-69%	Arunachal Pradesh	16-20%	16-20%	61-69%

Source: PM-KUSUM, SERC, Crisil Intelligence

Higher state subsidy contribution than the recommended 30% (non-special category states) under PM KUSUM help greatly reduce the final burden on the farmer. To provide a perspective, the agricultural power consumption from two of the leading solar pump states, Haryana and Maharashtra, accounted for nearly 20% of the India's agricultural power consumption in Fiscal 2023. This led to the promotion of solar-powered pumps systems being a significant policy area for the two states. Consequently, Maharashtra announced to provide solar-powered pumps

to 1 million farmers under Magel Tyala Saur Krushi Pump Yojana and Haryana also increased its state subsidy contribution to 45%.

As a result, these two states have accounted for 68% of total installations by July 2025 under PM-KUSUM Component B. This high penetration is also supported by the CFA under PM KUSUM, where Haryana and Maharashtra accounted for 48% of the total CFA released between Fiscal 2021 to June 2023 (₹7,262 million). Rajasthan is emerging as another active state with a rising rate of solar-powered pump system installations under PM-KUSUM and has witnessed CFA of ₹4,532 million over the same period.

The major beneficiaries of the PM-KUSUM scheme are individual farmers (with priority given to micro, small and marginal farmers), farmer cooperatives, panchayats, and Farmer Producer Organizations (FPOs). The scheme provides financial support for the installation of solar-powered pump systems and promotes sustainable agricultural practices. State and central governments also benefit from the PM-KUSUM scheme through decentralized solar power and subsidy reduction. The scheme supports broader socio-economic and environmental goals, contributing to sustainable development in rural areas.

The scheme is currently scheduled to conclude on 31 March 2026. However, based on secondary reporting, there are ongoing discussions between government officials and industry stakeholders regarding a possible extension of the PM KUSUM scheme beyond March 2026. Additionally, the central government is also working on plans to launch PM KUSUM 2.0, in response to rising demand of solar pumps.

Benefits of solar-powered pump systems:

1. Reduction in electricity costs: By installing solar-powered pumps, farmers can harness free solar energy, leading to substantial savings on electricity and fuel costs for both farmers and the government.
2. Enhanced irrigation efficiency: Solar-powered pump systems ensure a consistent water supply during the day, which is beneficial in regions with uncertain electricity supply during daytime. This reliability allows farmers to irrigate their crops more efficiently, leading to better crop yields and more consistent agricultural output.
3. Energy independence: Solar installations provide farmers with greater control over their energy resources, reducing their dependency on grid power or expensive diesel generators.
4. Long-term financial benefits: Solar-powered pump systems and installations have low operational and maintenance costs compared to traditional diesel pumps. While the initial capital cost of solar-powered pump systems is higher, the operating expenses are low at ₹2,000-3,000 per annum. On the other hand, the operational expenses for a diesel pump are ₹0.06-0.16 million per annum for a 3 and 5 HP pump. The long lifespan of solar equipment translates to lower long-term costs, further enhancing the economic viability for farmers.
5. Less capex and subsidy outflow requirement from DISCOM: It also reduces capital expenditure needs of the government to set up distribution infrastructure in rural / remote areas. Discoms lose large amounts of cash while supplying subsidised power to agricultural consumers. Agricultural connections are prone to power theft and/or unthoughtful use of power (using cheap inefficient equipment) resulting in huge losses to discoms. Solar-powered pump systems will help reduce the subsidy burden for the government as well as relieving farmers from erratic and staggered supply of power.
6. Other benefits: Solar-powered pump systems help renewable purchase obligations fulfillment, eases burden on discoms for maintenance of grid distribution infrastructure and promotes savings due to lower recurring maintenance and replacement costs

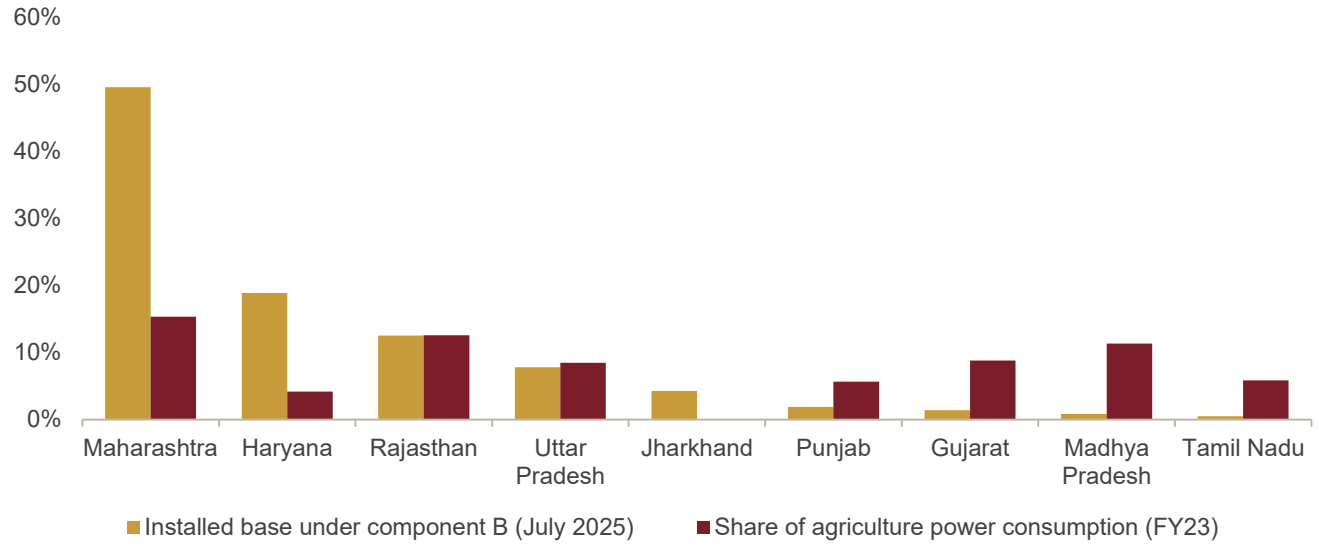
As per PM-KUSUM guidelines released on 22nd July 2019, only manufacturers of solar-powered pump systems, controllers or solar panels were allowed to participate in the bidding process to ensure quality and post installation

servicing. However, this was later amended on 13th November 2020 with the scope of participation extending to those who formed joint ventures with such manufacturers.

Out of the total 8,53,330 solar-powered pump systems installed by the end of July 31, 2025 (as per data accessed from PM KUSUM dashboard on 18th August 2025), the states of Maharashtra, Haryana and Rajasthan accounted for a lion's share of 81% in the installations owing to high irrigation requirements. To provide a perspective, the power consumption in the agriculture segment for these three states accounted for 37% of pan India agricultural power consumption in Fiscal 2022-23. The remaining solar-powered pump systems were contributed by the states of Uttar Pradesh (8%), Jharkhand (4%), Punjab (2%), Gujarat (1%), Madhya Pradesh (1%), Tamil Nadu (0.5%), Tripura (0.6%), Uttarakhand (0.17%), Karnataka (0.28%).

Nearly 99% of the additions were under component B of PM-KUSUM from the beginning of CY2022 to the end of July 2025.

Figure 9: States that dominate agricultural power consumption take the lion's share under component B



*Note: *PM-KUSUM data as accessed from PM-KUSUM dashboard provided till 18th August 2025*

Source: PM-KUSUM, Crisil Intelligence

Table 9: Player wise share in installations

Players	Type of player		Installations under PM KUSUM			
		CY 2022- 2025*	CY 2025*	CY 2024	CY 2023	CY 2022
Shakti Pumps Limited	Pump manufacturer	121,322	21,142	59,577	11,640	28,963
GK Energy Limited	Pure play EPC	55,626	8,594	29,392	10,658	6,982
Rotomag Motors and Controls Private Limited	Pump manufacturer	45,202	11,544	18,004	6,639	9,015
Oswal Pumps Limited	Pump and module manufacturer, EPC services	35,215	9,762	21,673	3,765	15

Avi Appliance Private Limited	Pure play EPC	23,783	4,520	10,818	7,038	1,407
Akshaya Solar Power Private Limited	Pump and module manufacturer	15,724	3,587	6,432	3,004	2,701
Icon Solar En Power Technologies Private Limited	PV module manufacturer	15,225	65	3,588	6,681	4,891
Sahaj Solar Private Limited	PV module manufacturer	14,342	2,831	5,024	3,914	2,573
Gautam Solar Private Limited	PV module manufacturer	9,845	6	292	5,139	4,408
Tata Power Solar Systems Limited	Module manufacturer	52,698	0	16	23,608	29,074

Note:

** For CY2025 the data represents solar pumps installations for the period January 1, 2025, to July 31, 2025. The PM-KUSUM data accessed from PM-KUSUM "List of beneficiaries" as on 18th August 2025*

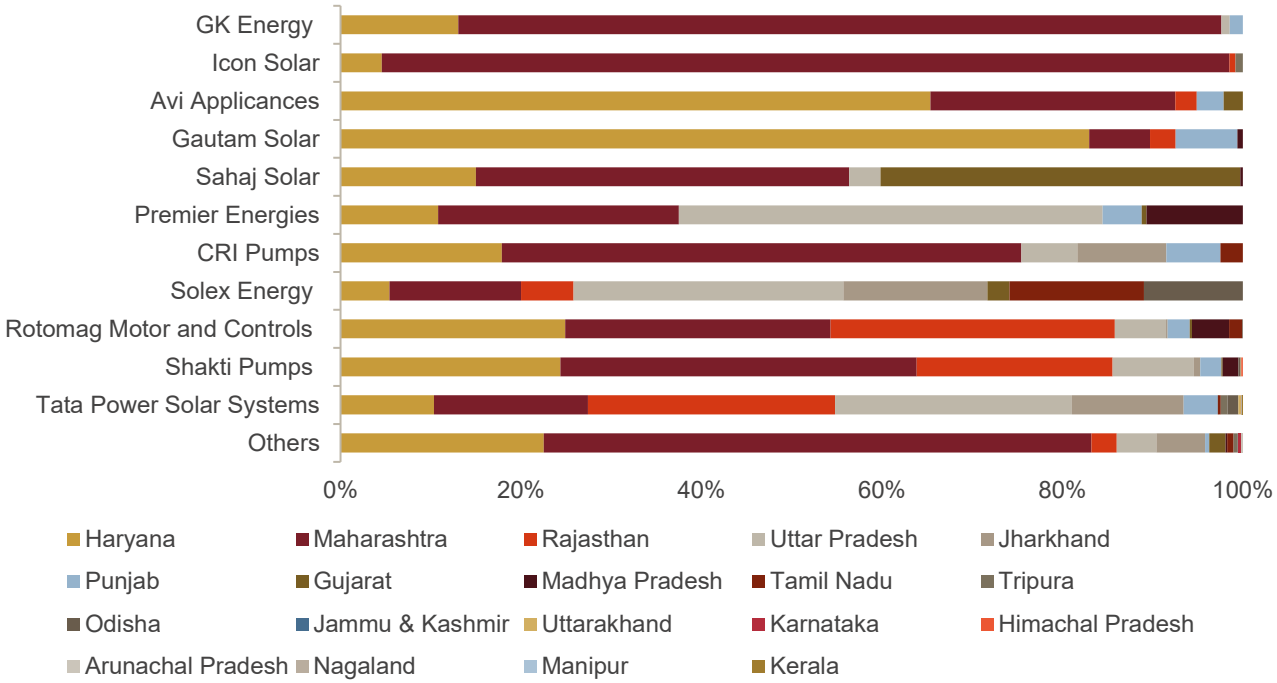
Order of the players sorted in order of installations as on CY 2024.

Source: PM-KUSUM, Crisil Intelligence

The industry is characterised by a diverse range of players, across photovoltaic (PV) module and pump manufacturers and engineering, procurement, and commissioning (EPC) companies. Shakti Pumps emerged as the leading pump manufacturer on an average across past three years, while GK Energy was the largest pureplay EPC player in terms of installations as of July 2025. To provide a perspective on concentration, from 1st of January 2020 till 31st of July 2025, top 10 players in the solar-powered pump systems market accounted for an average of 65% of share in installations.

Further upon examining state-wise dynamics, player share varied significantly. Out of the 6,96,479 solar-powered pump systems installed as on July 31, 2025 (as per data accessed from PM KUSUM "List of beneficiaries" as on 18th August 2025), markets across most states were dominated by 5 to 10 players.

Figure 10: Player presence across states (PM-KUSUM)

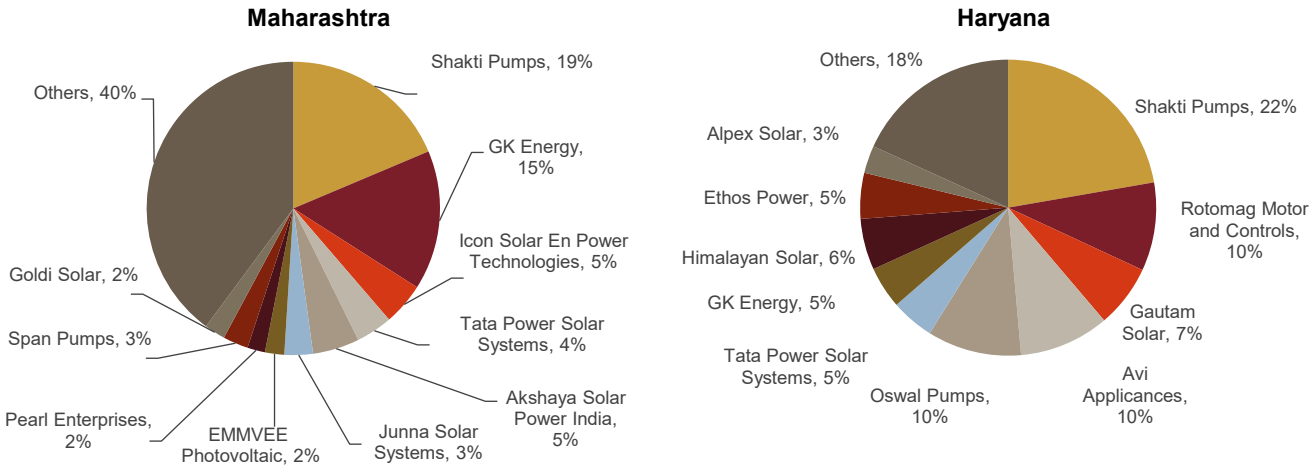


*Note: * The graph represents cumulative solar pumps installations as on July 31, 2025 (PM-KUSUM data accessed from PM-KUSUM "List of beneficiaries" as on 18th August 2025)*

The graph denotes the share of a particular state in a player's portfolio. Order of the players in ascending order of their presence in count of states.

Source: PM-KUSUM, Crisil Intelligence

Figure 11: Ten players account for 60-85% of the installations under PM KUSUM in Maharashtra and Haryana



Note: Share calculated as per cumulative solar pumps installations as on July 31, 2025. (As accessed from PM-KUSUM "List of beneficiaries" as on 18th August 2025.)
Numbers in the pie for Haryana have been rounded off and may not add up to 100%.

Source: PM-KUSUM, Crisil Intelligence

The table below illustrates the maximum depth from which solar-powered submersible pumps of various capacity can draw water. These values are derived from the shut-off dynamic head ranges listed for each pump capacity in the deep well (submersible) configurations that utilise DC motors

Table 10: Depth at which solar-powered submersible pumps of different capacity can draw water

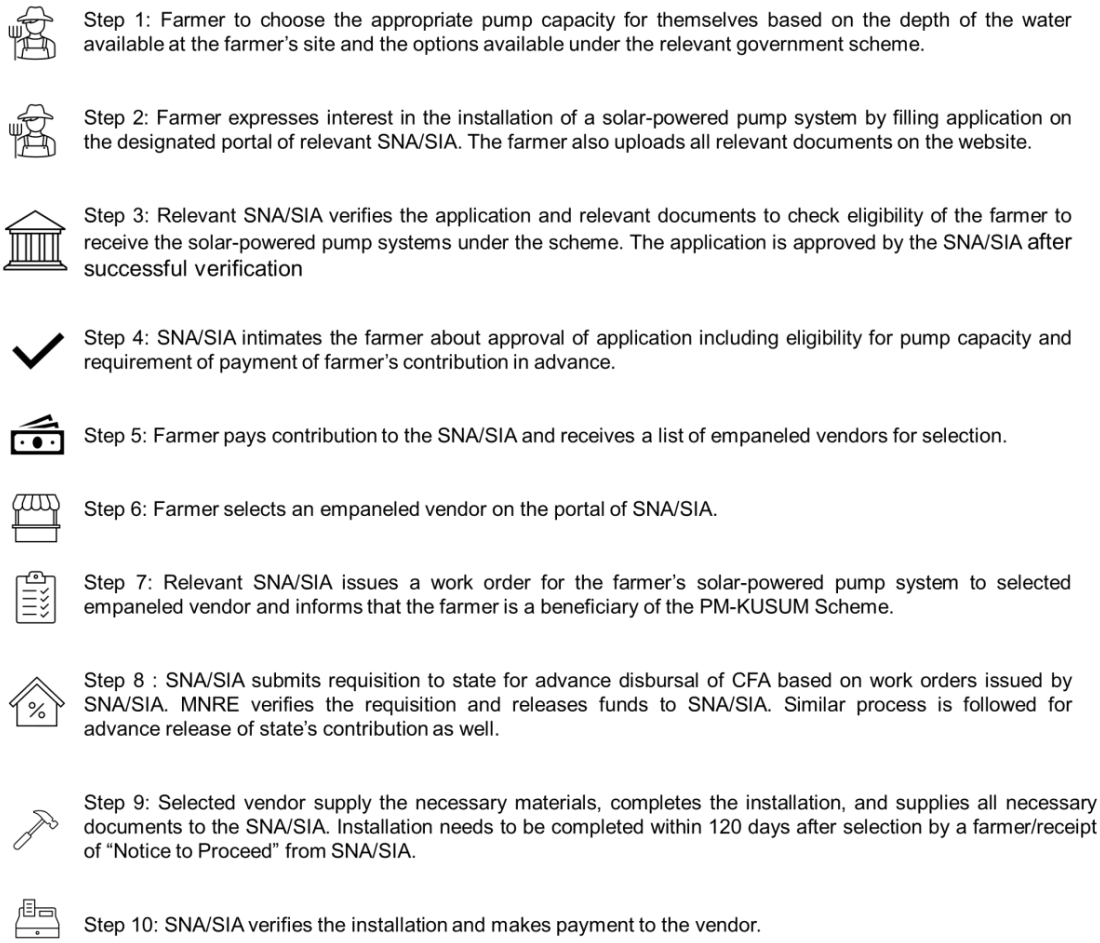
Pump capacity	Depth (meters)
3 HP	45 to 100
5 HP	70 to 150
7.5 HP	70 to 150
10 HP	70 to 150

Note: Ministry of New and Renewable Energy, March 22, 2023.

The price of solar-powered pump systems is determined through a government tendering process, whereby empanelled vendors participate in a bidding process, with the lowest bid establishing the price that all empanelled vendors must accept. The price varies according to the size of the pump. Furthermore, as each state has its own tendering process, the prices for the engineering, procurement, and construction (EPC) of solar-powered pump systems can differ significantly from one state to another

The execution process under PM-KUSUM follows the major steps as outlined below:

Figure 12: Process under PM KUSUM



Note: SNA/SIA – State nodal agency / state implementation agency

Source: Crisil Intelligence

Mukhyamantri Saur Krushi Pump Yojana

The Maharashtra government launched a scheme in 2019 to provide farmers with solar-powered pump systems, reducing their dependence on conventional electric or diesel pumps and addressing irregular power supply in rural areas. The scheme aimed to reduce electricity bills, ensure uninterrupted irrigation, and achieve the state's target of reducing greenhouse gas emissions and improving agricultural productivity. The beneficiary's contribution was limited to 5-10% of the total price for the pump system. The scheme was applicable for three years and has successfully deployed nearly 100,000 solar-powered pump systems, benefiting thousands of farmers.

Magel Tyala Saur Krushi Pump Yojana

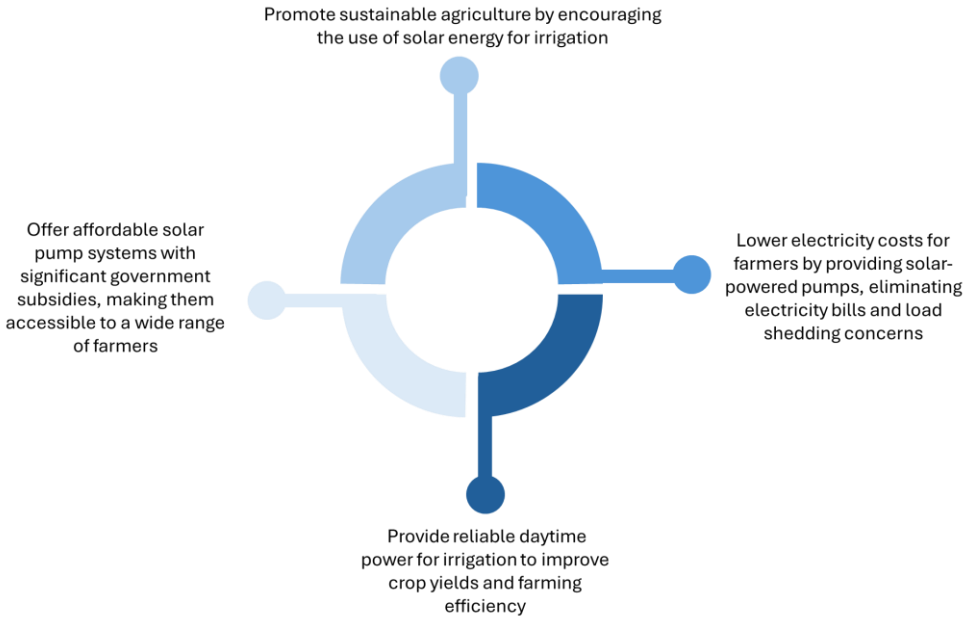
The Government of Maharashtra, having seen the success of Mukhyamantri Saur Krushi Pump Yojana, and PM-KUSUM, and considering the significant benefits to farmers and the state, as well as the significant demand for solar-powered pump systems, launched another initiative in early 2025 in the form of the Magel Tyala Saur Urja Yojana. This initiative is aimed at providing sustainable solar-powered irrigation solutions to farmers. Under this scheme, tenders for 0.1 million solar-powered pump systems were initiated as of September 2024, and an additional 0.1 million tenders were initiated in July 2024. Under this scheme, farmers can install solar panels and agricultural pumps with minimal upfront costs. The state subsidy ensures farmers must only bear 10% of the total

cost (upto 7.5 HP pumps) for general category farmers and 5% for Scheduled Caste and Scheduled Tribe farmers. Additionally, the scheme includes a five-year repair guarantee and insurance. By eliminating electricity bills, it ensures reliable daytime power for irrigation, benefiting farmers with access to water sources like wells and borewells.

The scheme includes eligible applicants with individual or community water sources. Furthermore, farmers who have not previously benefited from any of the earlier schemes are eligible to receive benefits under the Magel Tyala Saur Krushi Pump Yojana.

The objectives and benefits of the scheme include:

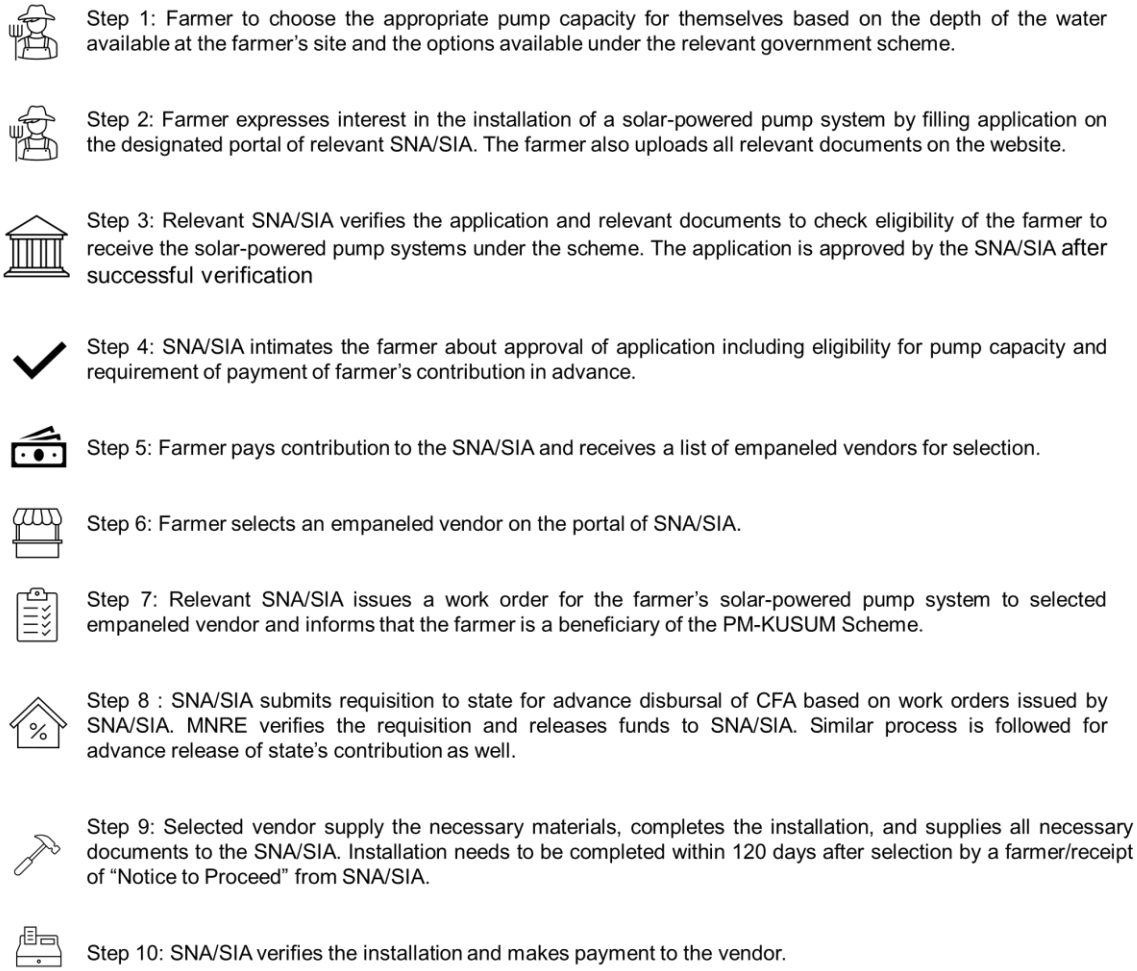
Figure 13: Objectives of Magel Tyala Saur Krushi Pump Yojana



Source: MahaVitaran, Crisil Intelligence

The application process under the scheme is as follows

Figure 14: Process under Magel Tyala Saur Krushi Pump Yojana



Note: SNA/SIA – State nodal agency / state implementation agency

Source: MahaVitaran, Crisil Intelligence

A farmer receives updates via SMS at every step of the process. The state presents a robust opportunity to the solar-powered pump systems industry as ~4.5 million farmers of the total 9.1 million individual farmer beneficiaries in the state rely on grid electric pumps while the balance awaits connections.

Chattisgarh's Saur Sujala Yojana

The Saur Sujala Yojana aims to provide solar-powered pump systems to farmers at subsidised rates to increase agricultural production and conserve groundwater. Launched in 2016, the scheme offers 3 HP and 5 HP surface and submersible solar-powered pump systems with a 5-year on-site warranty and maintenance. The Chhattisgarh State Renewable Energy Development Agency (CREDA) implements the scheme, and beneficiaries are selected by the agricultural department. Farmers contribute a portion of the installation cost, with varying amounts based on category. The scheme aims to empower farmers, strengthen the rural economy, and promote sustainable agriculture practices. The beneficiary's contribution in the scheme ranges from ₹7,000 to ₹20,000 depending on various pump capacity and caste.

In addition to the beneficiary contribution, a processing fee of ₹1 per watt (₹3,000 for 3 HP / 3,000 watt and ₹4,800 for 5 HP / 4,800 watt) must be paid.

As of March 2024, more than 0.1 million solar-powered pump systems have been installed under the scheme.

Pradhan Mantri Krishak Mitra Surya Yojana, Madhya Pradesh

In January 2025, the Madhya Pradesh government approved a scheme for the installation of solar pumps for irrigation purposes under the Pradhan Mantri Krishak Mitra Surya Yojana. As part of the initiative, a dedicated portal has been launched, enabling eligible state farmers to submit online applications. The scheme aims to alleviate the financial burden on farmers associated with electricity costs. Under the programme, farmers will be required to bear 5% of the capital cost for pumps up to 3 HP and 10% for pumps above 3 HP. The remaining costs will be covered by Government of India grant (60%) and agricultural loan, with the loan proportion varying depending on the pump's power: 35% for pumps up to 3 HP and 30% for those exceeding 3 HP.

Initiatives to improve scale and propagate benefits needed for solar powered pump systems

Despite state and central government subsidy to promote usage of solar power pumps, the adoption has been slow in the past. However, recent trends show that the installations have picked up pace with better product awareness and visible benefits to farmers already using solar-powered pump systems. Additions in the Fiscal 2025 stood ~0.45 million which were ~138% of the cumulative pumps' installations of ~0.33 million over April 2018 to March 2024.

The areas of concern for the sector initially have been high initial costs with savings accruing later, gradual spread of awareness on benefits, skills gap and higher time gap between pump installations and subsidy release.

Figure 15: Solar-powered pump systems challenges

Source: Crisil Intelligence

Risks and Monitorable

India's solar pump system market is expected to experience rapid expansion, driven by increasing farmer's awareness coupled with government support and a rising demand for eco-friendly and affordable irrigation solutions. However, the growth may be hindered by potential obstacles some of which are:

- Adverse changes in government regulations and policies - The central government and state governments have historically offered subsidies and incentives to farmers to install new solar-powered pump systems or replace existing systems powered by diesel fuel or grid-connected AC power. However, these incentive

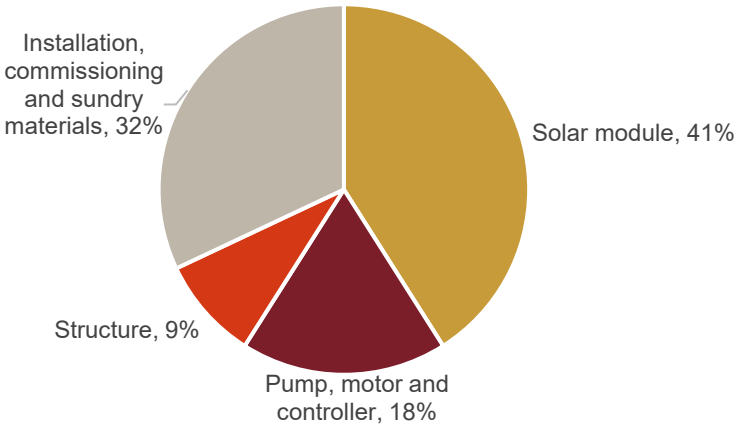
programmes may gradually decrease or be discontinued as solar power technology advances and becomes more affordable relative to other energy sources, or for budgetary or other reasons. A substantial reduction in the scope or discontinuation of government incentive programmes could lead to a decrease in demand for new solar-powered pump systems.

- Disruptions due to natural disasters, geopolitical tensions or trade disputes can lead to production delays and increased costs, impacting business operations.
- Volatile raw material prices, such as stainless steel, copper, and solar module can impact production costs and profitability due to global trade policies and economic conditions. Also, the risk of limited availability of DCR (Domestic Content Requirement) in solar cells and modules due to demand supply mismatch can further impact the production cost. However, the ability to pass through copper, steel and solar module costs or otherwise mitigate impacts on the profitability of the industry.
- High upfront costs of solar pumps and rooftop solar systems can deter customer adoption, making it essential to address affordability and financing concerns.
- Intense competition from domestic and international manufacturers with lower production costs can affect market share and pricing strategies, driving the need for research and development investments. The solar pump market is becoming increasingly competitive, with more companies expanding their operations, which may lead to heightened competition and the need for innovative strategies to maintain market share.
- Farmers' perceptions of the direct and indirect benefits of adopting renewable energy technology, such as where farmers assess the cost-effectiveness, performance and/or reliability of solar-powered pump systems to be inferior to pump systems powered by other energy sources.
- A decline in capital expenditure by farmers due to adverse agricultural conditions, such as droughts or floods, reduce crop yields and subsequently decrease the amount of disposable income available to farmers.
- Decreases in the prices of oil, which may make diesel-powered pumps more economical.
- The cost of capital and availability of credit, loans and other forms of financing for solar-powered pump systems.

Pricing trends of key raw materials

The cost breakdown of a solar powered pump typically involves three main components: Steel (for the pump and support structures), copper (for electrical wiring and components) and the solar module. Collectively these account for more than 40% of the cost of solar-powered pump systems.

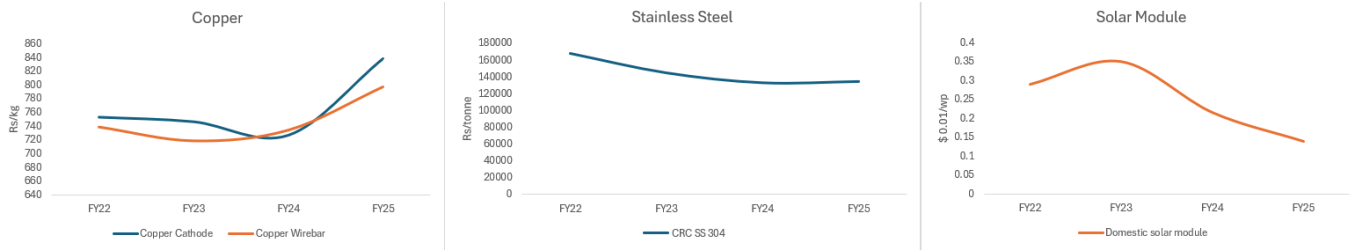
Figure 16: Solar modules, pumps, motors and controllers account for 58% of the bill of materials



Source: Industry, Crisil Intelligence

The ability to pass through copper, steel and solar module costs or otherwise mitigate impacts the profitability of the industry. Within the cost structure for solar powered pump systems, the share of EPC related services is the second largest component at 32% after solar modules and is thus a critical area of the solar powered pump system value chain.

Figure 17: The price of key inputs has remained volatile over the past three Fiscals



Note: Copper prices are provided for cathode and wirebar while steel prices considered for CRC – SS 304. Module prices are considered for domestic modules made using imported cells.

Source: Crisil Intelligence

Between Fiscal 2022 and Fiscal 2025, copper and stainless-steel prices, like the broader metal prices, fluctuated due to global dynamics. Copper prices dropped from Fiscal 2022 to 2024, then surged in Fiscal 2025, driven by increased demand in renewable energy and electric vehicles, as well as supply side constraints and the Russia-Ukraine conflict. Stainless-steel prices followed a similar trend, dropping sharply between 2022 and 2024 due to reduced raw material prices and demand moderation post pandemic driven surge, then recovered in Fiscal 2025 driven by increased demand in infrastructure projects and industrial applications, as well as rising raw material and energy costs influenced by geopolitical tensions. On the other hand, solar modules have witnessed a sharp fall over the years, except a blip in Fiscal 2023, owing to the oversupply supply of upstream components such as polysilicon, wafers and cells with the supply capacity being at least two times that of demand in 2023. On the domestic front, the sharp fall of 81% in Fiscal 2025 over Fiscal 2022 and 58% over Fiscal 2024 in imported wafer prices has helped reduce prices of Indian cells, resulting in moderation in prices of Indian-made solar modules. With the global oversupply situation likely to continue in Fiscal 2026, the prices of modules made using domestic cells are expected to be muted despite low cell manufacturing capacity in India.

Competition landscape in the solar powered pump segment

Diverse set of players function in the solar powered pump systems market. Business activity ranges from manufacturing a variety of pumps, providing EPC services across multiple verticals and specialising in only a specific component of the value chain.

Table 11: Operational profile comparison of key players from the industry

Players	Installation in 2022	Installation in 2023	Installation in 2024	Installation in 2025*	Latest order book (₹ billion)	Product profile/business presence
GK Energy Limited	7,633	10,600	29,265	15,061	10.3	Solar agriculture pump, solar photovoltaic module, Solar water pump controller, solar rooftop
Shakti Pumps Limited	28,963	11,640	59,577	8,594	13.5	Submersible pumps, centrifugal pumps, firefighting pumps, sewage and waste-water pumps, solar-powered pump systems, motors, controllers, inverter, tracker, cable
Oswal Pumps Limited	15	3,765	21,673	9,762	8.0	Solar, domestic, industrial, agriculture and pump controller

*Notes: * For the period January to July 2025*

Installations: All installations are under PM-KUSUM Scheme

GK Energy installations are as per company disclosures as of 31st July 2025.

Shakti Pumps' and Oswal Pumps' installations are on a calendar year basis as per data accessed from PM KUSUM "List of beneficiaries" as on 18th August 2025

Order book: GK Energy's order book is as of 15th August 2025.

Shakti Pump's order book is as of August 2025; Oswal Pumps' order book is as of March 2025

Source: Rating rationales, Company filings, PM-KUSUM, Crisil Intelligence

In September 2024, tender for 100,000 solar-powered pump systems was initiated under the Magel Tyala Saur Krushi Pump Yojana. An additional tender for 100,000 solar-powered pump systems was issued in July 2025. As of August 15, 2025, of the aforementioned 0.2 million tendered under the Magel Tyala Saur Krushi Pump Yojana, GK Energy accounted for 17% share, with 34,198 pumps in its order book. Meanwhile, Oswal Pumps and Shakti

Pumps constituted 17% and 7%, with 34,720 and 14,787 pumps, respectively, in their order books, as of August 12 and 13, 2025, respectively.

Financial profiles of key players operating in the industry

In fiscal 2025, GK Energy Limited reported a 166.32% y-o-y increase in revenue. This growth was largely driven by the timely execution of solar pump installations, facilitated by a steady allocation of funds from the government. Furthermore, the company's operating EBITDA margin and net profit ratio saw notable expansions of 515 bps and 337 bps, respectively, in fiscal 2025. These improvements were primarily attributed to operating leverage and the successful execution of higher-margin orders. As of fiscal 2025, the company's working capital cycle stood at 90 days, whilst its receivable days totalled 120 days.

Table 12: Financial profile of GK Energy Limited

		GK Energy Limited		
Financial parameters	**Units**	**FY25**	**FY24**	**FY23**
Revenue from operations	₹ billion	10.95	4.11	2.85
Revenue from operations growth (year-on-year)	%	166.32%	44.23%	NA
Total income	₹ billion	10.99	4.12	2.85
Operating EBITDA [(1)]	₹ billion	2.00	0.54	0.17
Operating EBITDA margin [(2)]	%	18.24%	13.09%	6.03%
Profit for the period/year (“PAT”) [(3)]	₹ billion	1.33	0.36	0.10
PAT Margins [(4)]	%	12.12%	8.75%	3.53%
Return on Equity (“ROE”) [(5)]	%	63.71%	64.49%	50.73%
Return on Capital Employed(“RoCE”) [(6)]	%	55.65%	50.10%	29.36%
Net Debt to Equity Ratio [(7)]	Times	0.74	0.94	1.93
Total Borrowings [(8)]	₹ billion	2.18	0.62	0.43
Net Debt to Operating EBITDA [(9)]	Times	0.78	0.98	2.24
Net Working Capital days [(10)]	Days	90	80	51
Receivable days [(11)]	Days	120	135	144

Notes: NA – not available
Audited consolidated financials are considered for GK Energy Limited for all years. The following formulae have been used:

(1) Operating EBITDA is calculated as profit for the year/period minus other income plus finance cost plus depreciation and amortisation plus tax expense for the year/period (“Operating EBITDA”).
(2) Operating EBITDA margin is calculated as Operating EBITDA divided by revenue from operations (“Operating EBITDA margin”).
(3) PAT is profit for the period/year is calculated as profit after tax is profit / (loss) for the year/period.
(4) PAT Margin is calculated by dividing PAT for the year/period by total income (“PAT Margins”).
(5) Return on Equity (“ROE”) is calculated as profit attributable to the owners of the Company for the period/year divided by Shareholders Equity as at the end of the year/period. Shareholders Equity is the sum of share capital and other equity as at the last day of the year/period (“Shareholders Equity”)
(6) Return on capital employed(“RoCE”) is calculated as EBIT for the year/period divided by the Capital Employed as at the end of the year/period. Capital employed is calculated by adding Total Networth and Net Debt as at the last day of the year/period. EBIT is calculated as profit for the year/period plus finance cost plus tax expense for the year/period (“EBIT”).

(7) Net Debt to Equity Ratio is calculated as Net Debt divided by Shareholders Equity as at the last day of the year/period. Net Debt is calculated as Total Borrowings reduced by cash and cash equivalents and other bank balances as at the last day of the year/period ("Net Debt").
(8) Total Borrowings is calculated as current borrowings plus non-current borrowings as at the last day of the year/period ("Total Borrowings").
(9) Net Debt to Operating EBITDA Ratio is calculated as Net Debt as at the last day of the year/period divided by Operating EBITDA for the year/period
(10) Net Working Capital Days is calculated as Receivables Days plus Inventory Outstanding Days reduced by Accounts Payables Days ("Net Working Capital Days"). Inventory Outstanding Days is calculated as closing inventory as at the last day of the year/period, divided by the cost of goods sold for the year/period, multiplied by 365 ("Inventory Outstanding Days"). Accounts Payables Days is calculated as closing accounts payables as at the last day of the year/period, divided by the cost of goods sold for the year/period, multiplied by 365 ("Accounts Payables Days").
(11) Receivable Days is calculated as closing receivables as at the last day of the year/period, divided by revenue from operations for the year/period, multiplied by 365.

Source: Company filings, Crisil Intelligence

Shakti Pumps Limited achieved an 83.57% y-o-y growth in revenue in fiscal 2025. The company's financial performance was further enhanced by significant expansions in its EBITDA margin and PAT margins, which increased by 760 bps and 590 bps, respectively. This robust revenue growth was driven by strong performances in both the domestic and export business, while the company's focus on operational efficiency improvements also contributed to enhanced profitability and margins. As at the end of fiscal 2025, the company's trade receivables stood at 152 days.

Table 13: Financial profile of Shakti Pumps Limited

		Shakti Pumps Limited		
Financial parameters	**Units**	**FY25**	**FY24**	**FY23**
Revenue from operations	₹ billion	25.16	13.71	9.68
Revenue from operations growth (year-on-year)	%	83.57%	41.65%	NA
Total income	₹ billion	25.33	13.74	9.71
EBITDA	₹ billion	6.03	2.25	0.67
EBITDA margin	%	24.00%	16.40%	6.90%
Profit for the period/year ("PAT")	₹ billion	4.08	1.42	0.24
Pat Margins	%	16.20%	10.30%	2.49%
Return on Equity ("ROE")	%	35.20%	18.75%	5.77%
Return on Capital Employed("RoCE")	%	43.90%	24.50%	9.84%
Net Debt to Equity Ratio	Times	NA	NA	NA
Total Borrowings	₹ billion	NA	NA	NA
Net Debt to EBITDA	Times	NA	NA	NA
Net Working Capital days	Days	NA	NA	NA
Receivable days	Days	152	178	92

Notes: NA – not available
Audited consolidated financials are considered for Shakti Pumps Limited for all years
Financial information for Shakti Pumps Limited is as per their regulatory filings.

Source: Company filings, Crisil Intelligence

Oswal Pumps Limited reported an 88.54% y-o-y growth in revenue in fiscal 2025, driven primarily by the company's successful deeper penetration of the Indian market with its solar-powered pump systems. The company's financial performance was further bolstered by substantial expansions in its operating EBITDA margin and PAT margin, which increased by 960 basis points and 680 basis points, respectively. As at the end of fiscal 2025, the company's trade receivables stood at 111 days.

Table 14: Financial profile of Oswal Pumps Limited

		Oswal Pumps Limited		
Financial parameters	**Units**	**FY25**	**FY24**	**FY23**
Revenue from operations	₹ billion	14.30	7.59	3.85
Revenue from operations growth (year-on-year)	%	88.54%	97.04%	NA
Total income	₹ billion	14.33	7.61	3.88
Operating EBITDA [(1)]	₹ billion	4.20	1.50	0.58
Operating EBITDA margin [(2)]	%	29.40%	19.80%	15.00%
Profit for the period/year (“PAT”)	₹ billion	2.81	0.98	0.34
PAT Margins	%	19.60%	12.80%	8.80%
Return on Net Worth (“RoNW”)	%	93.00%	88.70%	80.90%
Return on Capital Employed (“RoCE”)	%	82.50%	81.90%	45.50%
Net Debt to Equity Ratio	Times	0.70	0.42	0.70
Total Borrowings	₹ billion	3.24	0.75	0.59
Net Debt to Operating EBITDA	Times	0.77	0.50	0.96
Net Working Capital days	Days	NA	NA	NA
Receivable days [(3)]	Days	111	75	52

Notes: NA – not available
Audited consolidated financials are considered for Oswal Pumps Limited for all years
Financial information for Oswal Pumps Limited is as per their regulatory filings.
Source: Company filings, Crisil Intelligence

Module 4: Solar rooftop

Solar rooftop segmentation

The rooftop solar segment can be categorised as per consumer types into residential, commercial and industrial (C&I), government and social (institutions, colleges, hospitals, etc.). Residential rooftop solar systems are primarily aimed at individual households, with an average plant size of 1-10 kW. Consumer awareness and affordability play a key role in boosting installations in this category. C&I rooftop solar average sizes vary ranging from 30-1000 kW. This segment is driven by rising electricity costs and the need for energy independence. Lastly, government and the social categories' average plant size can vary from 10 kW to over 1,000 kW. These installations are driven not only to save energy costs but to also promote environmental awareness. All the categories may or may not be connected to the grid.

Review of global solar rooftop installations (CY 2018-2022)

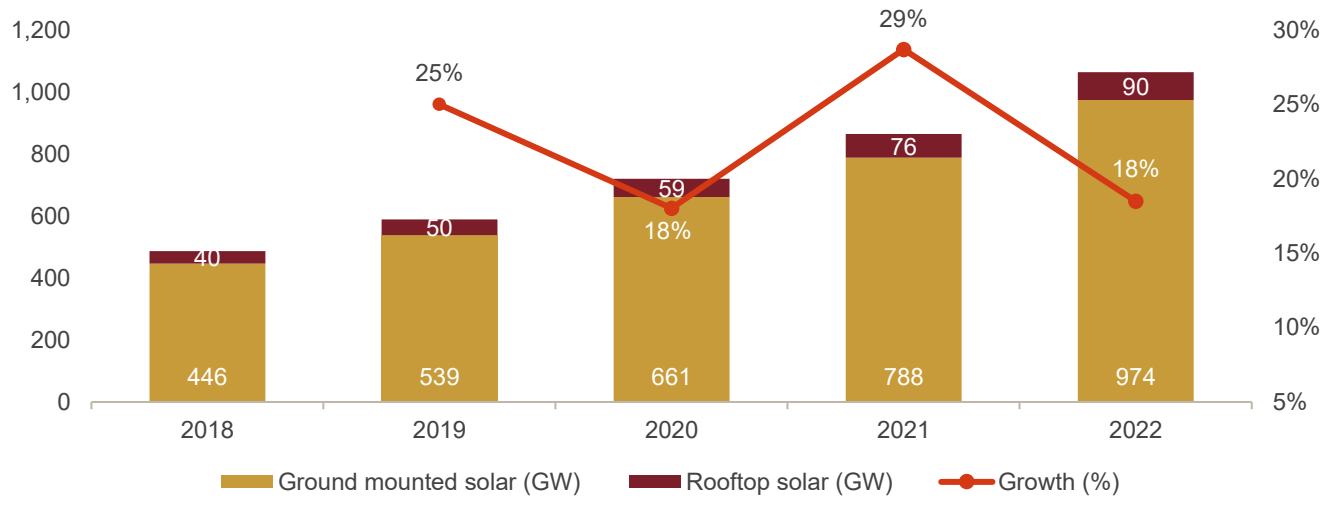
Rooftop installations on buildings are playing a major role in the global adoption of PV systems, accounting for approximately 40% of total solar installation. In various competitive environments, these rooftop systems are alleviating pressure on distribution grids, enabling both businesses and households to cut their electricity costs and helping reduce carbon emissions.

Rooftop solar close to surpassing utility-level installations to achieve the biggest share in solar market additions globally

Out of the 200 GW solar PV installations globally in 2022, solar rooftop contributed ~45%. This was an 18% growth on-year from 2021. In 2021 as well, the solar rooftop segment experienced significant growth with capacity additions increasing 29% from 59 GW added in 2020.

The increase in rooftop installations was driven by the residential and commercial sectors demonstrating a strong interest in generating electricity for self-consumption. This is driven by the benefits of reducing reliance on the grid and mitigating the impact of power price fluctuations, mainly caused by fossil fuels.

Figure 18: The total global rooftop installed base grew at a CAGR of ~24% from 2018 to 2022



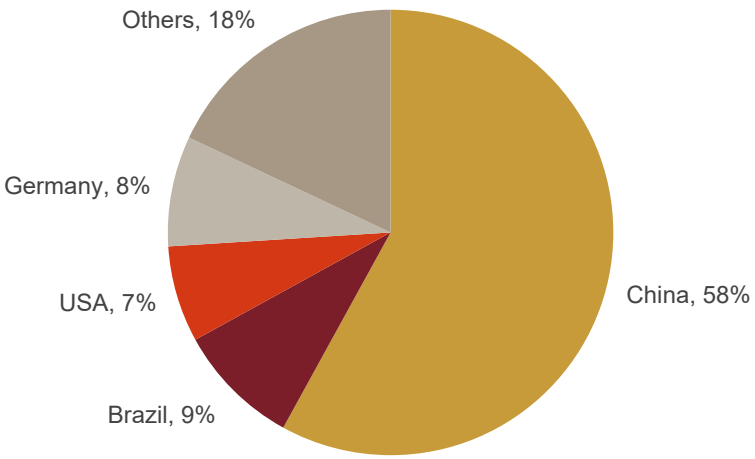
Source: IEA, Industry Reports

Four key countries drive growth especially through the residential segment

The distributed solar PV sector, encompassing small-scale power generation projects under 1 MW such as residential, commercial, industrial, and off-grid systems, is gaining traction due to favourable economic factors and policies. Key markets emerging in this sector include China, the US, Brazil and Germany.

The significant increase in global solar rooftop capacity has been driven by three major countries, China, the US, Brazil and Germany, contributing more than 80% to the global rooftop additions in 2022 as per data reported by National Renewable Energy Laboratory (NREL).

Figure 19: Solar rooftop additions in CY2022



Source: NREL, IEA, Crisil Intelligence

Favorable policies coupled with low PV system costs spur the global rooftop segment

While the policies that have resulted in solar rooftop growth are specific to each country, there are a few common drivers leading to high growth in the segment. These are high retail electricity costs, low PV system costs, and spare roof space.

Reduced PV system costs

Between 2010 and 2022, the average installed cost of PV worldwide declined consistently, largely due to the increased availability of materials, which led to reduced production expenses. Over the past decade, the cost of equipment and installation has decreased by more than 80%. China's focus on continuous innovation and development of a complete industrial chain has played a significant role in driving down production costs and making new energy products more affordable globally.

High retail electricity costs

Globally, solar rooftops offer a way for consumers to reduce dependence on traditional energy sources and mitigate the impact of fluctuating energy prices. In countries with high retail electricity prices, such as Brazil, Australia and the USA, consumers are motivated to seek energy independence. Rooftop solar systems enable individuals to generate their own power, thereby reducing reliance on centralised grids.

New business models

The adoption of rooftop solar PV systems is accelerating due to innovative business models and policy frameworks. Net billing and rental/lease options make solar energy more accessible, while new policies enable the sale of excess energy to third parties or neighbours. These developments maximize economic benefits, facilitate community-based solutions, and enhance the feasibility and attractiveness of solar PV systems for individuals and communities, driving sector growth.

Government incentives and regulatory support

Many countries offer subsidies, tax credits, and other incentives, which are crucial for the adoption of rooftop solar systems. Supportive policies and regulations, such as net metering and renewable energy mandates, have significantly contributed to the growth of solar rooftop installations.

China: China's Whole-County Rooftop Solar policy has been successful in promoting solar energy adoption at the county level. The policy involves partnering counties with large PV developers to cover a substantial percentage of rooftops within a specified timeframe. In 2021, 676 pilot projects were introduced across 31 provinces, driving significant progress in solar PV deployment.

Brazil: Brazil has established a new regulatory framework for distributed generation, covering renewable energy power generators up to 5 MW which are operating under a net metering regime. The framework ensures eligibility for net metering tariffs until 2045 and guarantees that projects installed by 2022 will not be subject to grid fees introduced in 2023. This aims to maintain economic attractiveness for Brazilian prosumers using rooftop PV and small solar parks.

USA: Federal policy has significantly supported the adoption of residential solar rooftop installations. The residential energy efficient property credit, which provided a 30% tax credit for solar panels, was available until the end of 2019. This credit decreased to 26% by the end of 2020 and 22% by the end of 2021.

Australia: The federal government's renewable energy target is a key support mechanism for rooftop PV systems under 100 kW. Additionally, several jurisdictions offer no-interest loans for solar PV systems and batteries, further facilitating the adoption of renewable energy solutions.

Germany: Germany has a rooftop solar technical potential of 409 GW as per market estimates, nearly twice the total solar PV 2030 target set by the federal government. The consistent increase in Germany’s rooftop solar deployment, particularly in the 0–30 kW category, has been driven by government programmes and legislation such as the 1,000 roofs and 100,000 roofs programme, the Renewable Energy Sources (EEG) Act, and solar package I.

Domestic solar market

Solar energy segment is categorized into two segments: utility and distributed

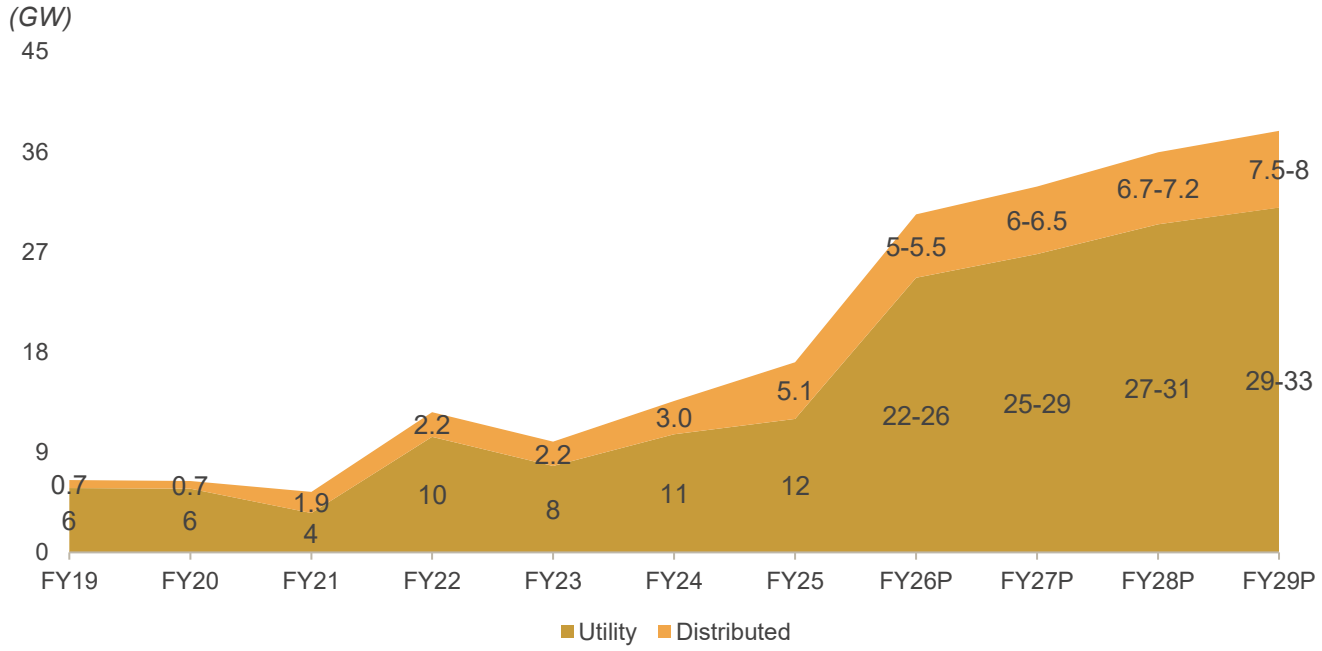
Utility-scale solar projects: These are large-scale power plants that generate electricity from solar energy, typically with a capacity of over 5 MW. These projects are ground-mounted and connected to the transmission or distribution grid. They sell electricity to wholesale utility buyers or markets under long-term power purchase agreements and operate as independent power producers.

Distributed solar photovoltaic (PV) systems: These are small-scale installations, rooftop-mounted, ground mounted or integrated into buildings, with a capacity of less than 5 MW. These systems generate electricity for on-site use and export excess power back to the grid. They are connected to the distribution network and typically operate under net metering arrangements or feed-in tariffs with utilities.

Simply put, utility solar plants are larger-scale facilities that generate electricity in bulk to be used by multiple customers, while distributed solar systems are useful for individual homes and businesses.

The total installed capacity in India of the ground mounted segment (competitively bid solar power plants and open access solar) was 92.3 gigawatts (GW) as of June 2025, while that of the distributed segment (solar rooftop) was 19 GW. The government has set a target of achieving 40 GW of rooftop solar by March 2026. In the next four Fiscals over Fiscals 2026 to 2029, Crisil Intelligence expects an addition of 110-115 GW capacity under the competitive bid utility and open access segment while 23-28 GW in rooftop.

Figure 20: Solar additions of 130-140 GW expected over Fiscals 2026-2029



Note: Utility includes competitive bidding and open access projects. Offgrid pumps are excluded in distributed solar.

Source: MNRE, Crisil Intelligence

Domestic solar rooftop market

Solar rooftop segments in India operate primarily through two business models

In the context of a solar power plant, a business model involves generating revenue through the sale of produced energy or savings by consuming the generated electricity. For consumers and investors, selecting the appropriate business model is crucial to reduce risks and maximise returns.

The two most prevalent models of operation in rooftop solar PV plants are the capex and Renewable Energy Service Company (RESCO) models. In the capex model, the project developer installs the rooftop power plant on its own roof, while in the RESCO (also known as operating expenditure (opex) model), the developer utilises the rooftop and receives proceeds from the sale of power to the rooftop owner and discom, on a mutually agreed power purchase agreement price.

In the capex model, the consumer owns the solar system and bears all upfront costs, including setup, maintenance, and operation, as well as expenses for equipment, labour, upgrades, and materials. Majority of the rooftop solar installations in India fall under this model.

The RESCO model involves the developer owning the solar project and using the consumer's rooftop for installation. The developer sells power to the consumer at a lower rate than the grid tariff, ensuring profitability. Customers pay only for the electricity used, not the solar system. They sign a long-term agreement for rooftop use and a power purchase agreement (PPA) for up to 25 years at a fixed rate. The power generated can be sold to the utility (gross metering) or partly consumed and sold to the utility (net metering), with a cap on capacity connected to the grid. Net metering is more prevalent due to state rooftop policies.

For improving the pace of solar rooftop installations in the residential segment, the government launched the PM Surya Ghar Yojna in 2024

Table 15: PM Surya Ghar Yojna

Subsidy (Rs per kW)	Description
30,000	For plant sizes up to 2 kW
78,000	For plant sizes of 3 kW and above
18,000	To housing societies for rooftop solar plants up to 500 KW for common area lighting, EV charging, etc.

Source: MNRE

Furthermore, states like Maharashtra have also approved a target of installing 2 million solar rooftop projects under the PM Surya Ghar Yojna to boost residential rooftop solar additions.

Review of the solar rooftop market (Fiscal 2019-Q1 Fiscal 2026)

The Indian solar rooftop market has grown ~10 times from the end of Fiscal 2019 to the end of Q1 Fiscal 2026. While the installations have expanded rapidly, the pace has still been lower than required to meet the proposed government target of 40 GW by Fiscal 2026.

Grid-connected rooftop capacity was ~18.8 GW as of June 30, 2025

The rooftop solar installed capacity was 18.8 GW as of June 30, 2025, with ~5.2 GW added in Fiscal 2025. Gujarat (32%), Maharashtra (24%), Kerala (10%) and Rajasthan (7%) accounted for 73% of these additions. Additions stood at 1,825 MW in Q1 fiscal 2026, up from 1,053 MW seen in same period during fiscal 2025, a rise of ~73 in additions. Additions in fiscal 2026 are being led by Gujarat and Maharashtra with their share at 29% and 16% respectively. Several factors such as increased consumer awareness, advancements in technology and proactive subsidy initiatives implemented by central and state governments drove the additions. Additionally, solar module prices for domestic modules (imported cell based) reached a low of United States dollar (US$ or $) $0.22/wp (excluding GST) in fiscal 2024 and continued to decline in fiscal 2025, reaching $0.13/wp (excluding GST). Despite a marginal increase in prices to $0.15 in Q1 Fiscal 2026, the growth in solar capacity continued. Moreover, prices for domestic cell-based modules stood at $0.22-0.25/wp (excluding GST) at the end of Q1 Fiscal 2026.

In January 2024, the residential rooftop segment received a boost from the launch of PM Surya Ghar Yojna, which aims to solarise 10 million households. Apart from this, the central government also announced that all government rooftops under the administrative control of central government ministries/departments, including autonomous bodies, subordinate offices etc. shall be saturated with rooftop solar to the extent that is technically feasible by 31st December 2025. Ministries may utilise available rooftop space for such saturation, through the RESCO mode or capex mode, on a priority basis.

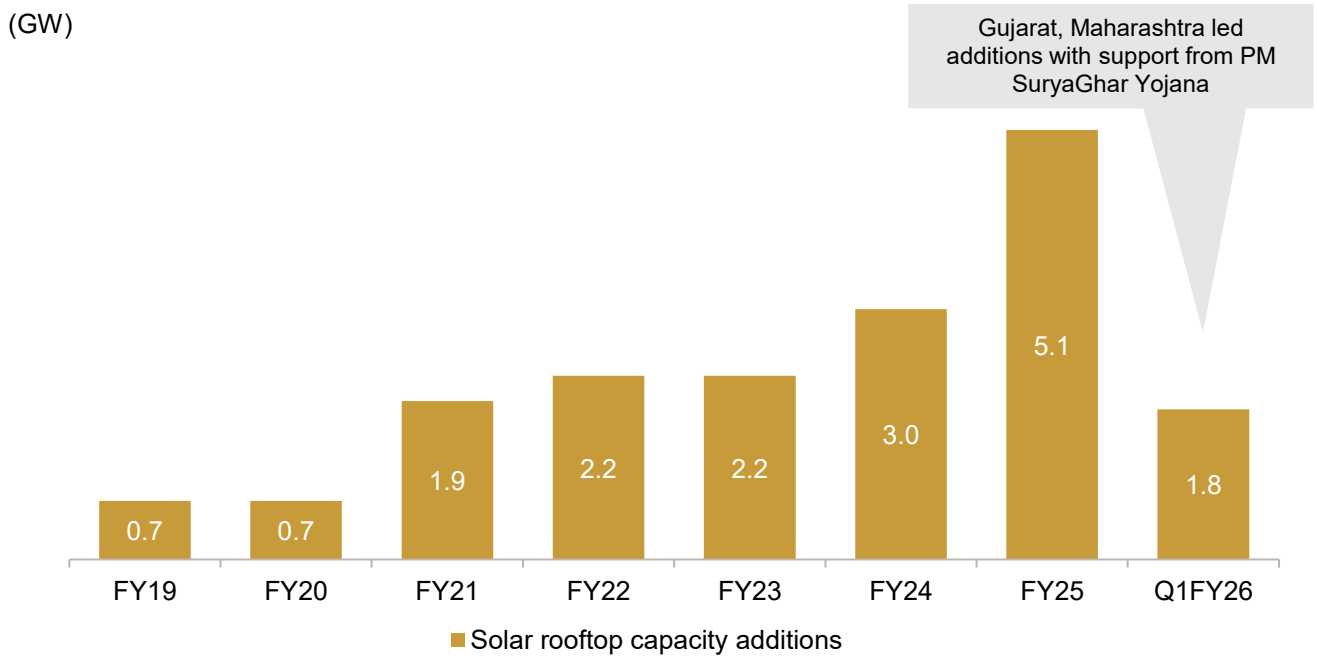
At a state level, the Telangana State Renewable Energy Development Corporation Ltd (TSREDCO) aims to install solar panels on 500 school buildings, promoting decentralised electricity generation, mitigating power shedding

issues in the state. Such initiatives are contributing to the growth of the solar rooftop sector across India. Gujarat launched the Surya Urja Rooftop Yojana; the scheme provided 40% and 20% state subsidy for installations up to 3 kW and 3-10 kW, respectively. Furthermore, the state allowed consumers to rent their premises or roofs to third parties for electricity generation under its solar policy, encouraging installations. Additionally, the micro, small and medium enterprise (MSME) policy of Gujarat released in September 2019 enabled the installation of solar projects with more than 100% of sanctioned load or contract demand. Under the scheme, MSMEs could sell excess power to the state government at ₹2.25 per unit for the first 5 years of the project and thereafter at 75% of the latest tariff discovered through competitive bidding process over the preceding 6 months, which shall remain fixed for the remaining project life, leading to increased installations.

Capacity additions in Fiscal 2023 were fuelled by robust additions under the residential rooftop segment, especially in Gujarat (0.68 GW), driven by Surya Urja Rooftop Yojana, and Maharashtra (0.54 GW), driven by a favourable rooftop policy. These states accounted for 58% of the 2.2 GW additions in Fiscal 2023. The 40% subsidy for 3 kW projects announced by the Haryana government also contributed to capacity additions. Majority of the additions were under the capex model, with states empanelling vendors and commissioning the allocated capacity under the Ministry of New and Renewable Energy's (MNRE) Phase II of the rooftop solar programme.

Capacity additions were also higher in Fiscal 2022 spurred by the deadline of Gujarat's Surya Urja Rooftop Yojana, which targeted rooftop installations for 0.8 million consumers by March 2022.

Figure 21: Q1 Fiscal 2026 continues momentum of previous fiscal



Source: Crisil Intelligence

From a pan-India perspective, the segment has faced roadblocks, including higher cost of rooftop projects compared to utility-scale projects, limited availability of financing for all types of rooftop consumers, lack of uniform policies across states, weak infrastructure of power discoms and divergence between state policies and implementation.

Nevertheless, rooftop solar projects have attracted interest from players across the entire value chain, ranging from module manufacturers (Tata Power Solar, Waaree Energies and Vikram Solar) to system integrators (Rays Power and Jackson Engineers) and independent power producers (Fourth Partner and Mahindra Solar), owing to

declining costs and favourable regulatory policies in key states (net metering, exemption of electricity duty, wheeling and cross-subsidy charges).

Indian rooftop solar capacity concentrated in six states

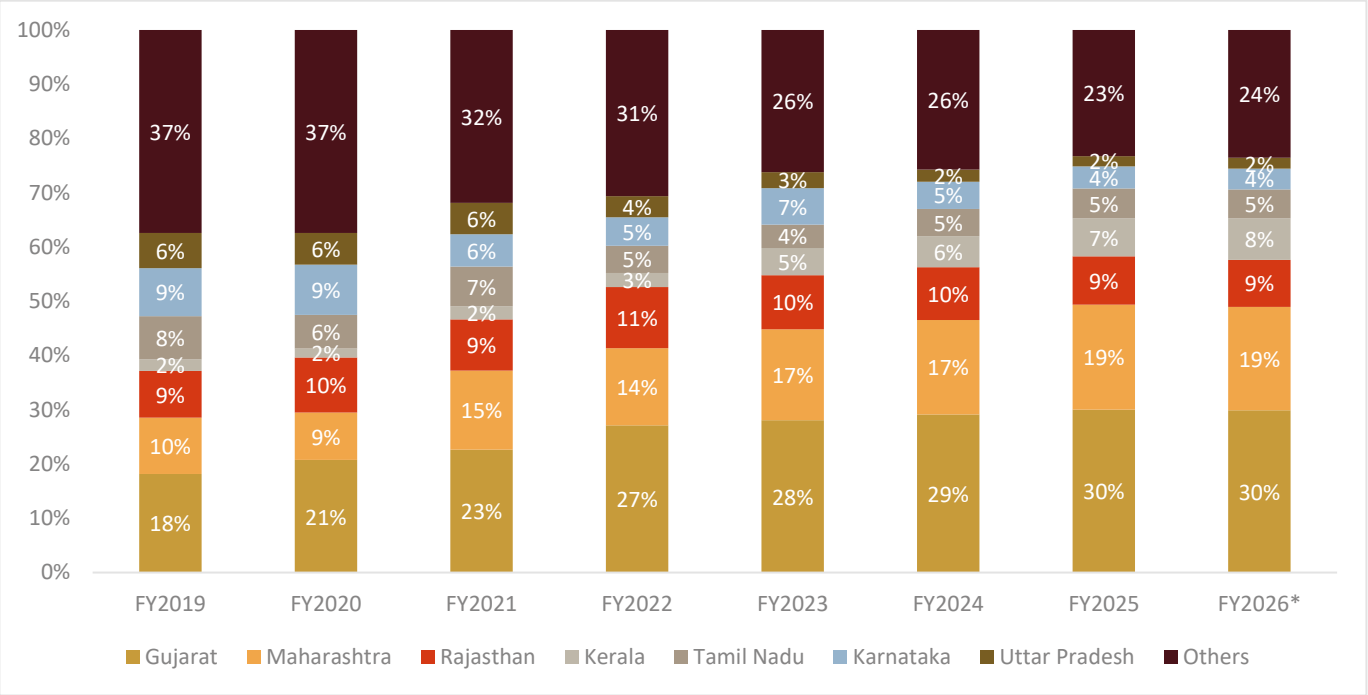
While pan-India capacity has accelerated since fiscal 2019, the pace of growth across states has not been uniform. The growth is driven by installations in a few key states with favourable government policies and higher acceptance by consumers, supporting the momentum.

Gujarat, Maharashtra and Rajasthan continue to lead in installed base, with their cumulative share increasing to 58% as of Q1 FY26 from 37% in fiscal 2019. Gujarat, a state with high solar irradiance and favourable policies, led the additions from PM SuryaGhar Yojana and the state government introduced the solar subsidy scheme Surya Urja Rooftop Yojana-Gujarat. Maharashtra too with clarity on policies, allowed net metering for all consumers and reduction of tariff to offer financial relief to consumers post the Covid-19 slowdown, setting a positive precedent in the rooftop segment.

While Tamil Nadu, Karnataka and Uttar Pradesh accounted for a cumulative share of 23% of the installed base in fiscal 2019, progress in these states did not follow the same momentum, and their share declined to 12% in fiscal 2024, but has now increased to 15% as of Q1 FY26. Tamil Nadu's restrictive policy on setting up rooftop solar units that interact with the state grid and the revocation of net metering facility for C&I consumers in 2017 hindered growth. In Karnataka, rooftop solar growth was challenged by the inconsistencies with net metering, wherein interruptions in electric supply disrupted the supply of surplus power to the grid generated by rooftop solar systems, making projects economically unviable for consumers.

Other than these six key states, Kerala started slow with a 2% share in rooftop installations in fiscal 2019 but tripled its share to 6% by fiscal 2024 and currently stands at 7.6% in Q1 fiscal 2026. This was mainly on account of the Soura Program phases I and II launched in 2019 and 2020 where the discom played a crucial role as a demand aggregator and paid for the total cost of installing rooftop projects, attracting more consumers. Kerala is the fourth largest benificary state under PM Surya Ghar Yojana, with 1,23,000+ installations under the scheme. Price correction in installation costs due to falling global component prices was a factor which helped in greater adoption of solar rooftop systems.

Figure 22: Gujarat, Maharashtra and Rajasthan accounted for ~58% of total installed rooftop solar as of Q1 Fiscal 2026



*Note: *FY2026 refers to April to June 2025*

Source: MNRE, Crisil Intelligence

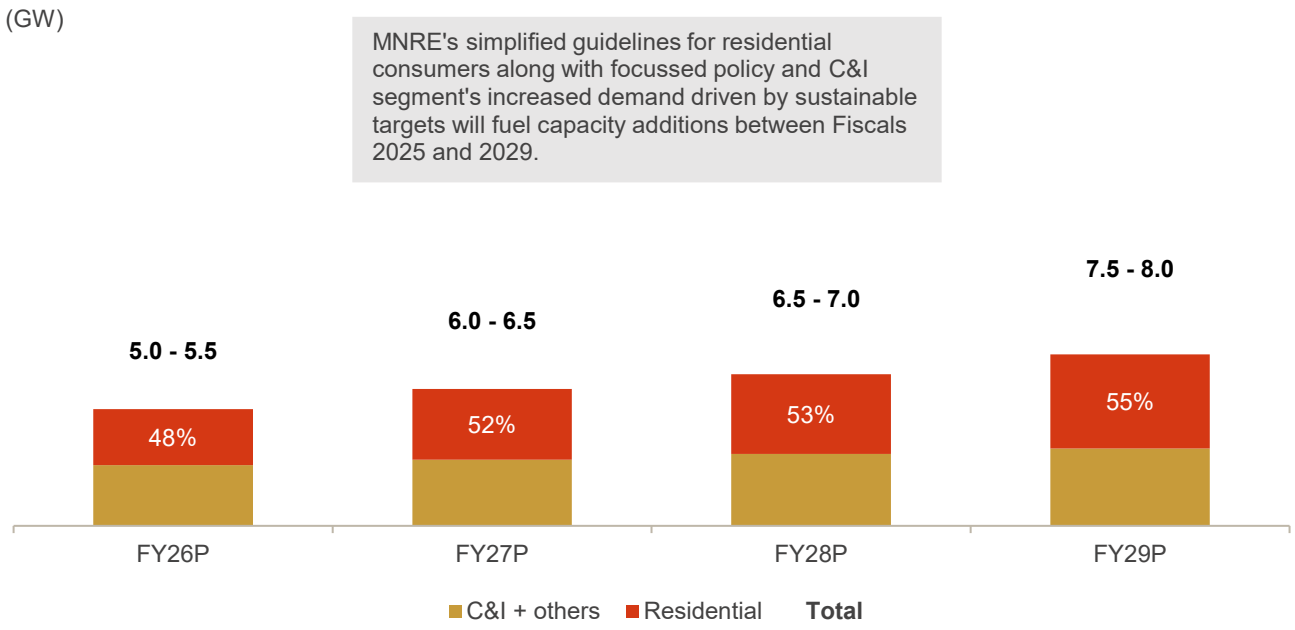
Outlook on solar rooftop capacity (Fiscal 2026-2029)

Over the next five Fiscals, solar rooftop installations in India are expected to accelerate supported by robust policies and focus on the residential segment by the government of India.

Rooftop solar additions of 23-28 GW expected over Fiscal 2026-2029 (~1.6 times higher than Fiscal 2020-2025)

Crisil Intelligence expects 23-28 GW of projects to be commissioned in the solar rooftop segment over Fiscal 2026-2029 led by the residential segment (12-13 GW) with the implementation of the PM Surya Ghar Yojna; however, the pace and success of execution remains a key monitorable. The remaining capacity will be added by the C&I segment (12-13 GW), under net/gross metering schemes of various states. The addition is influenced by various factors such as consumer awareness, availability of cheap source of funding and grid availability. Overall, the rooftop segment is expected to witness an investment of ₹0.85-0.95 trillion during Fiscals 2026 to 2029.

Figure 23: Residential segment to drive rooftop additions over the medium term



Source: Crisil Intelligence

To promote the installation of residential solar rooftops, MNRE provided the following for consumers:

- A national portal for consumers was developed with all relevant information on the segment
- Rooftop solar plants could be installed by consumers through an empanelled vendor of choice
- Any household beneficiary under the PM Surya Ghar Yojana would apply on the national portal in a centralised manner and the subsidy amount would be processed for installation of the RTS plant. As per the government of India, the scheme is expected to result in a saving of approximately ₹15,000 in a year for a household consuming up to 300 units a month, by installing a rooftop solar unit of 3 kW capacity

Solar power can act as an alternative for states with high load shedding, such as Tamil Nadu, Uttar Pradesh and Punjab, which are also served by diesel generator sets, and for rural areas with poor grid connectivity.

Key policy drivers act as an enabler for driving rooftop additions

The central government's aim to achieve 40% of the 100 GW generation capacity target under the National Solar Mission (NSM) from the rooftop segment by 2022 fell short by ~31 GW. Hence, favourable policy plays a key role in driving additions. The government allocated a budget of ₹200 billion toward its solar programme in the Fiscal 2026 budgeted expenditure in February 2025. This was 80% more than the Fiscal 2025 revised expenditure allocations. This is equivalent to a potential 3.5-4.0 GW of residential rooftop additions in Fiscal 2026.

Policy support to drive residential growth, C&I to be spurred by economics

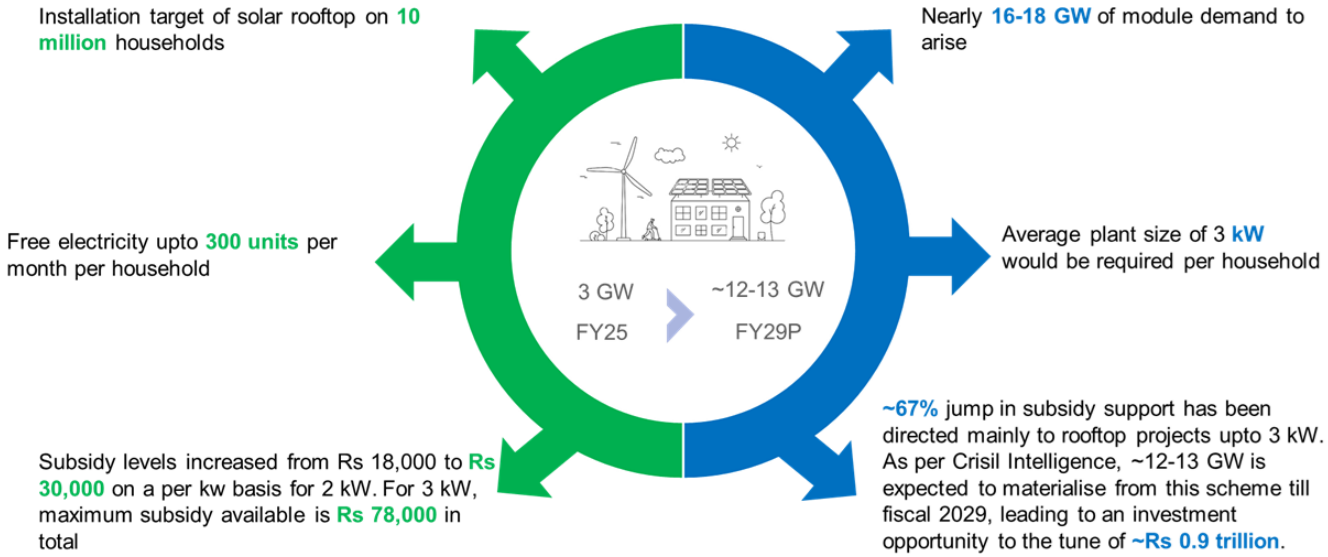
The PM Surya Ghar Yojna, launched in 2024, aims to boost residential solar rooftop adoption by addressing cost hurdles. The scheme provides subsidies for installing rooftop solar, helping households save on electricity bills. Some salient features of the scheme are:

- Subsidy has been increased to ₹30,000/kW for up to 2 kW plants and ₹78,000 for 3 kW plants.
- Electricity benefit as per the government is estimated to be up to 300 units/month/household.

- The scheme is expected to contribute 12-13 GW of residential rooftop additions over 4 years, where implementation is expected to continue post Fiscal 2029.

As of Q1 Fiscal 2026, almost all major banks and lenders have registered to provide financing for solar rooftop under the scheme. These provide loans at a floating rate of interest and for a maximum tenure of 5-10 years. While most banks, provide a maximum loan of ₹0.2 million, a few banks also provide a maximum loan of ₹4-5 million.

Figure 24: Residential solar base to grow ~4 times between Fiscal 2025 and Fiscal 2029



Source: Crisil Intelligence

In addition, the Indian government has also mandated public sector utilities under the power ministry to equip all buildings under central government administration with solar rooftops by 2025, as part of the PM Surya Ghar Yojna. The scheme outlines the roles of various stakeholders in achieving solar rooftop saturation. These stakeholders include Central Public Sector Enterprises (CPSEs) with renewable energy expertise, central ministries, state and union territory (UT) government departments, autonomous bodies, public sector enterprises, and other units under the administrative control of central ministries and state/UT government departments. The government has identified CPSEs, which have experience in the renewable energy sector as Scheme Implementation Partners (SIPs) for government rooftop solar programme. The ministry may identify additional SIPs under the scheme from time to time.

Declining PV system costs and sustainability goals have made rooftop projects increasingly appealing to C&I consumers. Availability of net metering in particular, under which power generated can be consumed captively and the balance/excess can be sold, has also been instrumental in spurring rooftop solar in the C&I segment.

Competition landscape in the solar rooftop segment

The solar rooftop segment, due to its fragmented nature, sees participation from many small to mid-sized companies as well as from large renewable energy generators who are also present in other renewable energy verticals.

Table 16: Peer comparison

Player	Business presence	Rooftop solar geographic presence	Capacity (MWp)	Main state for player (% of rooftop capacity)

Roofsol Energy	Ground mounted and rooftop solar	Madhya Pradesh, Maharashtra, West Bengal, Punjab, Uttar Pradesh, Tamil Nadu, Gujarat, Rajasthan, Odisha and Assam	84.6	Punjab (70%)
Orb energy	Ground mounted and rooftop solar	Karnataka, Maharashtra, Andhra Pradesh, Gujarat and Uttar Pradesh	15.8*	Karnataka (54%)
Amplus Solar	Ground mounted and rooftop solar	Karnataka, Maharashtra, West Bengal, Haryana, Uttar Pradesh, Telangana and Tamil Nadu	24.3	Maharashtra and Uttar Pradesh (50%)
Candi solar	Ground mounted and rooftop solar	Telangana, Maharashtra, Uttar Pradesh, Chandigarh, Punjab, Odisha, Haryana, West Bengal, Madhya Pradesh, Rajasthan and Tamil Nadu	18.6	Maharashtra (53%)

*Note: * Data is C&I only and excludes residential due to lack of disclosures in public domain*

Amplus Solar's name has been changed to Gentari

Company websites accessed as on 20th August 2025

Source: Company websites, Crisil Intelligence

While the industry is a mix of large and small players, the market dynamics suggest a regional focus. The above sample considered comprises of some of the key players with operational portfolios across India. While players naturally expand their presence across the country, nearly 70-75% of their installations are concentrated in only one or two states. This is also reflected by the PM Surya Ghar Yojna scheme where 35,000 vendors are enlisted owing to presence of regional players and the high fragmentation of the consumer base in the residential solar rooftop segment. States like Gujarat, Uttar Pradesh, Rajasthan, Maharashtra and the union territories of Dadra and Nagar Haveli and Daman and Diu see the most fragmentation in the vendor base, cumulatively accounting for 67% of total vendor options under the empanelled list.

Rooftop solar plants are generally more expensive on a per megawatt basis than ground mounted systems due to several factors.

1. Installation complexity: Rooftop systems require specialised mounting equipment and labour to secure panels on existing structures, leading to higher costs
2. Limited space: They often face constraints in rooftop size, orientation, and obstructions, which can limit efficiency and necessitate additional engineering solutions.
3. Operational requirements: From a developer's perspective, due to the decentralised nature of the solar rooftop segment, the requirement for decentralised infrastructure also rises leading to higher costs.

This usually results in rooftop solar being 1.1-1.2 times more expensive than ground mounted solar projects.

Financing landscape

Due to its classification as a green energy initiative, the solar rooftop sector has emerged as a focus area for multilateral and domestic financial institutions. As a result, these institutions are now prioritizing efforts to facilitate seamless access to financing for this rapidly growing market.

For instance, the Asian Development Bank (ADB) has approved $240.5 million in loans to finance rooftop solar systems in India. The funding will support the installation of rooftop solar systems through loans provided by the State Bank of India (SBI) and National Bank for Agriculture and Rural Development (NABARD). This is in addition to previous support from the World Bank, which had provided $813 million in financing for rooftop solar projects since

2017. The initiatives aim to accelerate the adoption of rooftop solar, reduce greenhouse gas emissions by 13.9 million tonnes, and provide loans to consumers and developers. The Indian Renewable Energy Development Agency (IREDA) also launched a retail division to provide loans to rooftop solar consumers and other business-to-consumer segments.

Securing focus and support from the lending community will be crucial in overcoming the operational challenges that affect the solar rooftop sector.

Risks and monitorable

The segment is poised for rapid growth owing to states with supportive policies and high solar irradiance.

Nevertheless, the growth of India's solar rooftop sector may face continued challenges such as ineffective state policies, poor consumer creditworthiness, and enforcement issues.

Distribution companies (DISCOMs) encounter difficulties in integrating rooftop energy into their grids due to aging infrastructure and net metering complexities. Furthermore, their revenue dependence on industrial customers and the availability of cheaper electricity from ground-mounted projects diminishes their motivation to promote rooftop solar connections. This often translates into poor frameworks for and implementation of rooftop solar.

The weak credit profiles of potential customers are another challenge for developers. Innovative solutions such as guarantees and access rights, combined with credit availability from multilateral agencies, can help stimulate adoption.

Enforcement of lease agreements and PPAs between producers and buyers is another critical challenge. Measures such as third-party access rights, dispute redressal, payment security, and insurance schemes could improve investor confidence. Under the RESCO model, the absence of long-term rooftop agreements and collateral limitations for service companies further impede growth. Further, grid variability due to rising rooftop solar penetration may strain infrastructure.

Addressing these challenges by ensuring legal safeguards for rooftop availability, strengthening transformer maintenance, employing battery-based storage solutions, would be vital to meeting the 40 GW target.

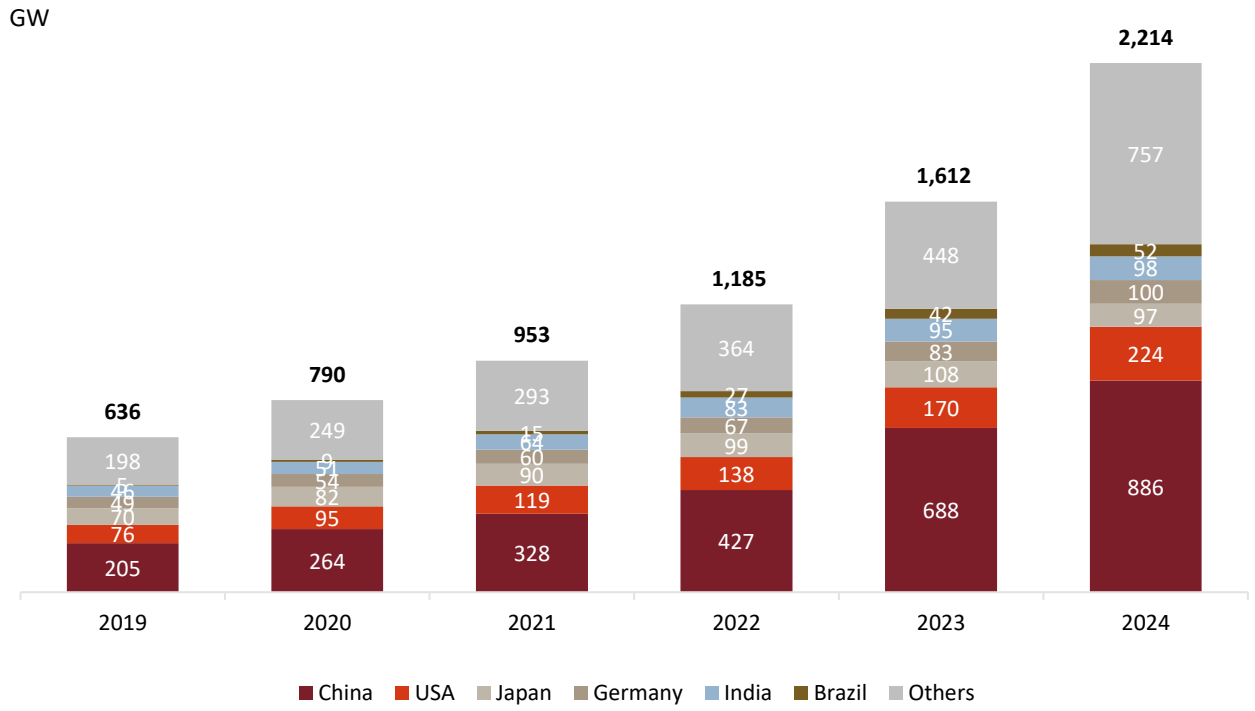
Notwithstanding the challenges in the segment, residential rooftop solar offers a promising avenue for the government to meet its renewable energy targets along with sustainability focus from corporates. Moreover, the combination of government subsidies and accessible financing options from multiple banks makes rooftop solar an attractive and affordable option for even small households.

Module 5 – Solar PV manufacturing

Global solar energy installation trend

According to the International Energy Agency (IEA) the global solar energy installed capacity has nearly increased 3.5 times since 2019, reaching 2,214 GW by the end of 2024. China leads the market with an installed base of 886 GW, followed by the US with 224 GW, and Japan with 97 GW, according to IEA. In India, the solar PV capacity installed base has increased at a CAGR of 16% between 2019 and 2024 to reach installed base of 97 GW in 2024.

Figure 25: Installed solar generation capacity nearly tripled in 5 years



Note: India's installed capacity data has been taken from the CEA. For other countries, data till 2023 has been taken from the IEA. Data for 2024 has been taken from the IEA PVPS

Source: IEA, IEA PVPS, CEA, Crisil Intelligence

Review of global solar module demand

Global cell and solar module demand was estimated to be -1,577 GW cumulatively over 2019 to 2024 and accounting for at least 602 GW in 2024. Going by installation rates, 43% of the demand was estimated to be driven by China,

followed by US (9%), India (4%), and Germany and Japan (5% total). Factors such as cost reduction resulting from the fall in prices and technological advancements globally is a major factor that drove additions in 2024.

Figure 26: China accounts for a lion's share in global solar installations

Notes: *1. The solar installations in a particular year have been considered as demand for solar energy from the respective country. The demand does not factor DC overloading*

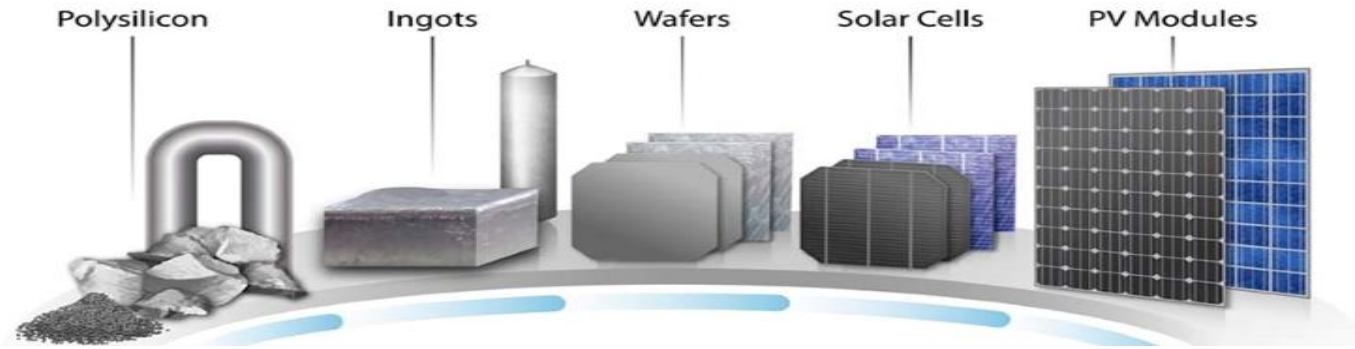
2. The above-mentioned nations accounted for 71% of solar capacity additions between calendar years 2019 and 2024.

Source: IEA, IEA PVPS, CEA, Crisil Intelligence

Review of global solar module manufacturing

The solar photovoltaic (PV) manufacturing process can be broken down into four distinct stages, forming a comprehensive value chain.

Figure 27: PV manufacturing value chain



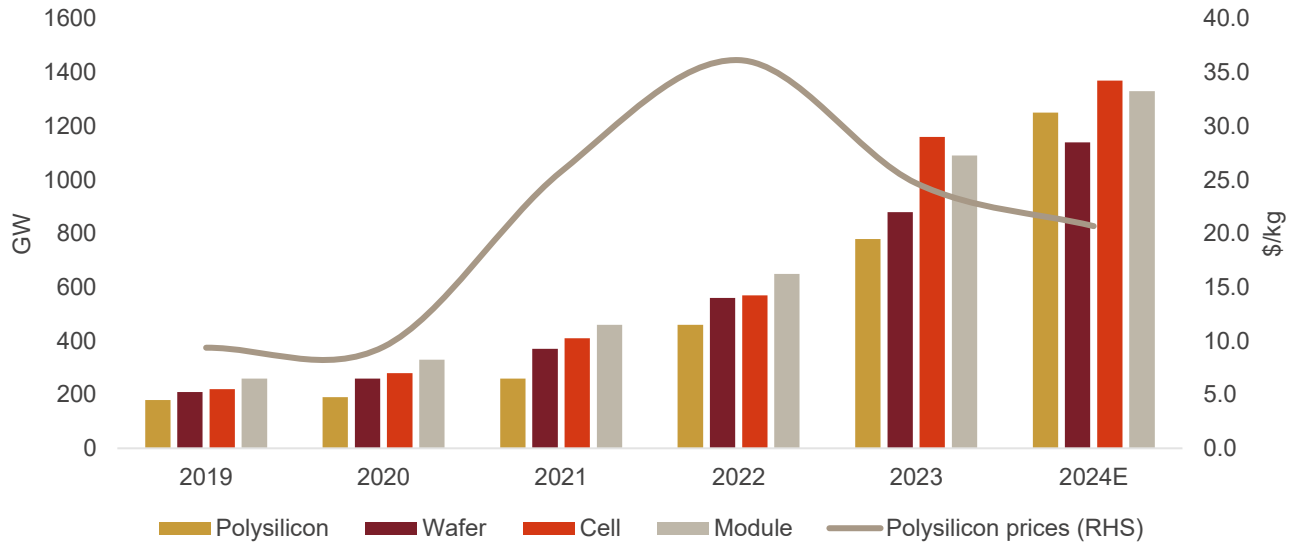
Silica (SiO2) is refined to metallurgical grade silicon (MG-Si) using a carbothermic process in an electric arc furnace. MG-Si is then purified through a chemical vapor deposition process converting it to trichlorosilane gas which is decomposed to produce ultra-pure solar-grade polysilicon.	Solar polysilicon is melted in a crucible to form a cylindrical ingot using crystal pulling or float zone method. The ingot is then sliced into thin wafers using wire saws. These wafers serve as the base material for manufacturing solar cells.	Solar wafers are processed to form solar cells by adding dopants to create a p-n junction, which enables electricity generation. An anti-reflective coating is applied, and metal contacts are added for electrical connections. The cells are then tested for efficiency before being assembled into solar panels.	Solar cells are connected in series and parallel, laminated between layers of protective materials, and sealed with tempered glass and a back sheet. The assembly is framed for structural support with a junction box added for electrical connections. This creates a durable weather resistant solar module ready for installation.

Note: Value chain and components used can differ based on the technology of solar cells, the above process is for the widely used cell technology (monocrystalline) in the world as of 2024.

Source: Crisil Intelligence

According to the International Energy Agency, global solar module manufacturing capacity has experienced a fourfold increase, reaching 1,124 GW at the end of 2024 from 250 GW at the end of 2019. This growth has outpaced demand, with 2024's solar module demand being only 60% of the total manufacturing capacity. In tandem, the production of upstream components has also seen significant expansion over the past five years, with a notable surge in growth since 2023, particularly in the polysilicon segment.

Figure 28: PV manufacturing capacity estimated to have crossed 800 GW across value chain in 2024



Notes: E: Estimated

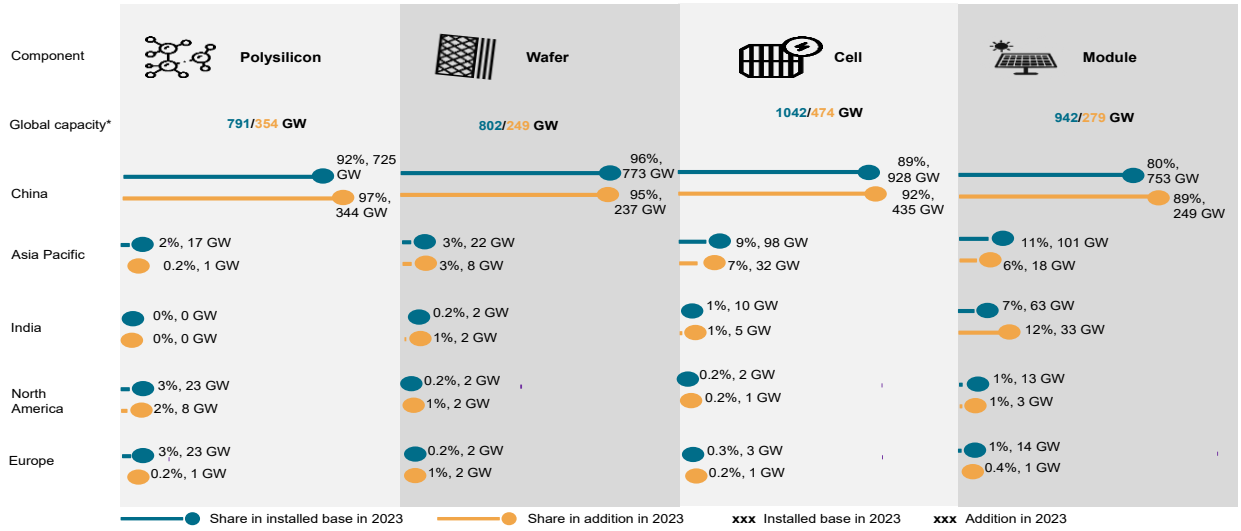
Source: IEA, Crisil Intelligence

From 2017 onwards, the limited availability of PV-grade polysilicon manufacturing capacity emerged as a significant constraint in the photovoltaic (PV) supply chain. This bottleneck became particularly apparent in 2021, when a combination of underinvestment and a fire at a major manufacturing facility led to a global polysilicon shortage, causing prices to triple. However, by 2023, China has significantly expanded its polysilicon production capacity, increasing it five times compared to 2021 levels. China's dominance in the PV value chain continued to grow, with the country estimated to account for over 80% of the installed base on an average across the value chain stages by the end of 2024. Going ahead, the module manufacturing capacity is expected to reach 1640 GW by CY2028, as per IEA. This will be accompanied by backstream components of 1590 GW of cells, 1300 GW of wafers and 1600 GW of polysilicon.

Geographical concentration across the value chain

China has a significant presence in the global solar photovoltaic (PV) industry, with a large proportion of manufacturing capacity for PV components concentrated within its borders. Although it is possible to source these components from other countries, the global solar PV supply chain is heavily reliant on China for the production of modules and upstream components, including polysilicon, ingots, wafers, and cells. This manufacturing dominance has created a high degree of dependence on China for the supply of these critical components.

Figure 29: China accounted for over 80% of the global supply in 2023



*Note: Balance share is spread across the rest of the world. *Global capacity is as of 2023. India's capacity is as of March 2024.*

Source: IEA, Crisil Intelligence

China accounted for the largest share of polysilicon to module manufacturing capacity and reinforced its dominant position as a manufacturer by increasing its share of global polysilicon production capacity nearly three times by 2023.

China's dominance in the global PV supply chain is evident, with more than 80% of cell and module manufacturing lines located within the country. This concentration of manufacturing capacity has created a high degree of dependence on China. Although China has a monopoly on wafer manufacturing, Southeast Asia has emerged as a significant player in cell and module manufacturing, driven by major Chinese solar cell manufacturers establishing production bases in countries like Vietnam, Malaysia, and Thailand to circumvent USA trade restrictions. The combined production capacity of these countries reached over 40 GW in 2023.

However, the US Department of Commerce published its final anti-dumping and countervailing duty tariff rates against solar PV cells whether or not assembled into modules from ASEAN countries. Tariff rates vary by country and are as high as 3,404% for Cambodia, 775% for Thailand, 543% for Vietnam and 171% for Malayasia. These tariffs are expected to impact the exports from these four countries to the US, who collectively accounted for 79% of module and 57% of cell imports in the US import basket. China also faces collectively rate of 50-60% under Section 301, Section 201 of US trade Act and anti-dumping and countervailing tariffs. Similarly, India also faces an investigation along with Indonesia and Loas.

Germany is a leading supplier of polysilicon for the c-Si PV module industry, while the US and Japan also have significant polysilicon manufacturing capacity. However, their production is primarily focused on semiconductor-grade products rather than catering to the PV industry.

While module assembly is geographically diversified, it's crucial to recognize that most of the required inputs, including wafers, cells, and other components, are manufactured in China. Despite the diversified assembly locations, China remains the primary source for essential PV components, highlighting its critical role in the global PV supply chain.

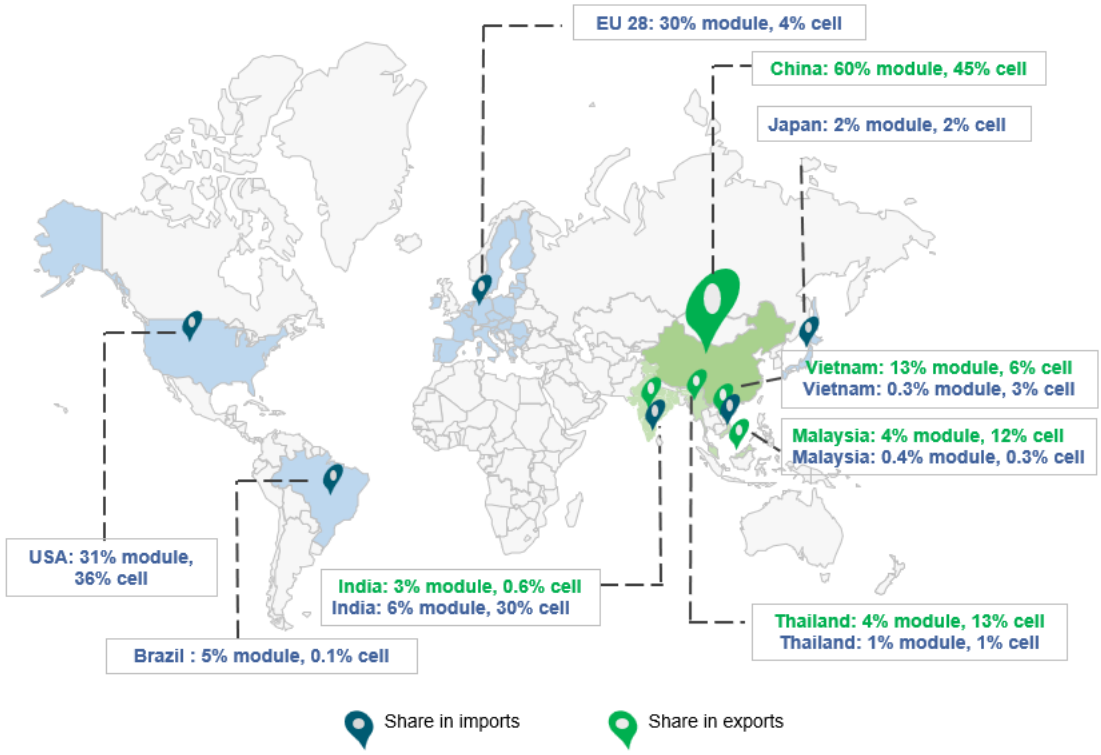
China dominates global trade in PV

The global solar industry experienced a significant upswing in demand for solar modules in 2024, driven by declining prices resulting from a supply surplus. This led to a substantial increase in imports. The United States emerged as

the largest importer of solar modules and cells, with around 31% of all module imports and 36% of cell imports destined for the country.

China maintained its position as the leading supplier of solar modules and cells, providing nearly ~60% of module imports and 45% of cell imports in 2024. However, the year also saw a notable expansion in manufacturing capacity, particularly in South-East Asian countries such as Malaysia, and Thailand, which increased their share in the global solar supply chain.

Figure 30: China trades 60% of module and 45% of cell exports in 2024; ASEAN countries catching up



Note: The data in blue represents import share, the data in green shows share in exports
Source: ITC Trademap, Crisil Intelligence

Over the years, India in global module exports has increased to $1.5 billion, with its share increasing to 3% in 2024 from 0.5% in 2019. The increase is attributed to rising module manufacturing/assembling capacity due to tariff and non-tariff barriers such as BCD and ALMM.

Overall, the global photovoltaic (PV) manufacturing capacity has undergone significant expansion and technological advancements over the years, driven by sustained investments in research and development. This has resulted in rapid price decline as well as notable improvements in efficiency.

Evolution of PV cell technology

The rapid growth of the sector, accompanied by intense competition in the supply chain, has driven a focus on enhancing product efficiency. As a result, technology has undergone significant advancements, transitioning from multi-crystalline to mono passive emitter rear contact (PERC) cell-based modules, and is now shifting towards more advanced cell technologies such as tunnel oxide passivated contact (TopCon) and heterojunction (HJT). Additionally, consistent increase in solar module wattage has also contributed to the conservation of land space for the same electricity output.

From a technological standpoint, mono-PERC cells dominated the market in 2019, followed by back surface field (BSF). While mono PERC remains the dominant technology globally as of 2023, TopCon and HJT have started to gain traction. On average, TopCon and HJT cells are expected to offer an incremental efficiency gain of 1-2% over mono-PERC cells, while HJT cells are estimated to provide an additional 2-3% efficiency gain over TopCon cells. This has enabled the possibility of higher electricity generation.

However, the capital cost intensity required to establish manufacturing facilities also increases with the initial capital expenditure (capex) for HJT estimated to be 2.5-3.0 times that of mono-PERC and 1.5-2.0 times that of TopCon. Nevertheless, large-scale manufacturing, combined with ongoing research and development, is expected to bring about economies of scale benefits in the future for these higher-efficiency cell technologies.

Table 17: HJT and TopCon cells: higher efficiency, higher cost

	Mono PERC	TopCon	HJT
Cell efficiency	23-23.5%	24%+	24-25%+
Module Efficiency	Upto 22%	22-24%	22-24%
Bifaciality	70-80%	75-85%	75-95%
Losses & Damages	P-type Mono PERC cells are prone to LID & PID losses. Losses highest in group.	PID & LID losses in TopCon are lower compared to Mono PERC, bit higher compared to HJT	Not prone to PID & LID losses, since general cell construction is n-type
Complexity	Moderately complex	Less than HJT	Most complex

Note: PID stands for potential induced degradation and LID stands for light induced degradation

Source: Crisil Intelligence

The solar PV industry is constantly at risk of technological disruption. According to the data available worldwide in the public domain, theoretically, tandem cells are expected to increase efficiency to up to 40% with material, such as perovskite, showing significant promise. Tandem perovskite cells will build on finished n-type TOPCon solar cells, adding ~25% efficiency to the base.

Meanwhile, several countries are promoting in-house PV manufacturing to enhance self-reliance and mitigate supply chain risks from international markets.

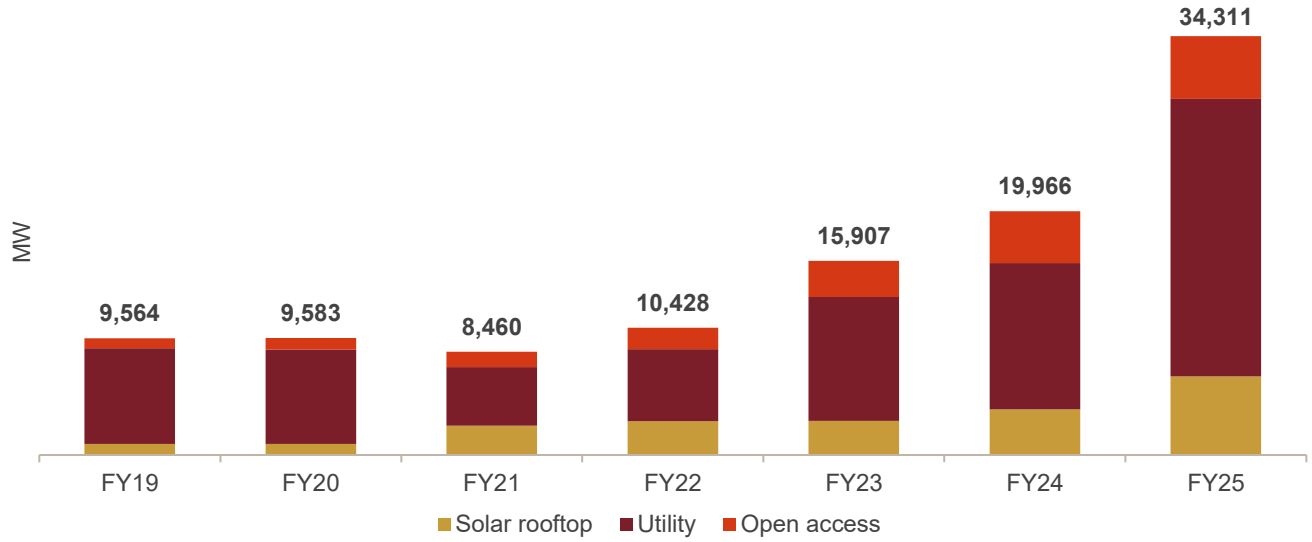
The domestic solar PV segment

The domestic PV segment has been driven by domestic demand for solar modules through various segments such as rooftop, utility scale and open access. From the beginning of Fiscal 2019 to the end of Fiscal 2025, India has witnessed a cumulative solar module demand of ~108 GW.

Review of domestic solar module demand

The domestic demand for solar module has been driven by the competitively bid utility segment at 66%, followed by the rooftop segment at 18% and open access segment at 16% between Fiscals 2019 and 2025.

Figure 31: India experienced an average annual module demand of 15 GW between Fiscals 2019 and 2025



Note: Demand includes DC overloading

Source: Crisil Intelligence

The growth of India's solar module demand was driven by a combination of factors, including declining module prices, supportive government policies, and increasing awareness of solar energy's benefits.

The competitively bid segment saw significant growth, with installed solar capacity more than doubling to 80 GW by the end of Fiscal 2025 over Fiscal 2019, driven by initiatives under the National Solar Mission, solar parks, renewable purchase obligations, and the Panchamrit targets pledged under COP26. Central tender allocations, led by SECI, accounted for at least 34% of these additions (over Fiscals 2019 to November 2024), while other central and state allocations contributed the remainder. States with high irradiance, such as Rajasthan and Gujarat, witnessed the most significant additions.

The rooftop solar segment also experienced significant growth, with installed capacity increasing nearly sevenfold by the end of March 2025 over March 2020, driven by subsidies under the national rooftop mission, PM Suryaghar Yojana, and state-specific initiatives like Gujarat's Surya Urja Yojana. Favourable policies, including net metering in some states, further incentivised adoption. The top three states - Gujarat, Maharashtra, and Rajasthan - accounted for 59% of the installed base by Fiscal 2025. The rooftop segment is poised to add 24-26 GW of capacity from Fiscals 2026 to Fiscals 2029, registering a growth of 1.7 times over Fiscals 2019 to Fiscals 2025.

Open access solar, which allows consumers to purchase solar energy directly from producers, also contributed to the rising demand for solar modules. This segment attracted large commercial and industrial consumers seeking cost savings and sustainability benefits. The Green Energy Open Access Rules of 2022 stimulated growth by reducing the minimum load requirement, making open access projects more attractive and financially viable. The open access solar segment is expected to witness 10-15 GW of capacity additions from Fiscals 2026 to Fiscals 2029, registering a growth of 1.1 times over Fiscals 2022 to Fiscals 2025.

Domestic manufacturing capabilities in India grew rapidly over the past 5 years

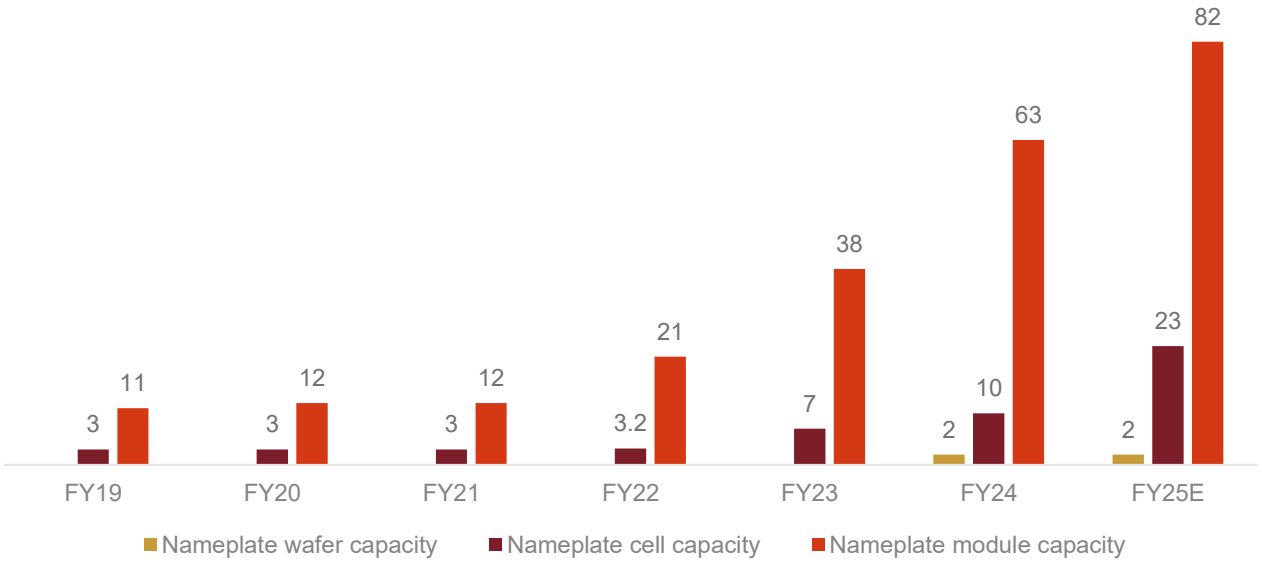
India's solar PV module and cell manufacturing capacity underwent significant expansion, increasing from 21 GW and 3.2 GW in March 2022 to an estimated 82 GW and 23 GW, respectively, by March 2025. This growth was driven by a strategic combination of government policies, market dynamics, and a growing commitment to renewable energy.

Often manufacturers quote manufacturing capability in terms of effective capacity. This term is used to denote the variation as compared with full manufacturing potential due to various factors such as operational period during the year and technological wattage/ module configurations actually produced. The production of a lower Wp module in a higher-rated line can lead to a different effective capacity when compared with nameplate, i.e., the full potential.

Despite robust demand for solar modules, India's domestic manufacturing ecosystem remained focused on the downstream component stage, primarily due to the capital-intensive nature of upstream components such as wafers and polysilicon. The availability of cheaper alternatives from China further contributed to this concentration.

Along with this, in terms of supply-capacity addition, solar manufacturing lines require a substantial amount of time for stability and ramp-up, typically ranging from 6 to 12 months for polysilicon to cell. Some manufacturers have reported that it can take up to 2 years to achieve full production capacity.

Figure 32: Expansion of capacity in cell to module stage



Note:
1) ALMM capacity considered for fiscal 2023 is as of February 2023 as per MNRE release. March capacity is considered for the other fiscals.

2) Due to the fragmented nature of the industry and the presence of unorganized entities, the latest and full disclosure on capacity is unavailable for small players for fiscal 2025 and the total capacity is estimated.

Source: Company reports, Crisil Intelligence

Between Fiscals 2022 and 2025, India's module and cell assembling/manufacturing capacity experieq`nced significant growth, with additions of approximately 61 GW and 19 GW, respectively. This expansion was driven by the government's efforts to reduce dependence on imported solar components, particularly from China. The introduction of ALMM played a significant role in the process by increasing 6 times to 77 GW between Fiscals 2022 and 2025.

While there has been significant expansion in module manufacturing capacity, cell expansion is also happening at rapid pace. If margins of pureplay cell manufacturers are evaluated, operating margins were ~19%[1] in Fiscal 2024 giving an indication of profitability in this segment of the value chain.

[1] Based on a sample set of 2 pureplay cell players which comprised 10% of cell manufacturing base as on Fiscal 2024.

To support local manufacturing, the Indian government introduced a range of protective measures, including a safeguard duty on imported solar cells and modules from July 2018 to 2021. In Fiscal 2023, a basic customs duty of 40% on modules and 25% on cells was introduced to enhance the competitiveness of Indian-made products. The government simplified duty structure in the budget 2025-26 with change in duty calculations on inclusion of AIDC. Duties on solar modules were split into BCD and AIDC at 20% each while that in cell was restructured to 20% and 7.5% of BCD and AIDC, respectively. Additionally, a domestic content requirement had been already applied on certain schemes, such as the CPSU scheme phase-II, PM Surya Ghar Yojna, and PM KUSUM.

The government also implemented measures like the approved list of models and manufacturers (ALMM) to ensure quality control and encourage capacity additions in the downstream stages. Furthermore, the Production-Linked Incentive (PLI) scheme for high-efficiency solar modules, launched in 2021, provided financial incentives to manufacturers based on their incremental production. These schemes played a crucial role in encouraging manufacturers to expand capacity, invest in new technologies, and pursue backward integration.

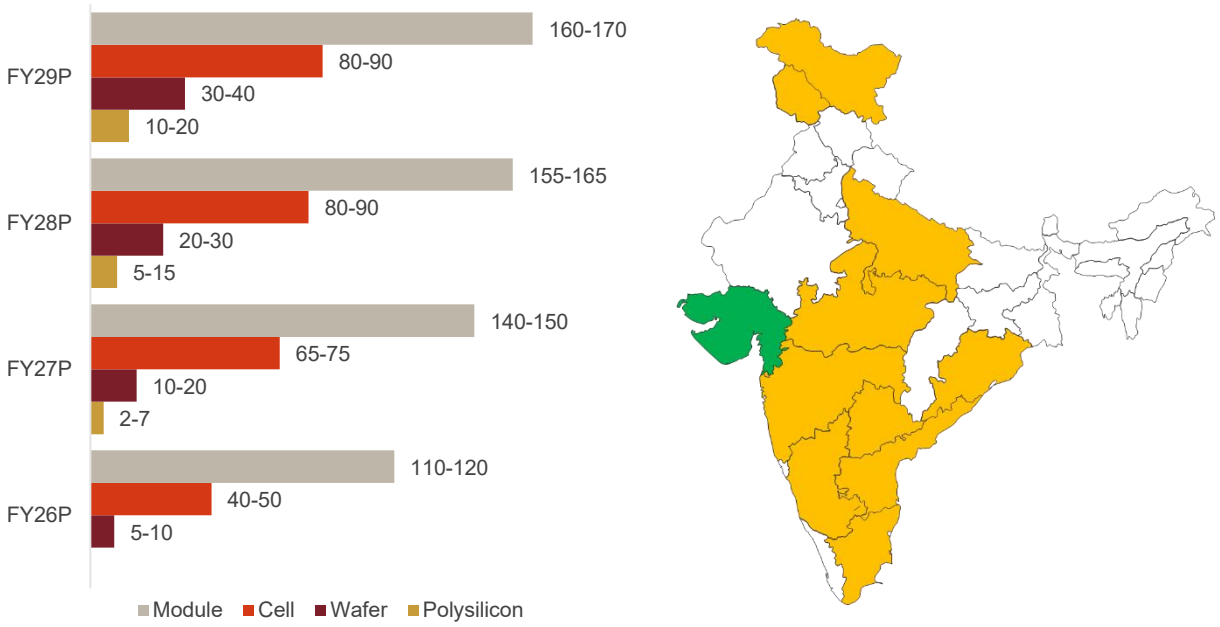
The industry has undergone significant consolidation in recent years, with new large-scale entrants gaining a significant market share. While the industry was highly fragmented in Fiscal 2019, the emergence of major players has led to consolidation. The large players, along with others, are expected to expand their presence across the value chain under the production linked incentive (PLI) scheme.

Domestic PV manufacturing to continue rapid expansion phase

By the end of Fiscal 2029, India's domestic module and cell manufacturing industries are projected to experience significant growth, with nameplate capacity (rated capacity or maximum manufacturing capability) expected to increase by approximately 2 times and 4 times, respectively from Fiscal 2025. Overall, the module manufacturing space has witnessed announcements of over 100 GW owing to the rising demand. However, Crisil Intelligence expects that with imposition of ALMM II from June 2026, the usable domestic manufacturing capacity for domestic consumption for applicable solar segments will be restricted to the enlisted manufacturers in the cell list. On the other hand, the country is expected to see the establishment of large-scale wafer and polysilicon facilities, with capacity reaching 30-40 GW and 10-20 GW, respectively by Fiscal 2029. This increase in manufacturing capacity provides an opportunity for India to expand its production and establish its position in the export market where US market is a potential export opportunity, hence, expansion in supply chain will cater to both domestic demand as well as exports.

This substantial expansion in capacity, particularly in the upstream components, is expected to be driven by a combination of trade, non-trade interventions and the PLI scheme, which aims to encourage investment and growth in the domestic solar manufacturing industry.

Figure 33: Upstream supply chain announcements to be driven by PLI; Gujarat emerges as the favourite destination for PV manufacturing



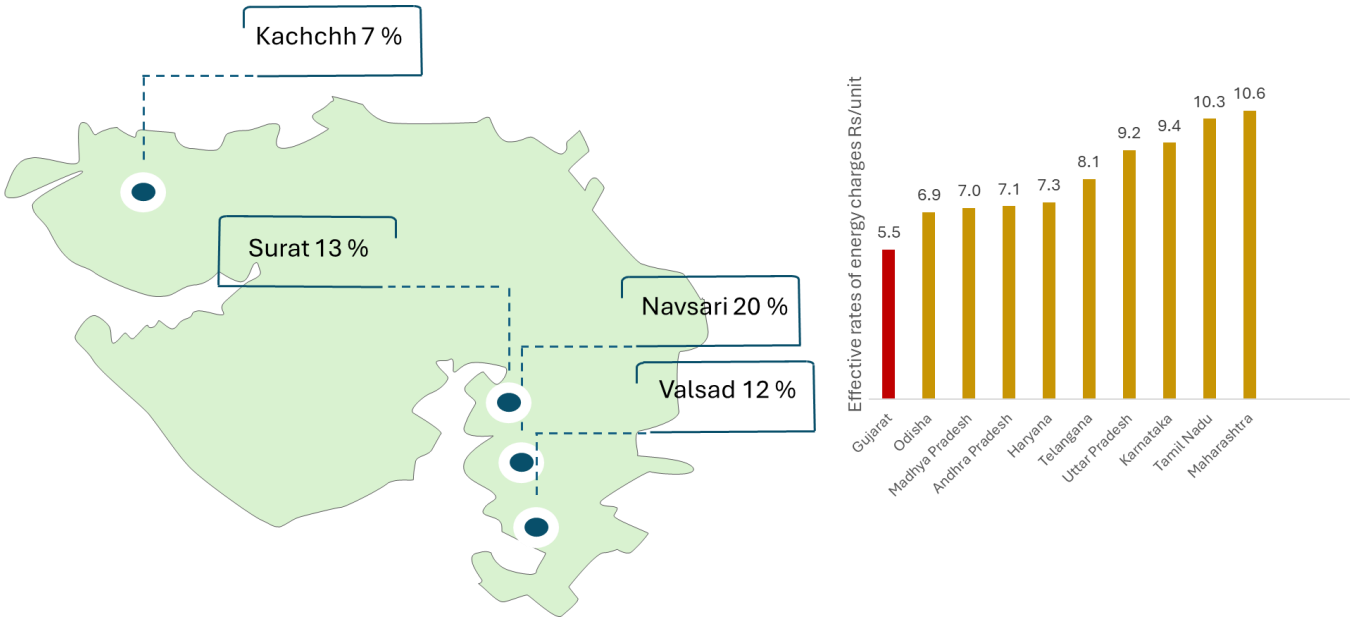
Note: The above capacity is based all market announcements available in the public domain.

Source: Company reports, Crisil Intelligence

Having integrated solar PV manufacturing plants that produce wafers, cells, and modules all under one roof have certain advantages such as improved efficiency and cost reduction. With reduced transportation costs and economies of scale, these plants can optimise their production flow and have better quality control. Integrated solar PV manufacturing plants also provide greater flexibility and supply chain security. The manufacturer can respond to changes in demand efficiently, dependence on external suppliers gets reduced along with access to advanced technologies, it can gain competitive advantages in terms of quality as well as price.

Gujarat is expected to be the epicentre of PV manufacturing capacity additions. This is because Gujarat has one of the lowest effective power rates for the industrial sector across major states. In fact, nearly 42% of the enlisted capacity of ~77 GW in the ALMM by March 2025 was situated in Gujarat.

Figure 34: Concentration again high within Gujarat with nearly 52% of capacity located in 4 districts



Source: ALMM, MNRE, REC, Crisil Intelligence

Until Fiscal 2025, India's solar industry was in its early stages, heavily reliant on imports for upstream components like cells and wafers. Hence, the availability of ports and trade routes also makes Gujarat an attractive location for manufacturing, and based on the pipeline the state is expected to continue dominating capacity additions in the future.

Over the next four years, the industry's technology setup is expected to undergo an upgrade. While mono PERC technology has been dominant until Fiscal 2025, more than ten players have announced capacity additions using TopCon technology, and a few have chosen to expand into HJT technology.

The growth in nameplate module manufacturing capacity for cells and modules is expected to help India reduce its reliance on imports by Fiscal 2029.

Import reliance to fall while exports may get a boost

Share of Chinese imports fall

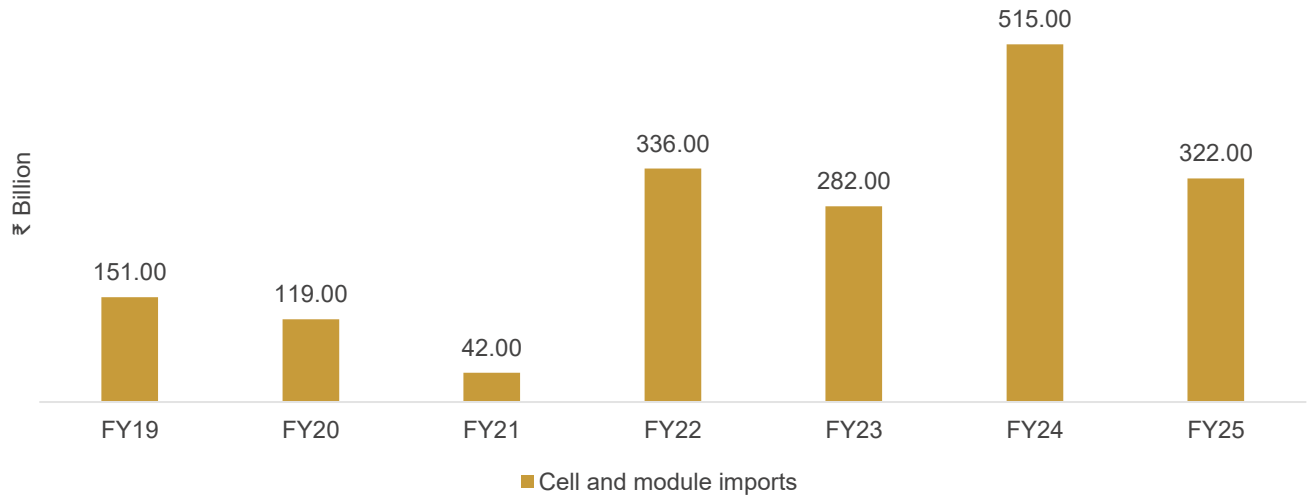
Between Between Fiscals 2019 and 2025, Indian companies invested significantly in solar cell and module manufacturing. Despite the potential for growth, domestic solar manufacturers have historically relied on export revenue, as Indian solar developers, in the past, have preferred imported modules, except in specific market segments where domestic content requirements apply, which account for a smaller portion of the overall renewable energy sector.

As a result, more than 50% of solar modules installed in India during this period were imported, primarily due to inadequate domestic capacity, competitive pricing, and technology preferences.

As of March 2025, India had ~23 GW installed capacity of solar cells and ~82 GW of modules. Even though India is one of the top 10 solar module producers, it is far behind its biggest competitor, China. In Fiscal 2022, imports increased by a staggering 494% on-year to ₹0.25 trillion (from ₹0.04 trillion). This sudden and sharp surge in imports was due to ease in restrictions coupled with expiration of time extensions provided to projects under the COVID-19 relief. While imports fell in Fiscal 2023 by 28% on-year, it sharply rose 184% on-year in Fiscal 2024 owing to ALMM

abeyance to meet rising solar power demand in the country. The reimposition of ALMM from April 2025, has led to reduction in imports to Rs 322 billion in fiscal 2025, a 38% decline over fiscal 2024.

Figure 35: Reimposition of ALMM in Fiscal 2025 results in lower imports

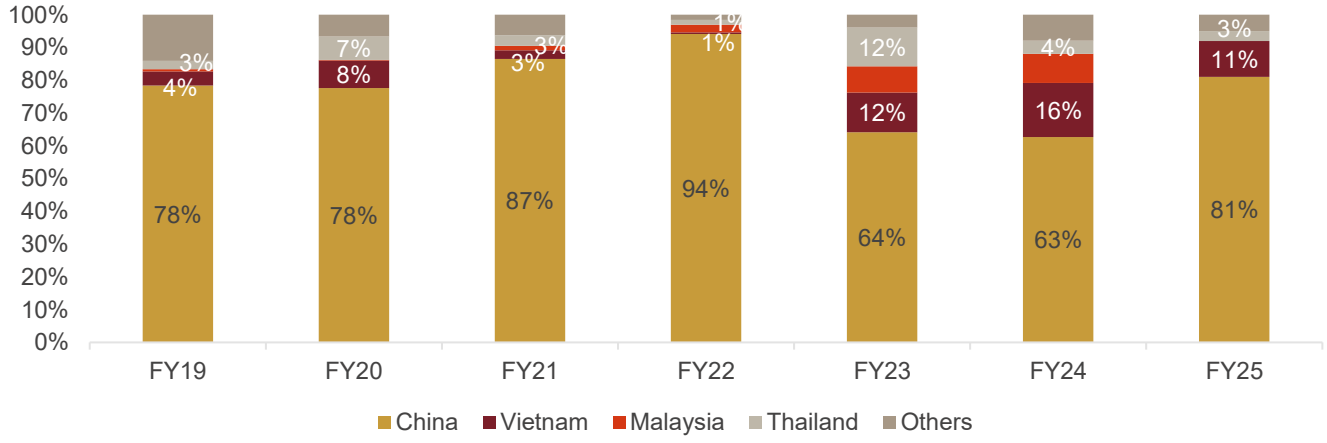


Note: HS Code 85414011 & 12 used till Fiscal 2022, and 85414200 & 300 used from Fiscal 2023.

Source: Ministry of Trade and Commerce, Crisil Intelligence

However, despite fall in imports, the share of China in India's import basket increased in 10M Fiscal 2025 owing to availability of cheaper raw materials. The share of ASEAN countries continues to remain robust as well in India's import basket.

Figure 36: Share of China volatile in India's import basket



Note: HS Code 85414011 & 12 used till Fiscal 2022, and 85414200 & 300 used from Fiscal 2023.

Source: Ministry of Trade and Commerce, Crisil Intelligence

Countries such as Vietnam, Malaysia and Thailand have gained market share over the years with some investment also coming in from Chinese players. However, lack of upstream components in the ASEAN countries has

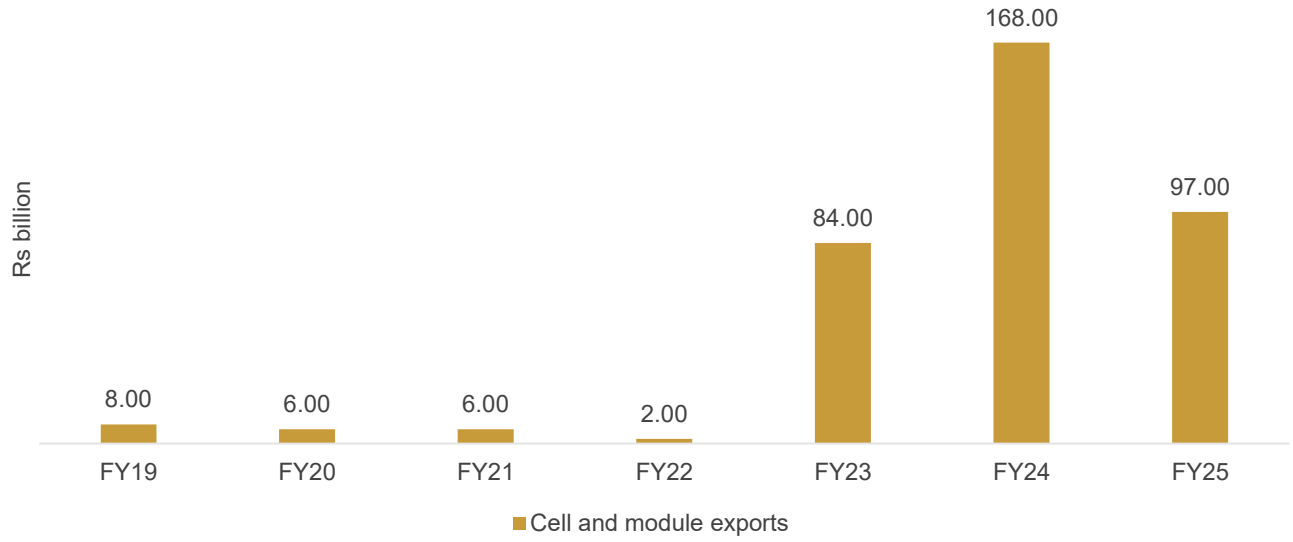
maintained price competitiveness with India. On the other hand, the landed price of imported solar modules remained at least ₹10-12/Wp lower than that of a domestically manufactured module in Fiscal 2025.

While imports contributed a high share in consumption in the past, exports have also shown a remarkable growth over the same period.

Exports grow multifold for India, so does geographical concentration

India's solar cell and module exports averaged a modest ₹5.51 billion between Fiscals 2019 and 2022. However, a significant boost in manufacturing capacity and shifting geopolitical dynamics led to a remarkable surge in exports, with a 39-fold increase in Fiscal 2023 compared to the previous year, followed by a 2-fold increase in Fiscal 2024. With reimposition of ALMM, the domestic demand rose sharply in Fiscal 2025 resulting in usage of domestic produce for Indian consumption. The fall in value of exports was also attributable to the reduced prices of solar modules on year in Fiscal 2025 while exports volume remained flat in the year.

Figure 37: Falling module prices and increase in domestic consumption impact export value

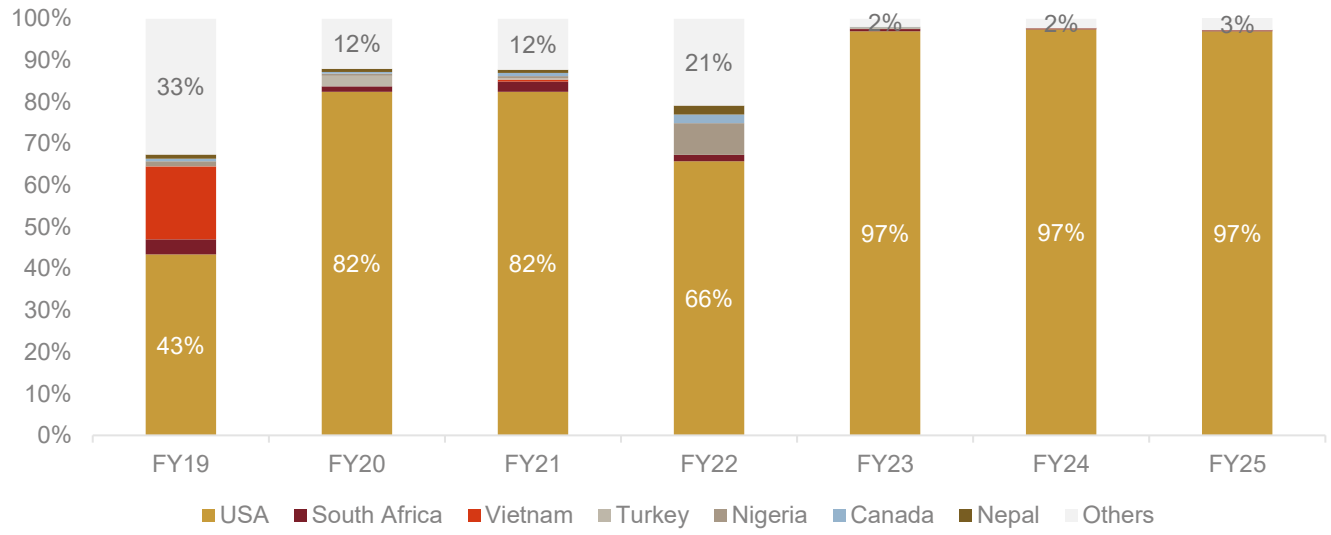


Note: HS Code 85414011 & 12 used till Fiscal 2022 and 85414200 & 300 used from Fiscal 2023.

Source: Ministry of Commerce and Industry, Crisil Intelligence

While the share of the US remained at over 60% on an average between Fiscals 2019 and 2022 in India's export basket, the share significantly jumped to 97% during Fiscals 2023, 2024 and 2025.

Figure 38: US accounts for 97% of Indian solar exports



Note: HS Code 85414011 & 12 used till Fiscal 2022 and 85414200 & 300 used from Fiscal 2023.

Source: Ministry of trade and commerce, Crisil Intelligence

A major reason for increased exports to the US is its sanction on imports from Xinjiang region imposed in June 2022 that opened doorways for other exporting economies such as Vietnam, Malaysia, Thailand and India. While India's prices remained uncompetitive to Chinese suppliers, they still offered a lower price compared to those manufactured in the US.

The act specifically focuses on imports of polysilicon, cotton and automotive parts from the Xinjiang region. It not only applies to the final product but also to upstream components, to ensure no component manufactured in the Xinjian region enters the US. Xinjiang is a large polysilicon manufacturing centre, catering to demand from various cell and module manufacturers. This has led to ban on individual companies, such as Xinjiang Daqo New Energy and Xinjiang GCL New Energy Material Technology, subsidiaries of large polysilicon manufacturers, Daqo New Energy and GCL Poly, respectively.

Strict measures have been implemented to prevent attempts to bypass the act by rerouting products through other countries. This effectively ensures Indian module manufacturers using Chinese cells would be unable to export to the US, thus presenting a unique opportunity for manufacturers using domestically manufactured cells. The Solar Energy Industries Association (SEIA) released a draft industry standard in 2024 to improve supply-chain transparency and help solar component importers comply with US laws. Standard 101 aims to ensure importers meet US Customs and Border Protection requirements. The SEIA developed it using real-world examples of solar product shipments detained and released by customs officials, with inputs from manufacturers, developers and third-party auditors. The strict nature of the SEIA standards has also had an impact on India's module exports.

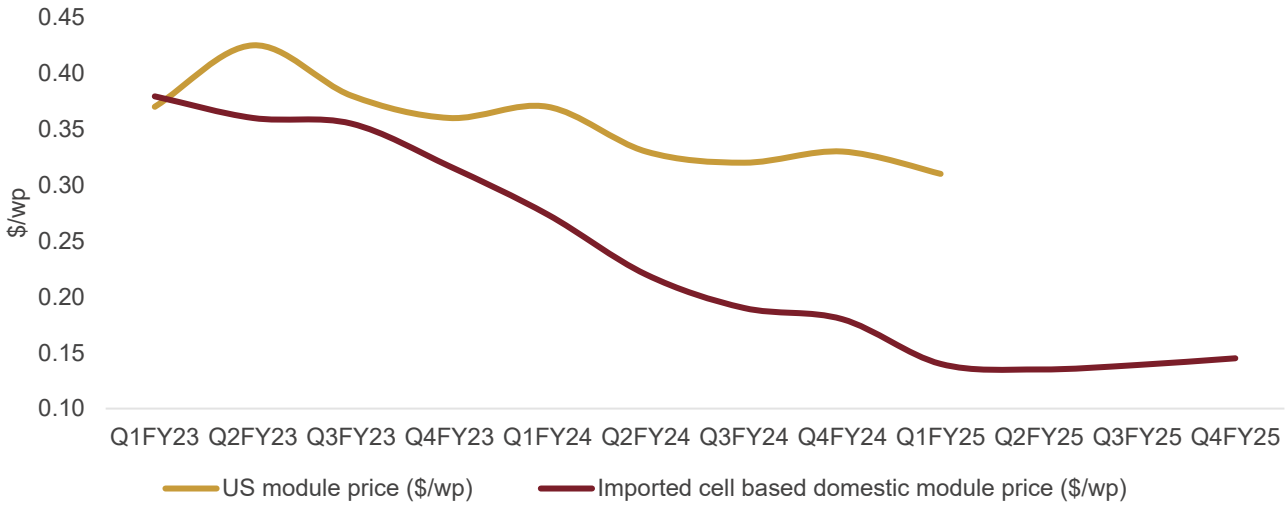
This industry standard had an impact on Southeast Asian (SEA) nations. While countries such as Vietnam, Malaysia, Thailand and Cambodia remain cost-competitive with India, they may face higher US tariffs due to dumping at artificially low prices and support from Chinese government subsidies. While the imposition of 50-60% tariffs on China under Section 301, Section 201 and countervailing duties has benefitted India and other SEA nations, the potential antidumping duty on SEA is expected to further strengthen India's competitive position.

In April 2024, a coalition of US solar manufacturers petitioned the federal government to impose tariffs on imports from Vietnam, Cambodia, Malaysia and Thailand. Furthermore, on June 6, 2024, the US ended the duty-free

imports for solar cells from these SEA nations. First Solar, Convalt Energy, Meyer Burger, Mission Solar, Qcells, REC Silicon and Swift Solar alleged that companies in the four SEA nations dumped solar cells in the US market at prices below the cost of production.

In July 2025, the US imposed a 25% tariff on India as part of its large-scale trade negotiations which is expected to witness another 25% increase from August 27, 2025 (unless policy changes). The price differential between global cell-based Indian modules and the US make remains favourable to India. Manufacturers are known to prioritise domestic cells to comply with ALMM and DCR mandates within India, while using a mix of imported and domestic cell-based modules for exports. With the imposition of ALMM-II from June 2026, the domestic cell capacity is expected to expand and improve backward integration, while non-DCR capacity can be used for higher-margin exports and other applications not bound by DCR mandates, such as green hydrogen. Furthermore, with solar PV no longer covered under Section 303 of the Defense Production Act (DPA) and low focus on expanding the IRA in the US, the favourable price differential is expected to continue in the near term.

Figure 39: Gap between average prices of US and India enable premium sales for domestic module makers



Note: Price mono crystalline technology-based modules.

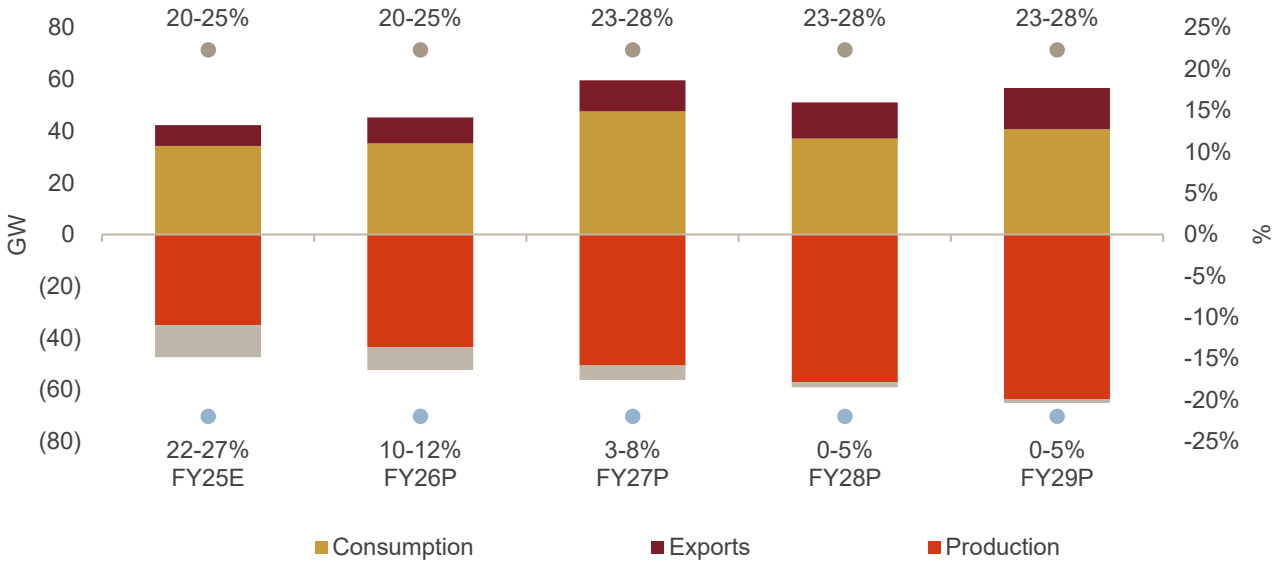
Source: EIA, Crisil Intelligence

On average, the difference between the module prices of US and Indian produce has been ~$0.06/Wp between Fiscal 2023 and Q1 Fiscal 2025.

Export-import balance to improve over the next four Fiscals

While the demand for solar modules remains robust at an average of 33-38 GW between Fiscals 2024 and 2029, the growth in production of modules is expected to result in oversupply from Fiscal 2025 onwards leaving room for exports. India exported ~7 GW of modules in Fiscal 2025, accounting for ~20-25% of the domestic production. Overcapacity of module manufacturing compared to domestic demand between Fiscals 2025 and 2029 is expected to create an export opportunity. While absolute exports will increase, the share of exports in production is expected to moderate between 20% and 28% over the years owing to rising domestic consumption needs.

Figure 40: Import dependence to fall below 5% by Fiscal 2029



Note: Exports potential may remain dynamic owing to trump tariffs.

FY26-FY29P numbers are projected

Source: Crisil Intelligence

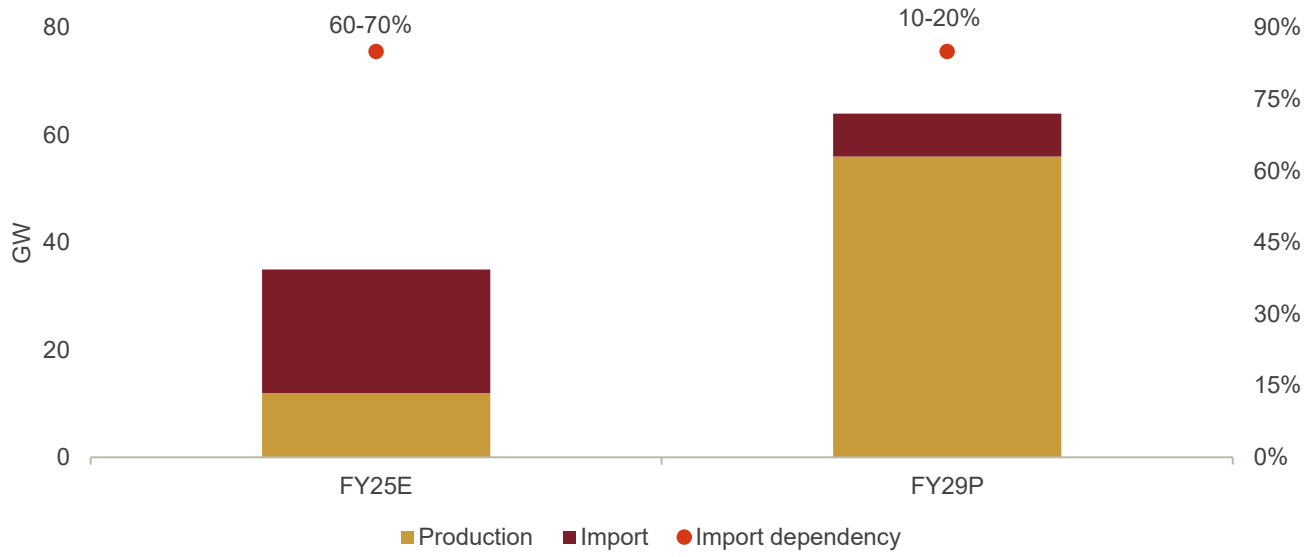
Crisil Intelligence notes that due to change in the geopolitical scenario, the exports have a downside risk owing to reciprocal tariffs and competitiveness. Further policy shocks in the US may also result in reduction of import demand of solar modules with the US. The impact will be dependent on trade negotiations and prolonged application of the same on India and its peers. Thus, it will remain monitorable.

Consequently, with rising nameplate capacity and ALMM applicability in Fiscal 2026, import dependency for modules is expected to fall from 65-75% in Fiscal 2019 to an average 0-5% between in Fiscal 2026 to 2029. However, a low base of fully integrated capacity would still result in high import reliance for upstream components such as polysilicon, wafers, and cells.

The prices of solar components fell significantly over the last three Fiscals supporting imports.

Furthermore, even with significant cell manufacturing capacity additions in the country, reliance of Indian module manufacturers on imported cells would remain high despite reducing significantly over the next five Fiscals. In percentage terms, import dependency is expected to go down from over 60-70% in Fiscal 2025 to 10-20% by Fiscal 2029 , majorly affected by the introduction of ALMM II.

Figure 41: Expansion of cell capacity to be largely used for in-house production



Note: Import dependency = (Imports / Demand)

Source: Crisil Intelligence

While India does export cells to the US and other Asian nations, the quantum remains low. Thus, the increase in capacity of cells is expected to be largely utilised for production of modules. MNRE had proposed a draft for application of ALMM on solar cells. Imposition of this can result in sharper reduction of cell imports and remains a monitorable as on date.

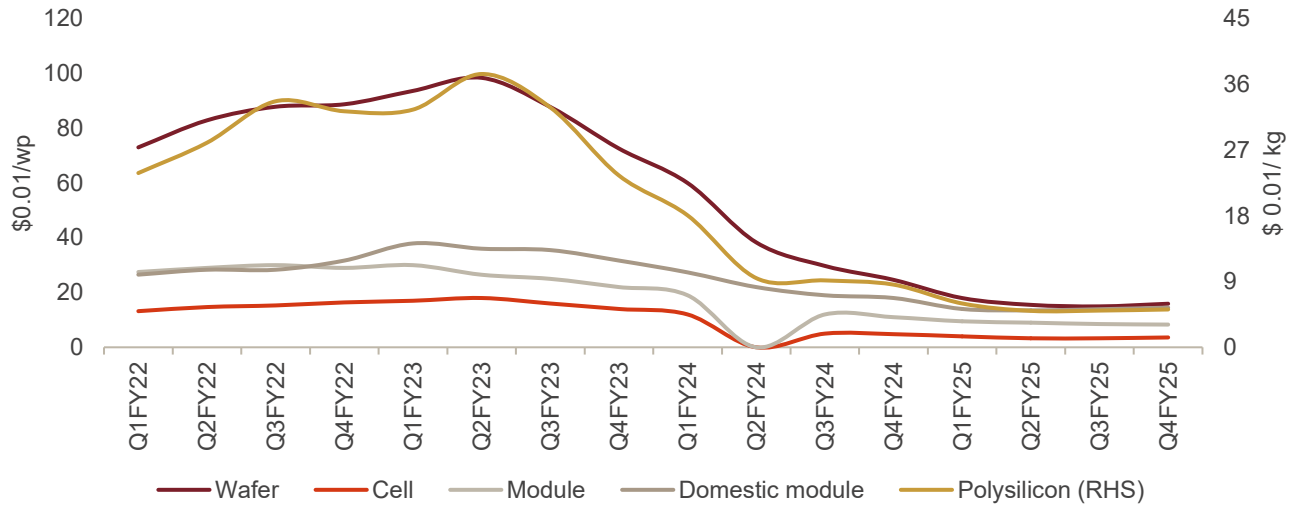
Sharp fall in prices of components due to supply glut

The prices of upstream components such as polysilicon shot up to $0.39 per kg in the second quarter of Fiscal 2023 owing to power rationing in solar provinces in China, followed by the Chinese energy crisis due to low coal stocks and demand surge. However, on a global scale, the polysilicon base expanded by 68% on-year by the end of December 2022, reaching a range of 1,000-1,100 tonne from the previous 600-650 tonne. Despite strong demand from China, the increased installed base by December 2022 resulted in oversupply, causing a dramatic price drop to $0.19 per kg by the Fiscal 2025, nearly half of the peak of the second quarter of Fiscal 2023.

Consequently, downstream components also witnessed significant price reductions, with wafer prices plummeting 53% to $0.15 per piece in Fiscal 2025 from $0.98 per piece in the second quarter of Fiscal 2023. The oversupply of polysilicon also prompted the world's largest monocrystalline solar wafer supplier to cut prices of its PV wafers twice between April and May 2023, reducing prices by 33% as cell manufacturers sought to fulfil their order requirements. Cell prices also saw a decrease in Fiscal 2025 over second quarter of Fiscal 2023, reaching $0.03 per Wp, while module prices fell 62% during the same period.

The combination of weak European demand and an accumulation of Chinese module inventory is expected to keep global module prices subdued in 2024.

Figure 42: Prices plunge as the world sees a supply glut



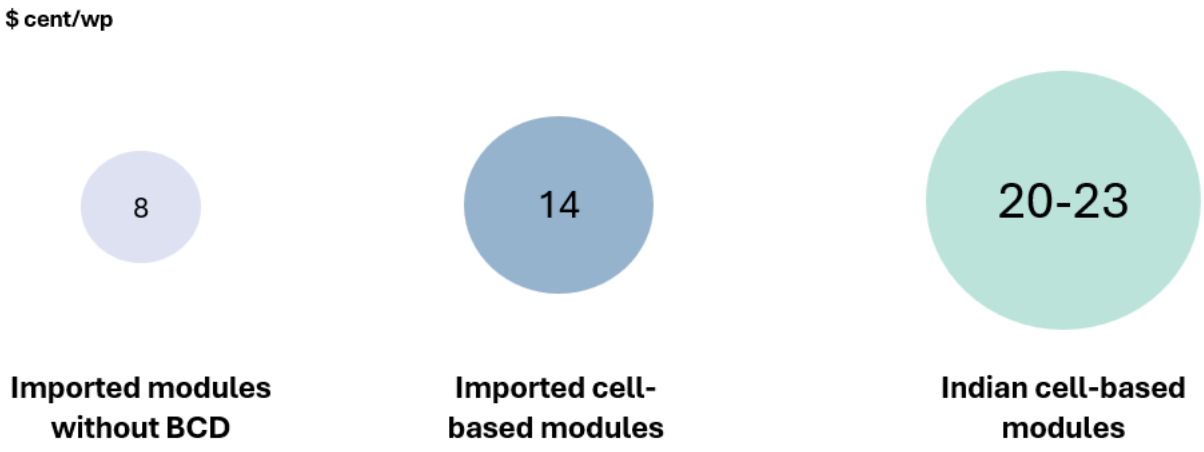
Source: Crisil Intelligence

The oversupply is expected to continue this Fiscal 2026, resulting in the prices of imported solar modules ranging $0.08-0.10 per Wp and $0.13-0.15 per Wp for the locally assembled ones. However, prices of modules assembled using Indian cells remained at least 1.2 times higher than those assembled using imported cells.

Pricing of Indian cell-based modules minimum 1.2 times higher than that of imported cell-based

The need for economies of scale is essential to achieve competitive pricing for domestically manufactured modules. Domestic content requirement ensures that projects utilise solar cells and modules produced in India. While the current approved list of models and manufacturers (ALMM) provides price resilience to domestic manufacturers, the absence of large-scale cell capacity has resulted in modules assembled using local cells being at least 1.4 times more expensive than modules utilising imported cells and ~2 times more expensive than a traded Chinese module.

Figure 43: Indian cell-based module prices 1.5-2 times of traded Chinese modules in Fiscal 2025



Note: Prices are for Fiscal 2025.

Source: Crisil Intelligence

As a result, a comprehensive policy initiative has been instrumental in driving significant expansion of domestic module manufacturing capacity, with a positive impact on the module segment of the value chain. This policy push is also expected to support the expansion of cell manufacturing capacity. However, the industry's reliance on imported upstream components is likely to remain in the long term, which may lead to a shift towards Chinese component imports. Furthermore, the export market is expected to be driven by policy-led diversification strategies, where Indian products will stand to gain if competitively priced against domestic alternatives. Despite high price differential, the demand for domestically made modules is expected to increase because of the mandate of using domestic made cells with the implementation of ALMM-II.

Policy supports key for photovoltaic manufacturing expansion

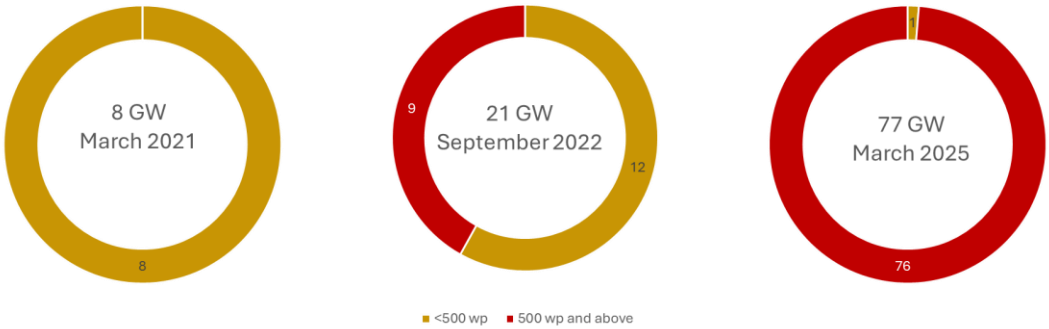
The PV manufacturing industry has received both demand and supply incentives over Fiscals 2019-2025. The fruits of these benefits are expected to materialise over the years.

Figure 44: Demand and supply drivers for PV

Source: Crisil Intelligence

1. **50 GW annual tendering capacity**: The government has decided to invite bids for 50 GW of renewable energy capacity annually for the next five years, that is from Fiscal 2024 till Fiscal 2028. Since RE projects take 18-24 months for commissioning, the bid plan will add 250 GW of renewable energy and ensure 500 GW of installed capacity by 2030.
2. **ALMM:** The approved list of models and manufacturers is an initiative by the Ministry of New and Renewable Energy of India to ensure that only high-quality solar models and manufacturers are used in projects supported by the government. The initiative introduced in 2021 has acted as a non-tariff barrier for global manufacturers to enter the Indian market. The list has been updated several times between March 2021 and December 2024 with increasing enlistments. The capacity enlisted touched 77 GW in March 2025, ~10 times more than that listed in March 2021.

Figure 45: Enlisted capacity grows ~10 times

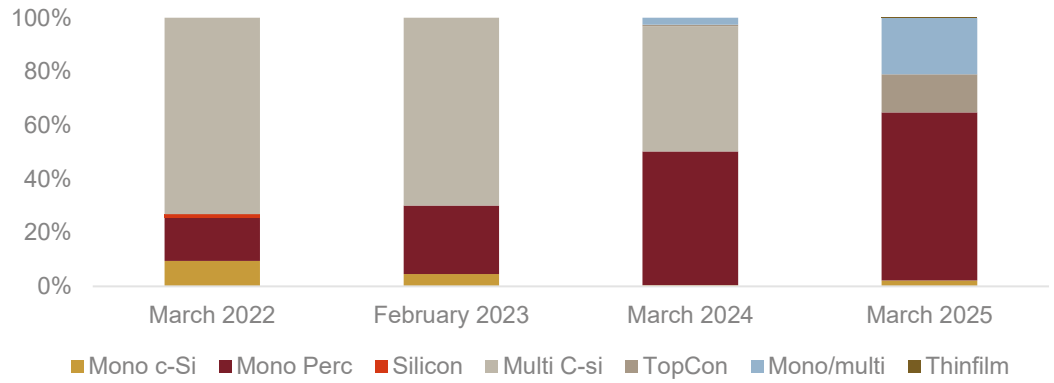


Note: Capacity inside the doughnut is the total enlisted capacity as per ALMM

Source: MNRE, Crisil Intelligence

The evolution of cell technology in India has mirrored the global market. As per the batch enlistment in the ALMMs over Fiscals 2022-2025, the share of Mono PERC and TopCon has risen sharply from 16% and 0% respectively in March 2022 to 63% and 14% respectively in March 2025. Consequently, lower efficiency cells such as Multi C-Si have lost their market share to 0% in March 2025 from 74% in March 2022. The shift in share of the technology is on account of the shift in the preference of the end use demand. Developers are increasingly moving towards TopCon technology in solar cells due to its higher efficiency, lower cost, and improved performance compared to older technologies. These cells boast significantly higher energy conversion rates, reducing the amount of land and material needed to generate the same amount of electricity, mitigating the problem of land congestion in several high irradiance locations across the country.

Figure 46: TopCon share inches up while Mono PERC continues to be largest



Note: The share of technology denotes the count of module batch enlistment per technology divided by total module batch enlistment in the respective month. MNRE has not released ALMM for March 2023 and thus February 2023 has been used.

Source: MNRE, Crisil Intelligence

The domestic PV segment has been driven by domestic demand for solar modules through various segments such as rooftop, utility scale and open access. From the beginning of Fiscal 2019 to the end of Fiscal 2025, India has witnessed an estimated cumulative solar module demand of 108 GW.

The initiative does not involve any foreign manufacturer's plant globally as of March 2025, providing price resilience to domestic manufacturers. The ministry is also announced ALMM for cells, to be imposed from June 2026. With

over 55 GW cell manufacturing capacity announced, the ALMM for cell is expected to help expand manufacturing in this value chain stage as well. Thus, timely commissioning of the cell capacity is crucial.

3. **Domestic content requirements (DCR):** The DCR mandates the use of solar cells and modules manufactured domestically as per specifications and testing requirements fixed by MNRE. There are various schemes announced by the government to promote the use of domestically manufactured modules such as CPSU scheme, PM-KUSUM scheme, grid connected rooftop solar programmes. All these schemes have a Central Financial Assistance (CFA)/VGF component to cover the cost difference between imported and domestic solar cells and modules. It is mandatory to use DCR cells and modules to avail the financial aid provided by the central/state government. Cumulatively, these projects provide at least 40 GW opportunity for Indian manufacturers Ramping up of cell manufacturing technology will be essential as domestic cells account for 50-60% of the domestic module prices. Scaling up of capacity can help gain economies of scale over the period. Additionally, the success of DCR installations also hinges on ramp in enlistment of cell capacity in ALMM II, which was 13 GW as of July 2025.
4. **China plus one strategy:** The China plus one strategy encourages companies to diversify their operations by expanding outside of China while still maintaining a presence in the country. India is one of the potential destinations for solar manufacturing due to its low labour cost as well as favourable political and regulatory environment for manufacturing. Rising manufacturing base has enabled domestic manufacturers to tap the export potential with nearly 97% of exports focused on the US alone.
5. **PLI scheme**: MNRE launched tranche I of the PLI scheme for high efficiency solar modules in April 2021 allocating 8.7 GW to three manufacturers with an outlay of ₹45 billion. However, this was later increased, and a second round of allocation was conducted based on oversubscription witnessed in tranche I. MNRE then announced tranche II of the PLI scheme in September 2022, to allocate 36 GW of fully integrated/partially integrated solar manufacturing with an outlay of ₹195 billion. As of 31.10.2024, an investment of around Rs. 350 billion has been made under the Scheme for High Efficiency Solar PV Modules. The purpose of the scheme was to enable the building of vertically integrated solar manufacturing capacity for better quality control and competitiveness. While the scheme remained technologically agnostic, technologies that yielded better module performances were to be incentivised. The scheme witnessed allocations to thirteen unique manufacturers in India across various stages of the value chain. While the players will only be eligible for PLI on half of the capacity allocated, the PLI scheme is expected to be pivotal in setting up a capital-intensive upstream value chain (polysilicon and wafer) as over 80% of all the expected additions in these segments will be driven through the scheme by Fiscal 2030, resulting in a reduction of Indian PV manufacturers' reliance on imports..
6. **Basic custom duty (BCD):** The government of India from time to time has intervened to reduce the price disparity between Indian and international modules in the form of safeguard duties and basic custom duty. Rising imports had discouraged manufacturing capacity expansion in the past and thus various players from the Indian domestic solar component manufacturing industry (mainly modules) filed additional duty petitions against imports.

   Despite the safeguard duty, imports dominated module supplies. Indian producers sought an extension, and the duty was extended for a year, then removed after July 2021. However, the Ministry of Power alternatively levied a BCD effective April 1, 2022. While the imposition of BCD of ~40% on modules and 25% on cells led to the capital cost increasing, the price disparity between a domestic assembled module and imported module reduced from $7-8 cents/Wp to $1-2 cents /Wp resulting in demand for domestic manufacturers.

   The recent simplification of duty structure in budget 2025-26 changed the duty structure.

Table 18: New and simplified duty structure

Solar module	Old duty structure	New duty structure
BCD	40%	20%
SWS	4%	-
AIDC	-	20%

Solar cell	Old duty structure	New duty structure
BCD	25%	20%
SWS	2.5%	-
AIDC	-	7.5%

Source: Crisil Intelligence

While the landed price of imported cells and module are estimated to decrease marginally, the implementation of ALMM and ALMM II is likely to protect demand for domestic make.

While the landed price of imported cells and module are estimated to decrease marginally, the implementation of ALMM and ALMM II is likely to protect demand for domestic make.

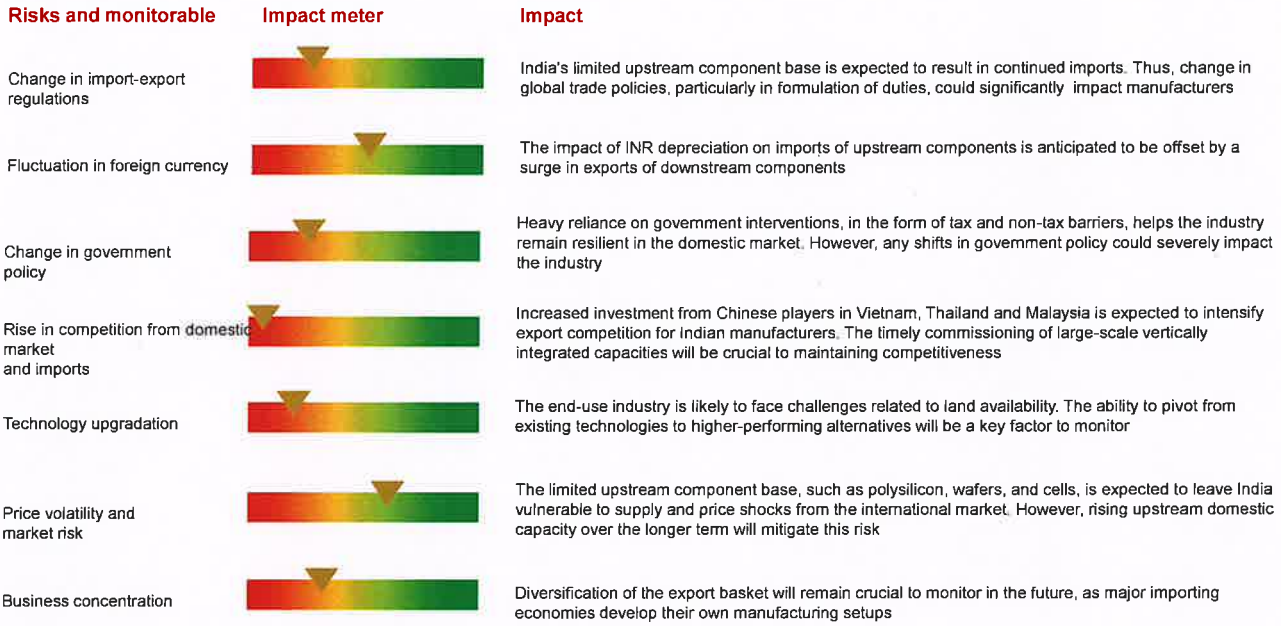
7. **SPECs**: The scheme for promotion and manufacturing of electronic components and semiconductors in India is a government initiative launched to boost domestic manufacturing of electronic components including those essential for solar PV modules. The scheme is part of the larger effort to create a self-reliant electronics ecosystem in India, reducing dependence on imports, particularly from China. Under the scheme, financial incentives are provided to manufacturers of critical components including solar cells, semiconductors and other electronics, which are vital for solar module production. The incentives include a financial subsidy that covers 25% of capex on new plants or machinery analogy upgrades, and research and development activities, aimed at enhancing India's production capacity and technological capabilities. The solar industry relies heavily on semiconductors, particularly for inverters, storage systems and other components, and the ability to produce these domestically is crucial for building a resilient solar supply chain. The scheme also contributed to India's China plus one strategy by encouraging global companies to invest in India's solar component manufacturing, positioning India as a reliable alternative to China for solar equipment.
8. **Domestic Tariff Area (DTA):** The DTA refers to the geographical region within a country where goods and services are freely available for trade, subject to domestic duties and taxes, as opposed to Export Oriented Units (EOUs) or Special Economic Zones (SEZs), where special exemptions apply. For solar cells and module manufacturers in India, the DTA policy framework plays a pivotal role in fostering domestic production. By ensuring that imported goods, such as solar cells or modules, incur tariffs under the BCD or other trade protections, the DTA helps create a level playing field for domestic manufacturers. This measure is particularly relevant given India's target of 500 GW of renewable energy capacity by 2030, with solar energy constituting a

significant share. The imposition of duties on imported solar cells and modules, particularly from countries like China, helps reduce dependency on imports and provides a competitive edge to local manufacturers

Risks and monitorable

While the growth drivers are expected to propel the industry, module manufacturers are vulnerable to multiple risks such as change in government regulations, exchange rate volatility, input price volatility, market, and competition risk, among others.

Figure 47: Government regulations, commissioning capability and technological progress key for the industry



Note: Red zone denotes high risk, amber denotes moderate risk and green denotes low risk

Source: Crisil Intelligence

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