ICRA ANALYTICS LTD

Solar Power Industry in India

Sadbhav Futuretech Limited

March 2026

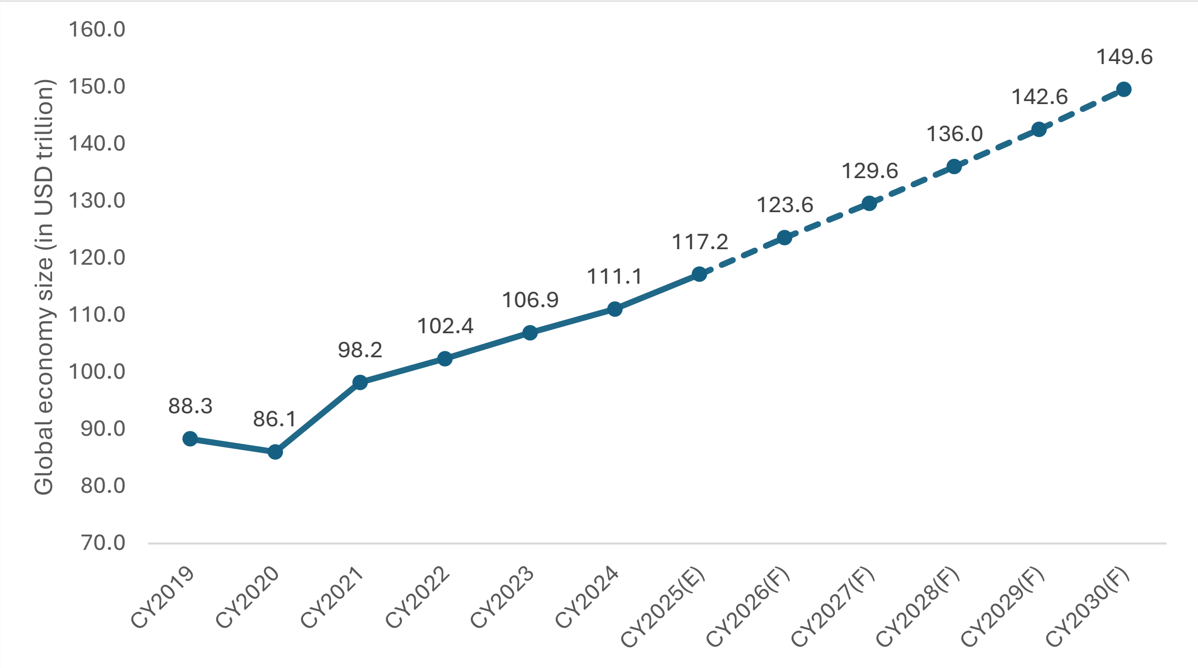
Contents

1. Global macroeconomic overview

As per the International Monetary Fund (IMF), the size of global economy is projected to reach USD 117.2 trillion in CY2025 (in nominal terms) and continue to grow to USD 149.6 trillion in CY2030 (in nominal terms) at a CAGR of ~5%. Despite multiple Global challenges, economic activity at the global level has remained broadly resilient with growth in employment and steady income levels, favourable demand and supply developments, utilization of substantial savings accumulated during the pandemic and healthy household consumption supported major economies to maintain their growth.

Key sectors including healthcare, technology, logistics, and services have significantly contributed to job creation and wage growth. With inflation nearing target levels in several advanced economies, central banks are beginning to shift toward a more accommodative stance, indicating a potential move toward monetary policy easing.

Chart: Global economy growth and prediction till CY2030 (in USD trillion- nominal terms)



Source: IMF (WEO October 2025), ICRA Analytics
Note: E-Estimated for CY2025, F-Forecasted; data from CY2026-CY2030 are forecasted

The global economy is currently navigating a complex landscape shaped by multiple interconnected challenges, including geopolitical tensions, rising interest rates, elevated debt-to-GDP ratios and constraints on both monetary and fiscal policies, all of which are influencing global GDP growth. Key factors include:

- **Inflationary Pressures**: Global headline inflation is projected to decline to 4.3% in CY2025, continuing its downward trajectory from 5.8% in CY2024 and 6.7% in CY2023. Advanced economies are expected to reach their inflation targets of around 2% more swiftly, while emerging markets are likely to see relatively higher inflation, averaging 5.5%. This disinflation is primarily driven by the easing of earlier energy price shocks, reduced labour market tightness, and improvements in global supply chains. However, risks such as renewed commodity price surges, increased financial market volatility, and escalating geopolitical tensions particularly in the Middle East, Ukraine, and the Taiwan Strait could disrupt this progress.

- **Monetary and Fiscal Policies**: Following a period of aggressive tightening from CY2022 to CY2024, most central banks have begun easing their monetary policies. A return to a neutral monetary stance is anticipated by the end of 2025. On the fiscal side, while some economies are cautiously increasing support to stimulate growth, their capacity remains constrained by high debt levels. The key challenge is balancing short-term stimulus with long-term fiscal sustainability, including rebuilding fiscal buffers.

- **Financial Market Volatility**: In CY2025, financial markets have witnessed increased volatility, especially during the first half of the year. This instability has been largely fueled by aggressive tariff measures most notably by the United States and ongoing geopolitical tensions.

- **Geopolitical Crises**: Rising social unrest, driven by high inflation, increased taxation, and declining purchasing power, along with spillovers from ongoing conflicts and widening inequality, pose risks to economic growth. These factors may also impede the implementation of structural reforms across various economies.

- **Commodity Price Increases**: Climate-related disruptions, regional conflicts, and intensifying geopolitical tensions are contributing to rising commodity prices. These pressures are affecting global supply chains and leading to sustained increases in the costs of essential goods such as food, energy, and raw materials, threatening economic stability and complicating inflation management.

- **China's Property Sector**: A deeper-than-expected downturn in China's property market could lead to financial instability, weaken consumer confidence, and reduce household consumption. Given China's pivotal role in global trade, such a decline could have significant spillover effects on international markets. Efforts by the Chinese government to boost domestic demand may strain public finances, and targeted subsidies particularly those aimed at supporting exports risk escalating trade tensions with key trading partners.

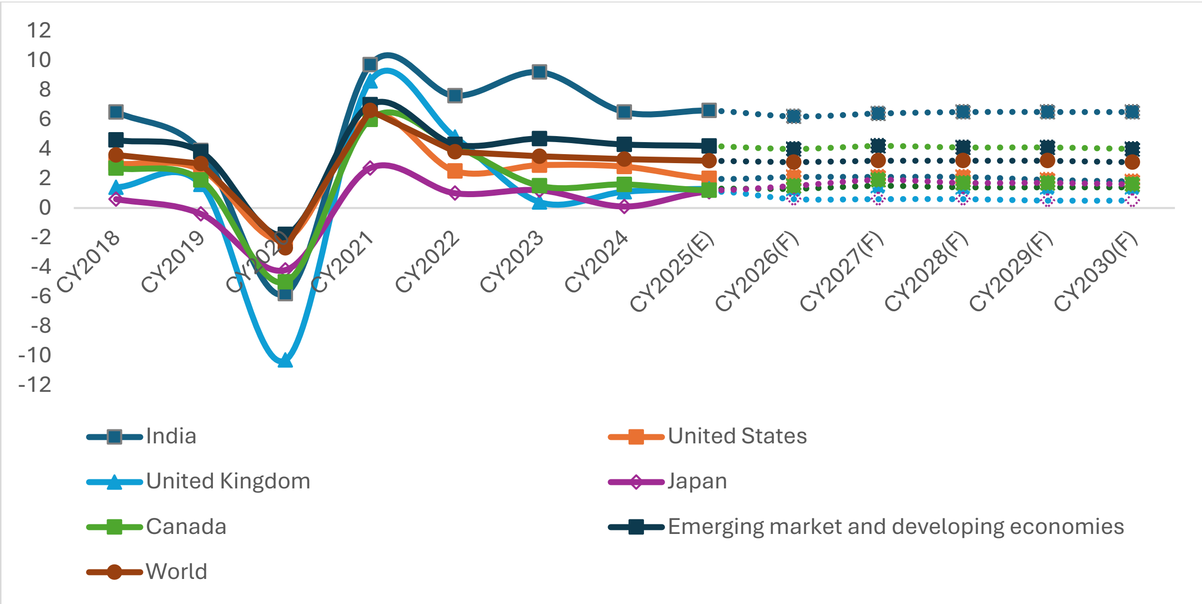
As per the IMF, World Economic Outlook published in October 2025, the Global growth is anticipated to decrease from an estimated 3.3% in CY2024 to 3.2% in CY2025, subsequently rebounding to a modest 3.1% in CY2026 as inflation continues to ease, real incomes recover, and financial conditions gradually normalize.

The global economy has shown resilience to the trade policy shocks, in part because these shocks materialized on a smaller scale than expected at their onset; however, the drag from shifting policies is becoming visible in more recent data. The IMF continues to note that protectionist measures and policy uncertainty constrain growth by discouraging investment and complicating supply chains.

The global inflation rate is predicted to decrease from an annual average of 6.6% in CY2023 and 5.7% in CY2024. Inflation is expected to decline to 4.2% globally in 2025 and to 3.7% in 2026, with notable variation across regions above-target inflation in the United States (with risks tilted to the upside) and subdued inflation in much of the rest of the world.

1.1 Global Economies and Growth Trend:

Chart: Real GDP growth rate (annual % change) of India and other economies



Source: IMF, ICRA Analytics
Note: E- Estimated for CY2025, F-Forecasted; data from CY2026-2030 are forecasted, emerging market and developing economies includes India, China, Saudia Arabia, Mexico, Vietnam and other developing economies.

Table 1: India v/s Other Economies (Real GDP, Y-o-Y % change)

Real GDP growth (Annual % change)	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025(E)	CY 2026(F)	CY 2027(F)	CY 2028(F)	CY 2029(F)	CY 2030(F)
India	6.5	3.9	(5.8)	9.7	7.6	9.2	6.5	6.6	6.2	6.4	6.5	6.5	6.5
Advanced economies	2.3	1.9	(3.9)	6.0	3.0	1.7	1.8	1.6	1.6	1.7	1.7	1.6	1.5
United States	3.0	2.6	(2.1)	6.2	2.5	2.9	2.8	2.0	2.1	2.1	2.1	1.9	1.8
Euro Area	1.8	1.6	(6.0)	6.4	3.6	0.4	0.9	1.2	1.1	1.4	1.3	1.2	1.1
United Kingdom	1.4	1.6	(10.3)	8.6	4.8	0.4	1.1	1.3	1.3	1.5	1.4	1.4	1.4
Japan	0.6	(0.4)	(4.2)	2.7	1.0	1.2	0.1	1.1	0.6	0.6	0.6	0.5	0.5
Canada	2.7	1.9	(5.0)	6.0	4.2	1.5	1.6	1.2	1.5	1.9	1.7	1.7	1.6
Emerging market and developing economies	4.6	3.8	(1.8)	7.0	4.3	4.7	4.3	4.2	4.0	4.2	4.1	4.1	4.0
China	6.8	6.1	2.3	8.6	3.1	5.4	5.0	4.8	4.2	4.2	4.0	3.7	3.4
World	3.6	2.9	(2.7)	6.6	3.8	3.5	3.3	3.2	3.1	3.2	3.2	3.2	3.1

Source: IMF, ICRA Analytics

Note: E-Estimated for CY2025, F- Forecasted; data from CY2026-2030 are forecasted, Advanced Economies includes United States, Germany, France, Japan, United Kingdoms, Canada and other developed countries. Emerging market and developing economies includes India, China, Saudia Arabia, Mexico, Vietnam and other developing economies.

In CY2025, global growth is being driven by strong domestic demand, resilient labour markets, and sectoral expansion across major economies. India is propelled by infrastructure investment and rising consumption, while the U.S. benefits from innovation and easing monetary policy. The UK and Japan are seeing modest recoveries through trade and capital investment. Emerging markets are gaining momentum through commodity exports, improving supply chains, and neutral fiscal policies, despite facing structural and geopolitical challenges

The global real GDP growth was 3.3% in CY2024 and is anticipated to decrease to 3.2% in CY2025 and 3.1% in CY2026. The rapid increase in trade tensions and exceptionally high levels of policy uncertainty is anticipated to considerably affect global economic activity. The growth is projected to remain at 3.1% in CY2030, wherein growth would be driven mainly by easing of monetary policy and strong private consumption.

1.2 Outlook on key advanced economies

In CY2024, advanced economies recorded a real GDP growth rate of 1.8%, which is expected to slow to 1.4% in CY2025, then gradually rise to 1.5% in CY2026, and reach approximately 1.7% by CY2030, indicating a stable growth path. The United States posted a growth rate of 2.8% in CY2024, projected to decline to 1.8% in CY2025 due to policy uncertainty, trade tensions, and subdued demand. Growth is expected to ease slightly to 1.7% in CY2026, rebound to 2.0% in CY2027, and stabilize around 2.1% through CY2030.

In Europe, the region recovered from a low growth rate of 0.4% in CY2023 to 0.9% in CY2024, with a slight dip to 0.8% expected in CY2025, followed by an improvement to 1.2% in CY2026. Within the Eurozone, France grew by 1.1% in CY2024, with a projected slowdown to 0.6% in CY2025. Italy recorded 0.7% growth in CY2024, expected to ease to 0.4% in CY2025. Spain saw a strong expansion of 3.2% in CY2024, anticipated to moderate to 2.5% in CY2025. Meanwhile, Germany experienced a contraction of -0.2% in CY2024, with growth expected to remain flat in CY2025.

Canada real GDP was 4.2% in CY 2022 as its economy bounced back from the pandemic. Growth decelerated to 1.5% in CY 2023 due to inflationary pressures. It remained stable at 1.6% in FY 2024 indicating that Canada avoided a recession many had feared. Growth is expected to dip to 1.2% in FY 2025 and then move to 1.5% in CY 2026. The IMF initially predicted a strong 2%+ growth but was revised sharply downward after the US imposed new tariffs. The trade restrictions along with slowing global economy expected to weigh on Canada's mid-decade growth. Looking further out it is foreseen that Canada's growth staying modest in CY 2030 hovering around 1.6% with biggest challenge of poor productivity growth, However, if Canada successfully raise productivity growth through technology adoption, business investment and workforce development and navigate trade relationships effectively it could uplift its long run GDP growth above the current projections.

Japan's economic growth has remained modest, largely due to structural issues such as an aging population and low productivity, despite continued support from government spending and monetary policies. Compared to other countries, Japan's recovery after the pandemic has been relatively weak. GDP was 1.0% in CY2022, rose to 1.2% in CY2023, but dropped to 0.1% in CY2024 due to weak global demand and internal challenges. GDP is expected to grow 1.1% in CY2025, then slowdown to 0.5% annually through CY2030.

In comparison with other advanced countries, the United Kingdom grew 0.4% in CY2023, improved to 1.1% in CY2024, and is expected to maintain 1.3% growth in CY2025. Long-term growth may stay around 1.4% by CY2030.

1.3 Outlook on key emerging and developing economies

In CY2024, emerging and developing economies registered a real GDP growth rate of 4.3%, which is projected to decline to 3.7% in CY2025, followed by a slight recovery to 3.9% in CY2026. This slowdown is largely attributed to recent trade policies and tariff pressures that have weakened export competitiveness in several Asian countries. While domestic demand continues to offer some support, export-driven growth models, particularly in ASEAN nations closely integrated with global supply chains, are facing significant challenges. As a result, overall growth in emerging and developing Asia is expected to fall from approximately 5.3% in CY2024 to 4.5% in CY2025.

China's GDP growth stood at 5.0% in CY2024 but is forecasted to decline to 4.0% in both CY2025 and CY2026, despite ongoing policy support. The economy continues to be weighed down by a prolonged property market downturn, demographic headwinds, and renewed trade tensions, including U.S. tariffs.

China's economic growth has eased from its previous high-growth trajectory, challenged by structural factors such as declining productivity, stress in the property sector, and demographic shifts. Although public investment and policy support have provided some stability, the post-pandemic recovery has been uneven. Real GDP expanded by 3.1% in 2022, picked up to 5.4% in 2023, and is expected to slow to 5.0% in 2024, driven by consumer spending but weighed down by weak property investment. Growth is forecast at 4.8% in 2025, with a gradual deceleration to about 3.4% annually through 2030 if significant reforms are not implemented.

Middle Eastern countries like the UAE, Saudi Arabia, and Qatar have implemented bold policy reforms that have significantly boosted their real estate markets. The UAE's Golden Visa, 100% foreign ownership, and expanded freehold zones have attracted global investors, while Saudi Arabia's Vision 2030 and giga projects like NEOM are reshaping urban landscapes. Qatar, post-FIFA World Cup, is leveraging global visibility to draw investment into its property sector. These reforms, backed by transparent legal frameworks and sustainable financing models, have made the region a competitive force for India.

In Sub-Saharan Africa, GDP grew at a solid 4.1% in CY2024 and is expected to remain stable at 4.1% in CY2025. The region's youthful population and rising consumer demand provide a strong base for future growth. Within the region, South Africa and Nigeria, the two largest economies, recorded growth rates of 0.5% and 4.1% respectively in CY2024, with projections of around 1.1% and 3.9% for CY2025.

Meanwhile, emerging and developing European economies saw growth of approximately 3.5% in CY2024, which is expected to decline to 1.8% in CY2025. In Latin America and the Caribbean, GDP growth is forecasted to drop from about 2.4% in CY2024 to remain flat at 2.4% in CY2025.

India remains the fastest-growing major economy globally, with real GDP growth rising from around 7.6% in CY2022 to approximately 9.2% in CY2023. However, growth moderated to 6.5% in

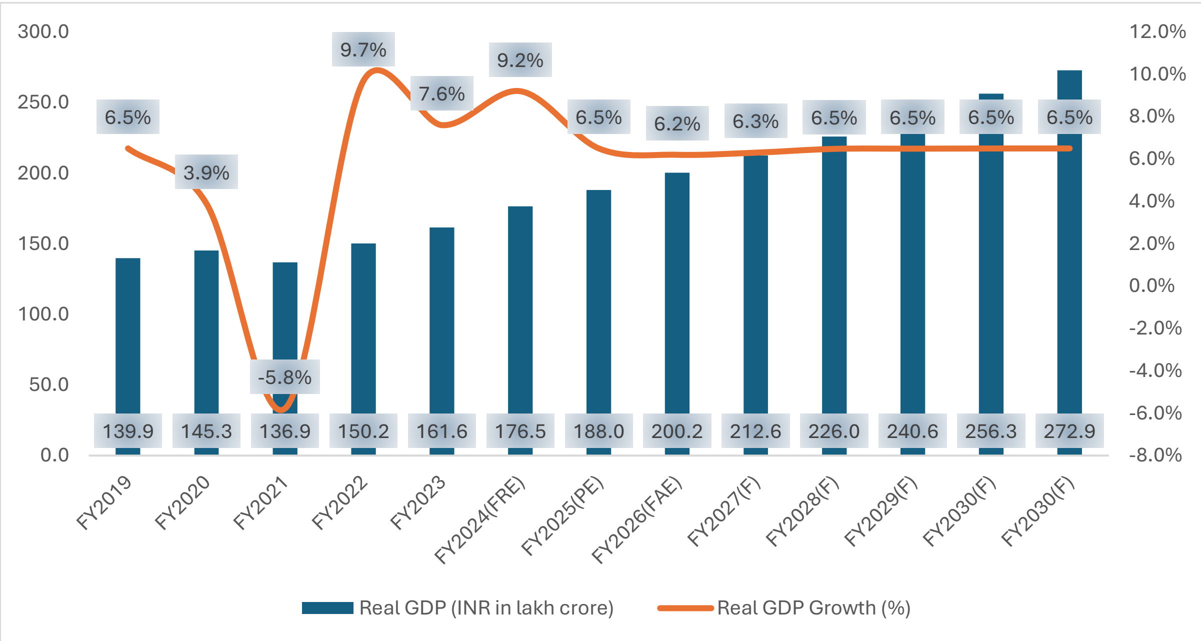
CY2024 as the post-pandemic surge in demand tapered off and the economy aligned with its underlying potential. According to the IMF, India is projected to grow by 6.6% in CY2025 and 6.2% in CY2026, driven by strong private consumption particularly in rural areas and sustained investment activity. However, these projections are slightly lower (by 0.3%) due to rising global trade tensions and economic uncertainty. Looking ahead to CY2030, India’s growth is expected to remain steady at around 6.5%, supported by ongoing structural reforms, infrastructure development, and favourable demographics.

2. Domestic Economic overview

2.1 Trend in GDP growth in India and its Outlook

India's real Gross Domestic Product (GDP) for FY2025 is projected to grow by 6.5%, according to the Provisional Estimates (PE) released by the National Statistical Office (NSO), Ministry of Statistics and Programme Implementation (MoSPI) in May 2025. This represents a slight upward revision from the initial estimate of 6.4% published in January 2025. GDP to now reach a level of INR 188 lakh crore (trillion) . India's real GDP registered 9.2% growth in FY2024 as against 7.6% in FY2023, making FY2024 the 3rd year of real GDP growth of 7.0% or above. Growth was majorly driven by robust domestic demand, vibrant demographic landscape, ongoing economic reforms, India is establishing its growing impact on global trade, investment, and innovation, coupled with Government's focus on infrastructural and economic development supported this upward trend in the country's growth rate. Furthermore, International Monetary Fund (IMF) expects India to continue being the fastest growing economy in the world, whereby it expects India's output to grow by 6.5% from FY2028 to FY2031.

Chart: Historical trend and projection of Real GDP of India (INR lakh crore)- Base year (2011-12)



Source: RBI, IMF, ICRA Analytics
Note: F-Forecasted; E- Estimated
Data from FY2026-2031F are forecasted from IMF
FY2025(E) is the provisional Estimates released by the National Statistical Office (NSO)

The Reserve Bank of India's (RBI) Monetary Policy Committee (MPC) has updated its growth forecast for India's Gross Domestic Product (GDP) to 7.4% for FY2026, as stated by RBI Governor Sanjay Malhotra on Friday, January 6. This adjustment is slightly above the previous estimate, indicating a positive outlook for domestic demand despite ongoing global trade challenges and uncertainties in financial markets.

Although the central bank continues to highlight a slowdown in momentum towards the end of the year, the revised projection positions growth above both its earlier quarterly estimates, which have also been adjusted, with growth now projected at 6.9% and 7% for the first and second quarters of the fiscal year, respectively, an increase from the earlier estimates of 6.7% and 6.8%.

Table: Real GDP growth forecasted by Reserve Bank of India

Real GDP Growth (at constant 2011-12 prices)	FY2025 E	FY2026 F			FY2027 F	
% change	(E)	Q3 (F)	Q4 (F)	(F)	Q1 (F)	Q2 (F)
GDP at market prices	6.5*	7.0	6.5	7.4	6.9	7.0

F- Forecasted; E- Estimated

Source: RBI, ICRA Analytics

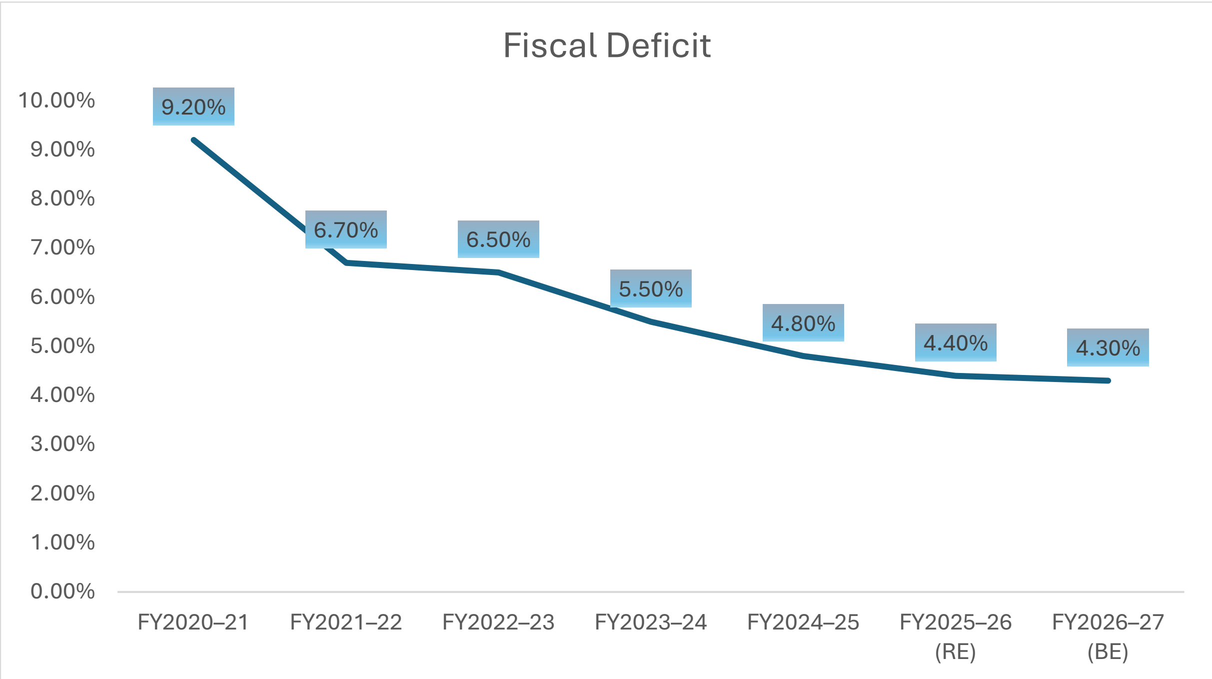
2.2 Fiscal Deficit (as a % of GDP) (FY2020–FY26)

The fiscal deficit represents the extent to which government spending exceeds its revenues, indicating how much the government must borrow to bridge the gap. In India's case, this measure goes beyond a simple accounting Chart it serves as a key indicator of the nation's economic health and the credibility of its fiscal policy.

In FY2020–21, India's fiscal deficit climbed to 9.2% of GDP, the highest in its post-independence history. The government increased expenditure on large-scale relief programmes such as the PM Garib Kalyan Yojana and Atmanirbhar Bharat, while revenues collapsed due to widespread shutdowns and disrupted economic activity.

In the years that followed, the economy began recovering steadily, supported by stronger tax compliance, rising GST inflows, and improved corporate earnings, all of which helped lift government revenues. With conditions stabilising, the focus shifted back toward maintaining fiscal discipline, allowing the fiscal deficit to ease to 6.7% in FY2022, 6.5% in FY2023 and further to 5.5% in FY2024.

The government successfully met its revised target of 4.8% of GDP for FY2025 and was achieved despite being an election year. Government has aimed for a fiscal deficit of 4.4% of GDP for FY 2026 and 4.30% for FY2027.

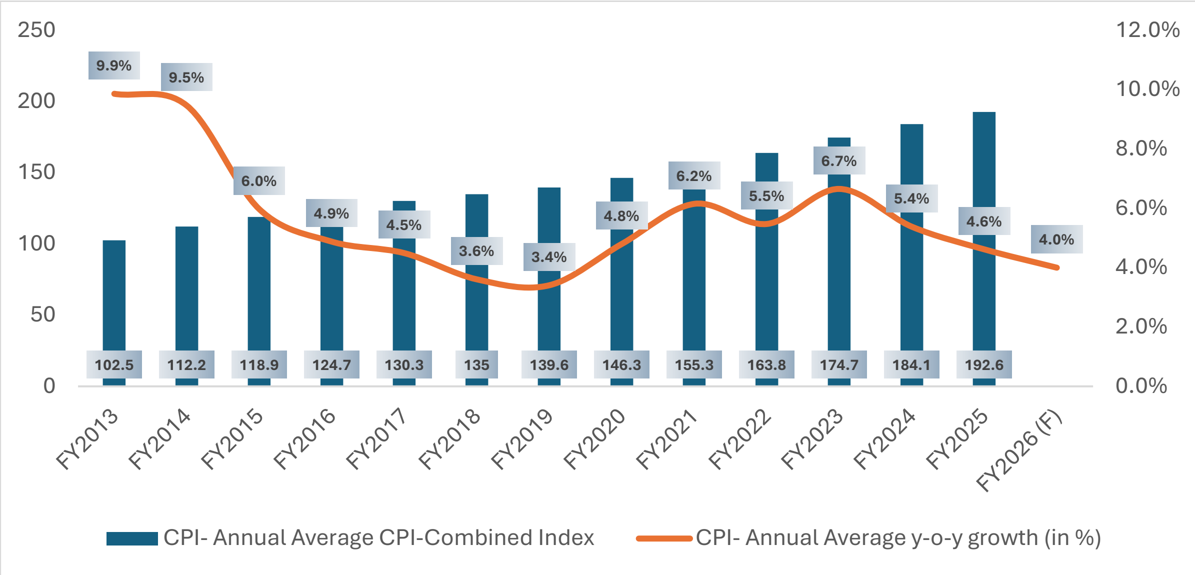


Source: RBI, ICRA Analytics

2.3 Performance of key macroeconomic indicators

2.3.1 Review of inflation in India

Chart: CPI trend over the past ten years, FY2016-FY2025



Source: RBI, MOSPI, ICRA Analytics

Retail inflation in India, as indicated by the Consumer Price Index (CPI), which represents the cost of daily goods and services, retail inflation in India has followed a steady downward path over the past three financial years, falling from 6.7% FY2023 to 5.4% during FY2024, and further to 4.6% during FY2025. This consistent moderation highlights the combined impact of the Reserve Bank of India's calibrated monetary policy and the Government of India's focused interventions to ease supply-side constraints and stabilise prices of essential commodities. The declining trend has helped ease cost-of-living pressures and fostered a more stable environment for economic growth.

The Monetary Policy Committee (MPC) of the Reserve Bank of India made revision to its inflation forecast for FY2026, lowering the Consumer Price Index (CPI) estimate to 2.1% from the previous 2%. This decision was revealed at the end of the MPC meeting on 6th Feb, 2026, led by Sanjay Malhotra, along with the latest monetary policy statement from the central bank.

Furthermore, the MPC has raised its inflation forecasts for the first two quarters of fiscal year 2027, now anticipating 4% inflation in Q1 and 4.2% in Q2. This suggests a belief that inflation will decline at a slower rate than previously expected. According to the revised assessment, the MPC has outlined the following inflation trajectory:

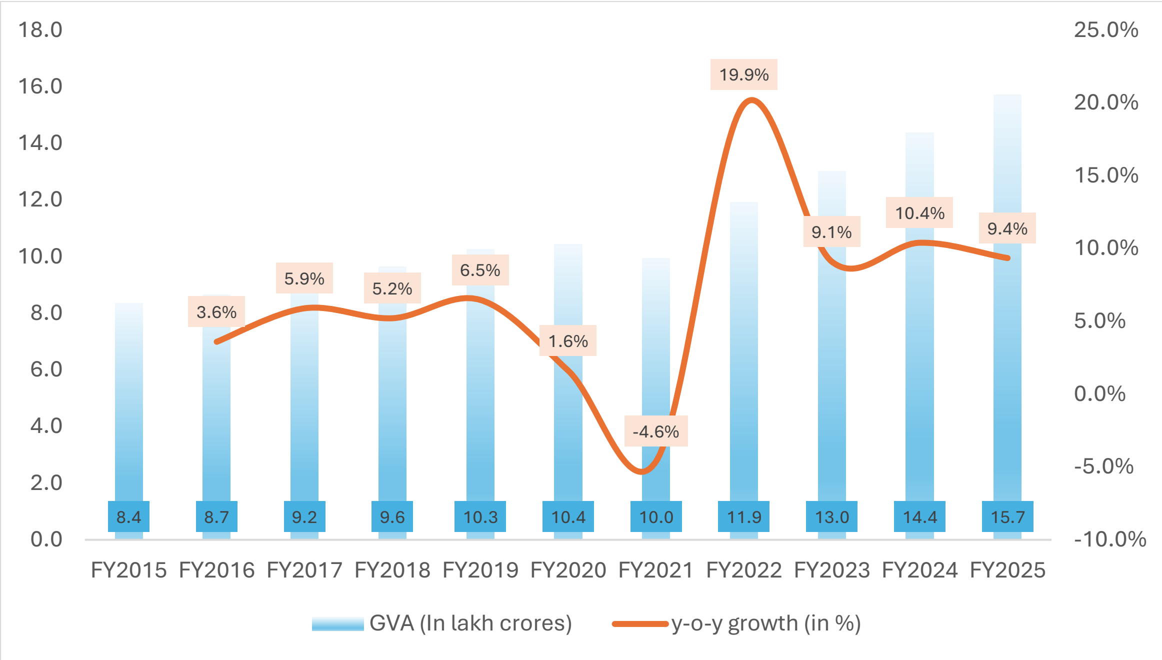
- Q4 FY26: Adjusted to 3.1% from 2.9%
- Q1 FY27: Adjusted to 4% from 3.9%
- Q2 FY27: Adjusted to 4.2% from 4%.

The central bank indicated that, excluding precious metals, the underlying inflationary pressures remain subdued, and the risks are currently balanced. The committee noted that the near-term food supply outlook is positive, bolstered by robust kharif production, sufficient foodgrain buffer stocks, promising rabi sowing, and adequate reservoir levels. Core inflation, which excludes potential fluctuations from precious metals, is anticipated to remain stable, with underlying pressures continuing to be contained.

The RBI warned that geopolitical uncertainties, fluctuations in energy prices, and adverse weather conditions present upward risks to the inflation forecast. Additionally, it pointed out that negative base effects, following a significant drop in prices in Q4 of 2024–25, are likely to elevate year-on-year inflation in Q4 of the current year, despite overall momentum remaining subdued.

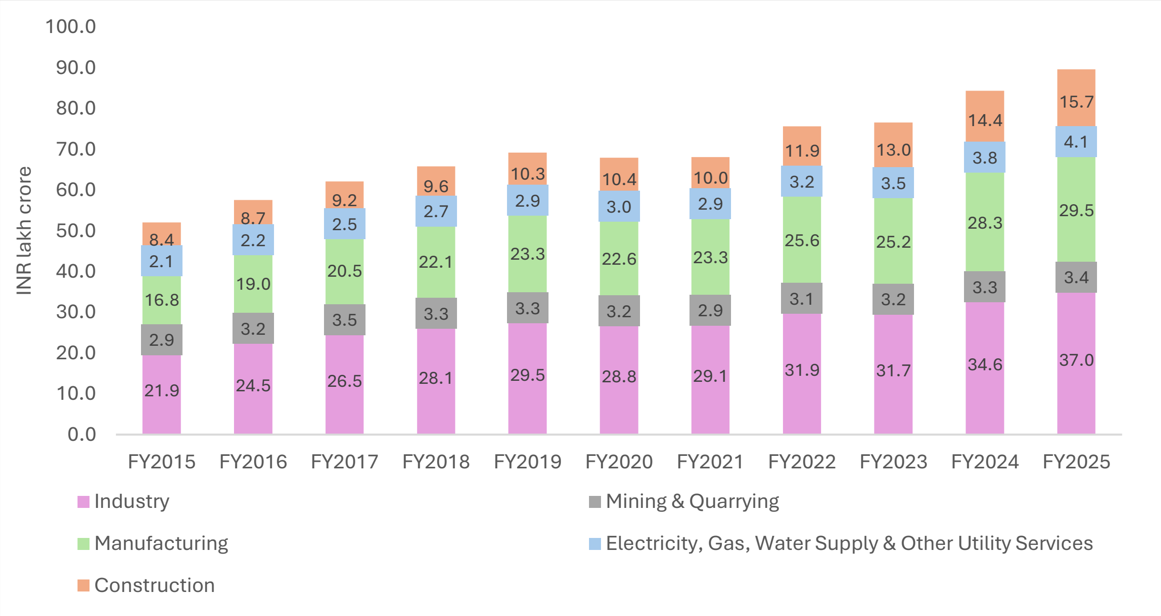
2.3.2 Overview of share of construction in GVA in India

Chart: GVA at Basic Prices (Base Year: 2011-12) Constant Prices (in INR lakh crore) and y-o-y growth (in %) FY2015-FY2025



Source: RBI, ICRA Analytics

Chart: GVA Sectoral growth of construction sector and other relevant sectors, FY2015-FY2025 (INR In lakh crore)



Source: RBI, ICRA Analytics

India's construction sector, currently ranking as the world's third largest market, posted strong growth in FY2025. The sector accounted for 9.1% of the total India's GVA in FY2025. The construction sector has grown at a CAGR of 7.3% during the period of FY2015 to FY2025 from INR 8.4 lakh crore to INR 15.7 lakh crore. This growth is attributed to government's emphasis on infrastructure development, a low base effect and robust order book. While roads and buildings have maintained its share, comprising a major part of the order book, the urban infrastructure, water and sanitation have also shown a substantial boost in the recent years. Its proximate coincident indicators - steel consumption and cement production expanded by 11.5% and 6.3%, respectively, in FY2025. Increased infrastructure spending, private sector investment in various construction projects and technological advancements has improved efficiency, reduced costs and propelled its growth.

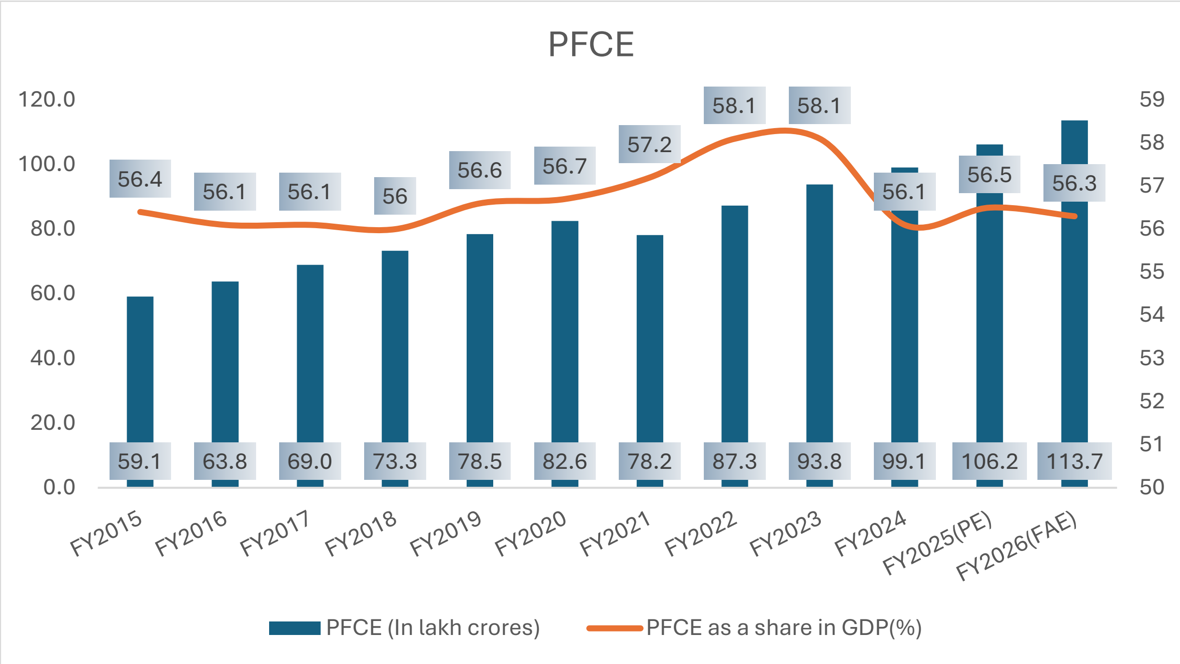
In FY2025, Gross Value Added (GVA) at constant prices for the industry sector reached at INR 37.0 lakh crore, which accounted for 21.5% of the total India's GVA of INR 171.9 lakh crore. The share of industry sector has grown by ~6.8% from FY2024 to FY2025. The growth is mainly driven by the manufacturing sector and electricity, gas, water supply & other utility services sector exhibiting a CAGR growth rate of ~6.4% and ~7.4% respectively.

The manufacturing sector contributed 17.2% to the total India's GVA. The growth in manufacturing sector has been 4.5% from FY2024 to FY2025. The growth is driven by robust capital expenditure, government initiatives such as Production Linked (PLI) Scheme. This growth has been prominent in the past few years as India develops into a globally competitive manufacturing hub and attracting more manufacturing investments. While construction sectors have a significant contribution of 9.1% to the total India's GVA, the growth is expected to be mainly driven by the manufacturing sector in the coming years.

The mining industry reached at INR 3.4 lakh crore, with a CAGR of 1.8% during the period of FY2015 to FY2025. The expansion of the industry has been relatively low due to the various challenges faced by industry such as environmental impacts, groundwater depletion, waste generation, health issues, and social and cultural issues. In terms of future growth prospects, construction sector is expected to continue to contribute a significant share in the country's total GVA, driven by government initiatives and private sector investments in various construction projects.

2.3.3 Private Final Consumption Growth in India

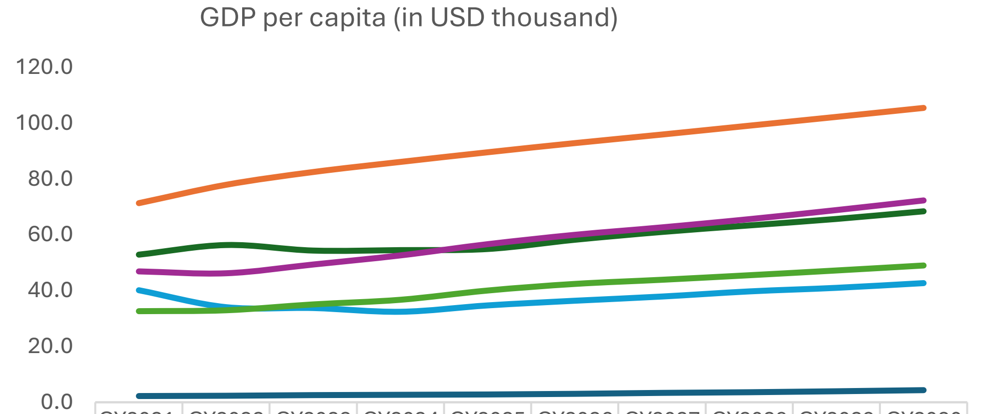
Chart: India's Private Final Consumption Expenditure (PFCE)(in INR Lakh crores) and share of GDP (in %) FY2015-FY2026



Source: MOSPI, RBI, ICRA Analytics
Note: PE: Provisional Estimates; FAE: First Advance Estimates

Private Final Consumption Expenditure (PFCE) at constant (2011-12) prices, was estimated at INR 99.1 lakh crore and INR 106.2 lakh crore, respectively for FY2024 and FY2025. The corresponding PFCE to GDP ratio for FY2024 and FY2025 are 56.1% and 56.5% respectively. In FY2025, it is forecasted at INR 113.7 lakh crore with a 56.3% share of the GDP. The rising PFCE is contributing by various factors such as expanding middle class population, increasing disposable income which enables consumers to spend more, easy access to credit and financing options which enables consumers to make purchases and invest in assets, various governmental policies (schemes such as Pradhan Mantri Awas Yojana, Ayushman Bharat Yojana) that supports consumer spending, advancements in technology, digital payments and other innovative developments. Private consumption accounts a significant share of the country's GDP and hence its rise has contributed to overall economic growth. The growth rate has increased from 5.6% in FY2024 to 7.2% in FY2025, reflecting signs of economic acceleration.

Trends in GDP per capita of India vs other major economies



	CY2021	CY2022	CY2023	CY2024	CY2025	CY2026	CY2027	CY2028	CY2029	CY2030
India	2.2	2.3	2.5	2.7	2.8	3.1	3.3	3.6	4.0	4.3
United States	71.4	77.9	82.5	86.1	89.6	92.9	96.0	99.1	102.3	105.5
Canada	52.9	56.4	54.4	54.5	54.9	58.2	61.0	63.4	65.7	68.4
Japan	40.2	34.1	33.8	32.4	34.7	36.4	37.9	39.7	41.0	42.7
United Kingdom	46.9	46.2	49.4	52.6	56.7	60.0	62.7	65.6	68.9	72.3
Europe	32.7	33.0	35.1	36.7	40.1	42.4	43.9	45.5	47.2	49.0

India United States Canada Japan United Kingdom Europe

Source: IMF, ICRA Analytics
Note: The data provided for India is for the fiscal year, mapped to the calendar year as FY(t/t+1) = CY(t). Eg: CY2021 is FY2022 for India

India's GDP per capita has shown a steady and sustained upward trajectory from USD 2.3k in FY2022 to USD 2.8k in FY2025, marking an overall increase of ~20%. This growth reflects India's economic resilience, supported by strong domestic consumption and ongoing structural transformation. Key contributors to this progress include rapid expansion in the digital economy, technology-enabled services, and extensive government-led infrastructure development particularly in transportation, energy, and urban sectors which have collectively enhanced productivity and income levels.

2.3.4 Trends in Industrial growth

The Index of Industrial Production (IIP) is a key indicator that measures how industrial production is changing over time. It is a monthly indicator which reflect the monthly changes in the volume of production of a representative basket of industrial products, with reference to a specified base year. IIP is widely used for economic policy formulation and serves as an important input for estimating the Gross Value Added (GVA) of the manufacturing sector in GDP.

The Index of Industrial Production (IIP) rose by 7.8% in December 2025, improving from the 6.7% growth recorded in November 2025. During December, output in the mining, manufacturing, and electricity sectors increased by 6.8%, 8.1%, and 6.3%, respectively. Their corresponding IIP values stood at 153.0 for mining, 169.9 for manufacturing, and 204.9 for electricity. Flagship schemes such as PLI, PM MITRA, National Manufacturing Mission, and skill India are accelerating capacity building and strengthening India's manufacturing ecosystem. India's manufacturing export engine remained strong even amid global uncertainty, supported by shifts in global supply chains towards India.

Within the manufacturing segment, 16 of the 23 NIC-2-digit industry groups registered year-on-year growth when compared to December 2024. The strongest contributors to this expansion were:

- Basic metals, which grew by 12.7%,
- Motor vehicles, trailers and semi-trailers, which surged by 33.5%, and
- Pharmaceuticals, medicinal chemicals, and botanical products, which advanced by 10.2%

Budgetary expenditure on Infrastructure

India's infrastructure and construction capital expenditure (CapEx) plays a significant role in forming the country's economic trajectory, while enhancing connectivity, driving growth and creating employment. The recent trend in the government spending highlights the sustained focus on infrastructure development for achieving long term economic growth.

For FY2026–27, the government has announced the following infrastructure-focused priorities:

- Public capital expenditure has been set at INR 12.2 lakh crore, continuing the push for large-scale infrastructure development. This follows the INR 11.21 lakh crore allocation for the infrastructure sector in the FY2025–26 Budget, aligning with the broader goals of Viksit Bharat 2047. Government capital outlay rose 4.2x from INR 2.63 lakh crore in FY2018 to INR 12.2 lakh crore in FY2027 (BE)
- Plans include the development of seven High-Speed Rail corridors to reinforce inter-city connectivity and facilitate economic integration across major growth regions.
- The government will also expand inland water transport by bringing 20 new National Waterways into operation, aimed at improving logistics efficiency and strengthening links between industrial centres, mining regions, and ports.
- Investment efforts will continue in Tier II and Tier III cities with populations above 5 lakh, acknowledging their emergence as important new drivers of economic activity.

- Overall, the strategy places strong emphasis on infrastructure-led regional development, targeting manufacturing clusters, service hubs, and emerging urban economic regions.

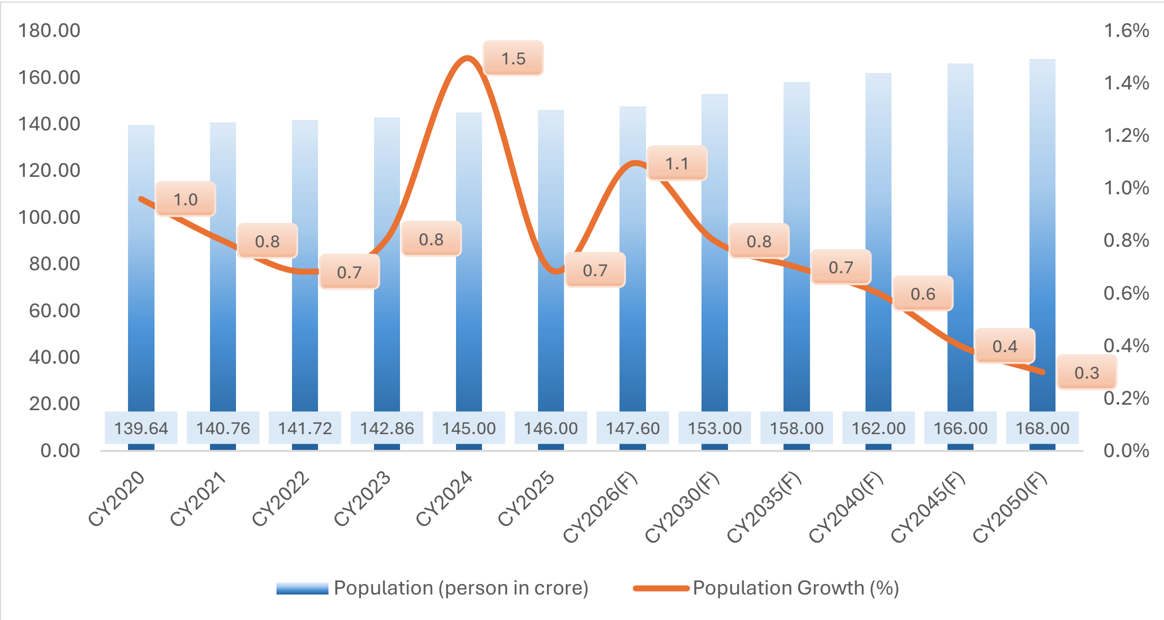
2.3.5 Overview of other key fundamental growth drivers for India

Demographic overview of India

India, the world's seventh largest country by land area, is home to staggering 144 crore people (as of CY2024, IMF estimate), making it the most populous nation in the world, accounting for 17.8% of the world's population. As per the World Population Review report, India's population is younger with the median age as 28 years, as compared to China at 38 years, Japan at 48 years & US at 38 years. With a large growing population and increasing focus on development of skills, literacy and education, India has the potential to become a significant economic power.

Population growth trend and outlook

Chart: India's population trend and forecast (persons in crore) with y-o-y growth (in %)

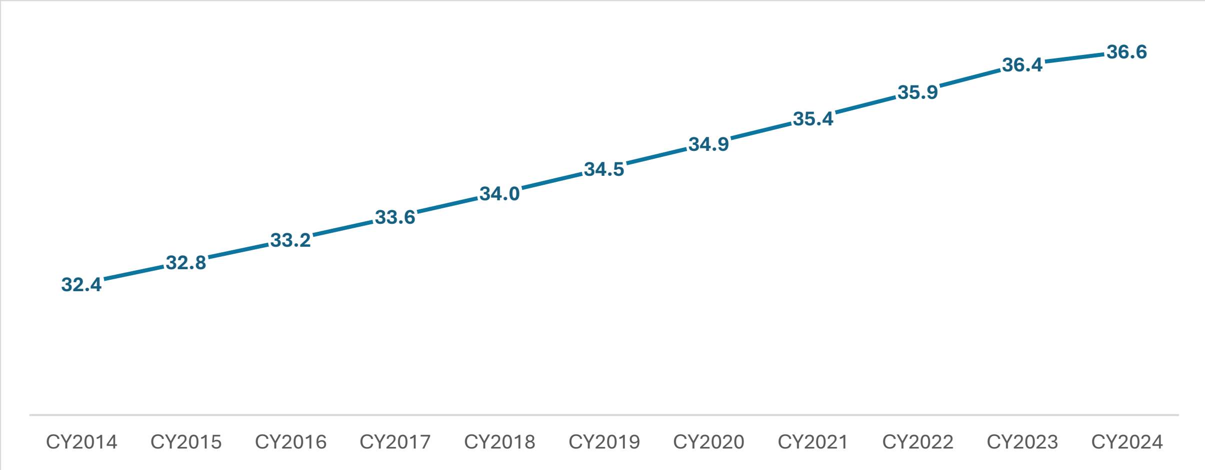


Source: IMF, World Population Prospects: The 2024 Revision, ICRA Analytics
Note: F: Forecasted, E: Estimated

In CY2024, India surpassed China and became the most populous country, with a total population of 144 crore. India's population growth rate has declined considerably over the past decade, mainly attributed to increasing urbanization, rising education levels and rising alleviation of poverty. The country's population is expected to continue to grow steadily at a slower rate of 0.9% in CY2025 and CY2026 and 0.8% in CY2027. The growth rate is expected to further slower down to 0.7% in CY2035 and 0.6% by CY2040.

Rise in urbanization

Chart: India's Urban population (% of total population), CY2014-CY2024



Source: World Bank, Worldometer, ICRA Analytics

In CY2024, India's urban population rate stood at 36.6%. India's urban population growth is fuelled due to by economic opportunities, better access to education and healthcare and infrastructure development. As per World Bank, by CY2036, the country's urban population is expected to grow to ~40%. The urban population is expected to contribute to ~70% of the country's GDP.

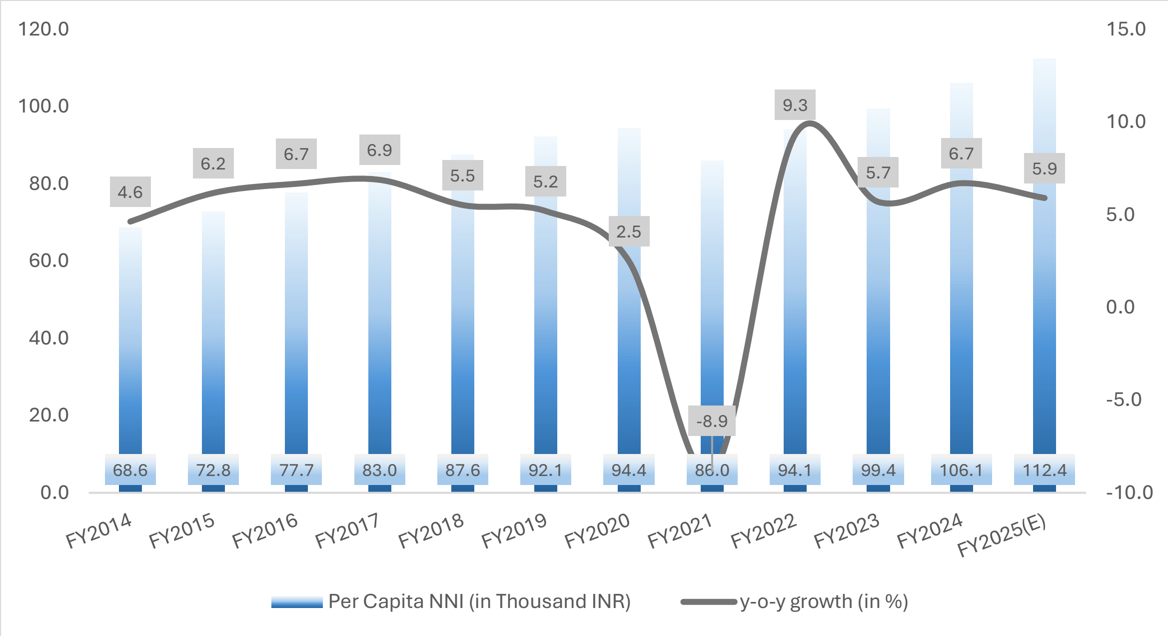
Rapid urbanization intensifies the strain on current infrastructure such as housing, transportation, and essential public services highlighting the urgent need for modern, well-developed systems to support sustainable growth. According to World Bank, ~70% of the infrastructure needs to be built by CY2047, for which an investment of USD 84,000 crore will be required by CY2036, averaging USD 5,500 crore or 1.2% of the GDP per annum. According to estimates, only 50% of the required quantum of investment has been fulfilled (an average investment of 0.6% of the GDP), thereby requiring further boost in investment both by private and public sectors. Government of India has undertaken various schemes for increasing the overall private investment such as Viability Gap Funding Scheme (VGF), modern concession agreements, policies and guidelines promoting Public Private Partnerships (PPPs) and so on.

To achieve sustainable urbanisation, India needs to prioritise the urban planning and investment in the metropolitan cities. Some of the steps taken by the government to deal with the rapid urbanization are as follows:

- **Smart Cities Mission:** It aims at promoting sustainable and inclusive urban development in 100 cities across the country.
- **Jawaharlal Nehru National Urban Renewal Mission (JNNURM):** It aims at providing financial assistance to the urban local bodies for infrastructure development.
- **Pradhan Mantri Awas Yojana (PMAY):** It aims at providing affordable housing to urban residents, particularly for the low-income groups.

Per capita Net National Income (NNI)

Per Capita NNI (in Thousand INR) trend and y-o-y growth (in %), FY2014 to FY2025

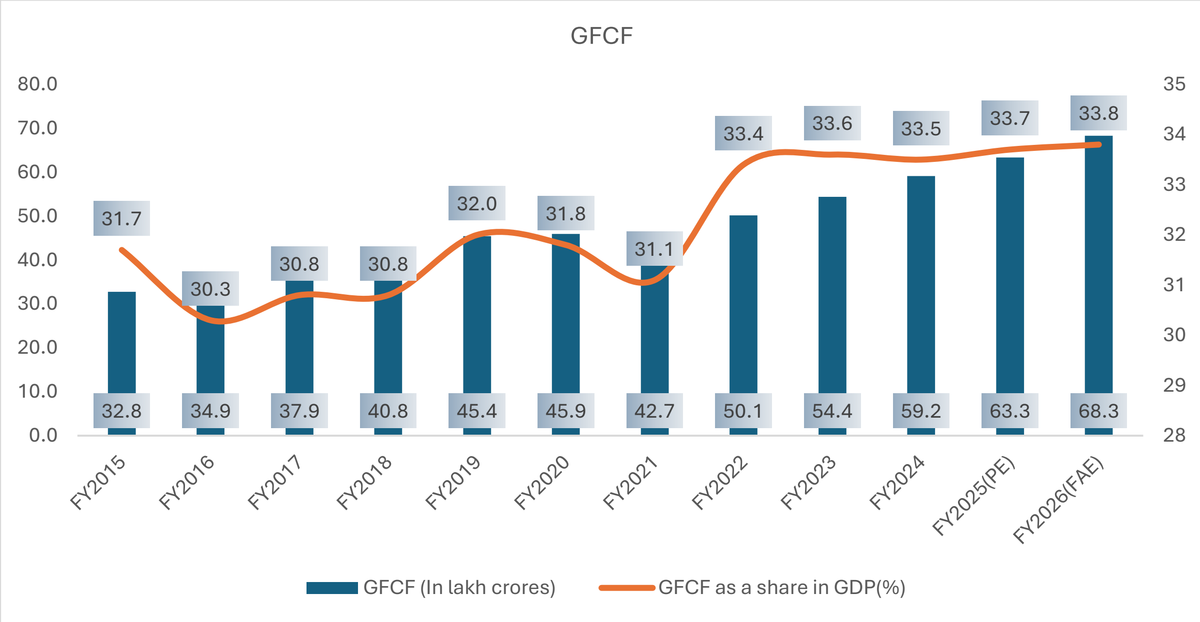


Source: MOSPI, ICRA Analytics
Note: E- Second Advanced Estimates
Note: F: Forecasted

As per the latest estimates from Ministry of Statistics and Program Implementation (MOSPI), India's per capita Net National Income (NNI) at constant (2011-12) prices increased to INR 112.4 thousand in FY2025(E) from INR 106.1 thousand in FY2024, thereby reflecting 5.9% y-o-y growth. The rising per capita income is expected to have a significant impact on the country's economy. The country is likely to witness a substantial growth driven by the increase in external trade and household consumption and investment. Higher per capita income would expand India's middle class, creating new opportunities for businesses, improving the standard of living, increasing savings and investment, thereby driving economic growth

Overview of gross fixed capital formation (GFCF) in India and share in GDP

Chart: India's Gross Fixed Capital Formation (GFCF)(in INR Lakh crores) and share of GDP (in %) FY2015-FY2025



Source: RBI, ICRA Analytics
Note: E- Second Advanced Estimate

India's Gross Fixed Capital Formation (GFCF) has expanded from INR 32.8 lakh crore in FY2015 to INR 63.3 lakh crore in FY2025 at a CAGR of ~ 6.8%. The GFCF to GDP ratio increased to 33.7% in FY2025 from 33.5% in FY2024. The GFCF experienced a moderation in growth by ~7.1% in FY2025 from ~8.8% in FY2024. This indicates a rise in investments, mainly led by government spending on infrastructure and growth in domestic consumption. Among the components of GFCF, the construction sector showed a robust growth marked by the growth in its proximate coincident indicators - steel consumption and cement production. In FY26, investment has persistently supported growth alongside consumption, with the gross fixed capital formation (GFCF) share projected at 33.8%.

3. Indian Power Sector

3.1 Evolution of Power Sector and its Structure in India

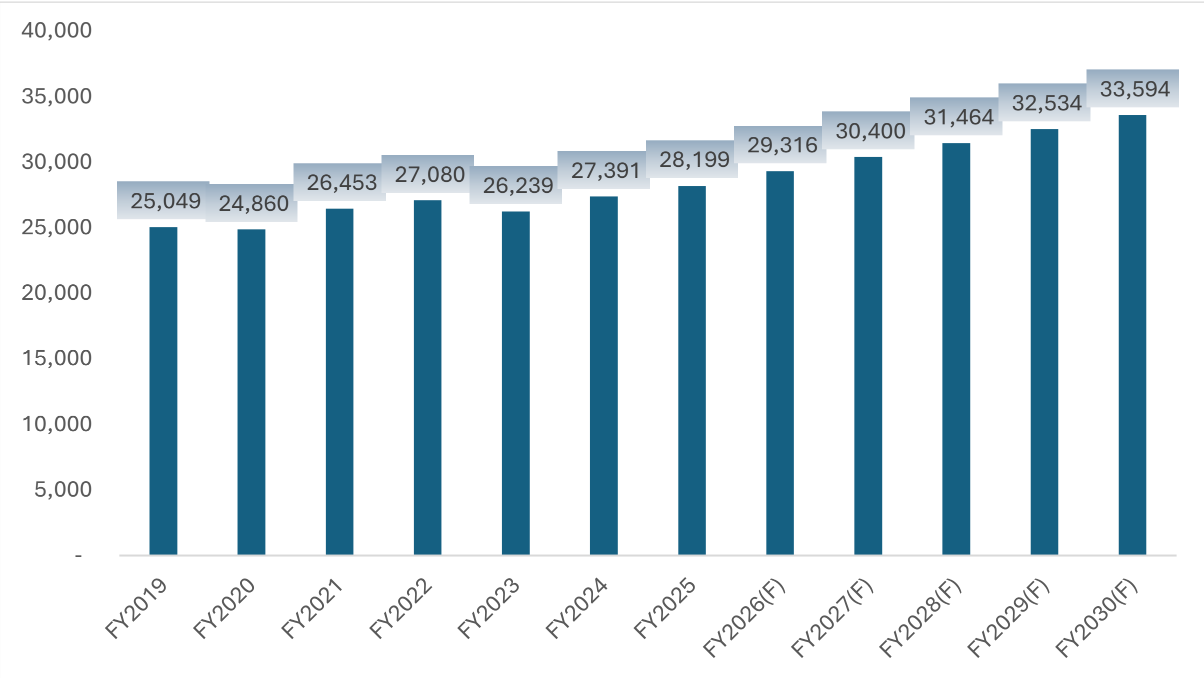
- Over the last ten years, India's power sector has seen a major shift, driven by rapid capacity growth, near-universal electrification, accelerated adoption of renewables, and significant reforms in electricity distribution.
- Since 2014, India has added more than 190 GW of new generation capacity, moving from a power-short nation to a power-surplus one. Installed capacity has reached 505 GW as of October 31, 2025, up from roughly 250 GW in FY2014. Power shortages have also fallen sharply, dropping from about 4.2% in FY2013-14 to just around 0.1% in FY2024-25, highlighting better planning and improved supply availability.
- Through the Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA), nearly 2.8 crore households were connected to electricity, marking one of the fastest global expansions of energy access as recognized by the IEA.
- Per capita electricity consumption has risen steadily from 957 kWh in FY2013-14 to 1,395 kWh in FY2023-24, and further to 1,460 kWh in FY2024-25 reflecting deeper penetration of appliances and broader electrification.
- The Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) played a key role in electrifying 18,374 villages, leading to 100% village electrification on April 28, 2018, and strengthening the foundation for rural economic development.
- Under the UJALA programme (Unnat Jyoti by Affordable LEDs for All), the cost of LED bulbs dropped by nearly 90% between FY2014 and FY2019 from INR 310 to INR 39.90. Over 36.86 crore LED bulbs have been distributed, contributing to large-scale energy savings.
- The Revamped Distribution Sector Scheme (RDSS) has prioritized smart metering, improved financial health of DISCOMs, and reduction of AT&C losses. The rollout of smart meters and modernization of distribution networks has enhanced billing efficiency and helped lower technical and commercial losses across various states.
- India surpassed the milestone of sourcing more than 50% of its installed power capacity from non-fossil fuels in June 2025 five years ahead of its Nationally Determined Contribution (NDC) commitment. Non-fossil capacity has now crossed 259 GW, of which over 250 GW comes from renewable sources. Flagship initiatives such as PM Surya Ghar (rooftop solar), PM-KUSUM for solar-powered agricultural pumps, the PLI scheme for solar PV manufacturing, the National Green Hydrogen Mission, and early offshore wind projects are accelerating the shift toward clean energy.
- During 2025 (up to November), the country registered its highest-ever renewable capacity addition at 44.51 GW almost twice the 24.72 GW added during the same period in 2024. Total renewable capacity rose to 253.96 GW in November 2025, marking a 23% jump from 205.52 GW a year before. Solar energy led this surge, adding 34.98 GW compared with 20.85 GW last year. Installed solar capacity first crossed 100 GW in January 2025 and further climbed to 132.85 GW in November 2025, a 41% rise from 94.17 GW in November 2024. Wind energy added 5.82 GW (vs. 3.2 GW in 2024), taking total installed wind capacity to 53.99 GW by November 2025 up 12.5% from 47.96 GW the previous year and crossing the 50 GW mark in March 2025.
- India has also laid out an ambitious plan to build 100 GW of pumped storage hydropower by FY2035-36. This will be crucial for large-scale energy storage, enabling smoother

integration of renewable energy, with total storage needs projected to reach 161 GW by FY2034-35.

- In a significant development for the nuclear sector, Adani Power announced the creation of Adani Atomic Energy Ltd., signalling one of the earliest major private-sector moves into nuclear energy after recent policy reforms opened the sector to private participation.
- Despite the rapid growth of renewables, thermal power comprising coal, gas, and lignite continues to anchor grid stability as the primary source of base-load supply. Thermal capacity currently stands at about 245–246 GW, representing nearly 49% of total installed generation. Coal remains the dominant contributor, accounting for close to 70% of overall electricity output, reflecting the continued reliance on coal during the transition period.
- To meet the rising energy demand of India's expanding economy, 13.32 GW of coal-based thermal capacity has been awarded in FY 2025-26 (up to 30 November 2025). In the same period, 7.21 GW has already been commissioned, pushing total coal and lignite-based capacity to 226.23 GW. Additionally, 40.35 GW of new capacity is currently under construction, with 7.03 GW expected to be completed within FY 2025-26. Another 24.02 GW is at various stages of planning, clearances, and bidding.

3.2 Global consumption trend

Chart: Global Power Sector: Electricity Demand (in TWh), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

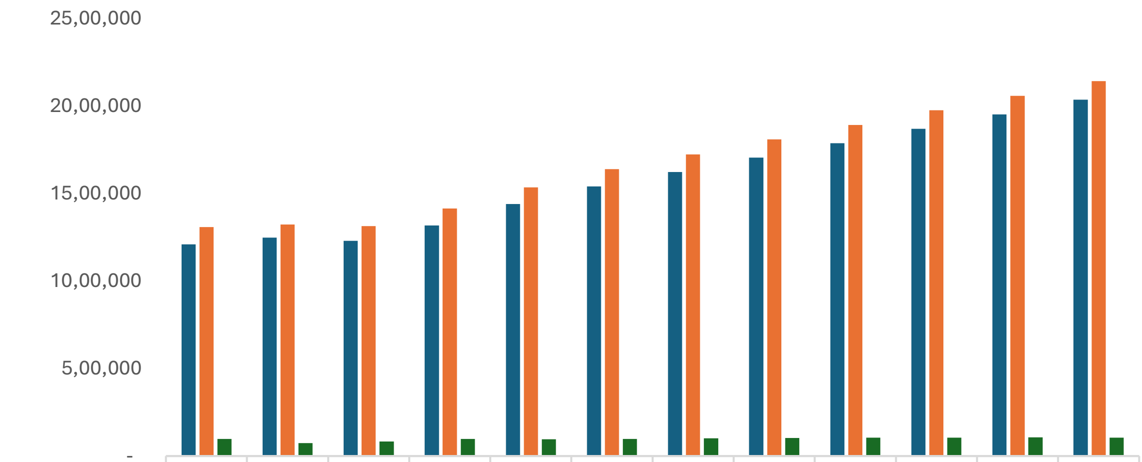
Global electricity consumption reached 28,199 TWh in FY2025, rising at a compound annual growth rate (CAGR) of 2.0% between FY2019 and FY2025. Looking ahead, global demand is expected to climb to 33,594 TWh by FY2030, implying a faster CAGR of 3.5% during FY2026-FY2030. This growth trajectory reflects increasing electrification, wider digital adoption, and steadily rising energy needs across economies.

Electricity consumption worldwide is set to grow at its strongest and most sustained pace through 2030. The surge is being fuelled by industrial and transport electrification, the rapid expansion of data centres, and a growing need for cooling systems. The International Energy Agency has described this trend as the beginning of a new "Age of Electricity," with power demand rising at more than two-and-a-half times the rate of overall energy demand. Much of this momentum is expected to come from emerging markets, with China remaining the biggest driver.

3.3 Review and Outlook of the Power Demand-Supply in India

3.3.1 Power Demand, Supply, and Deficit in India

Chart: India Power Demand–Supply Balance and Surplus/Deficit Outlook (in GWh), FY2019-FY2030F



	FY2019	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026(F)	FY2027(F)	FY2028(F)	FY2029(F)	FY2030(F)
Power Demand	12,09,972	12,48,086	12,30,208	13,16,765	14,40,311	15,40,587	16,22,969	17,04,832	17,87,004	18,69,743	19,51,824	20,36,534
Power Supply	13,07,685	13,23,048	13,14,025	14,13,904	15,35,664	16,38,977	17,24,204	18,08,690	18,91,889	19,75,133	20,58,088	21,42,470
Surplus(+)/Deficit(-)	97,713	74,962	83,817	97,139	95,353	98,390	1,01,235	1,03,858	1,04,885	1,05,390	1,06,264	1,05,936

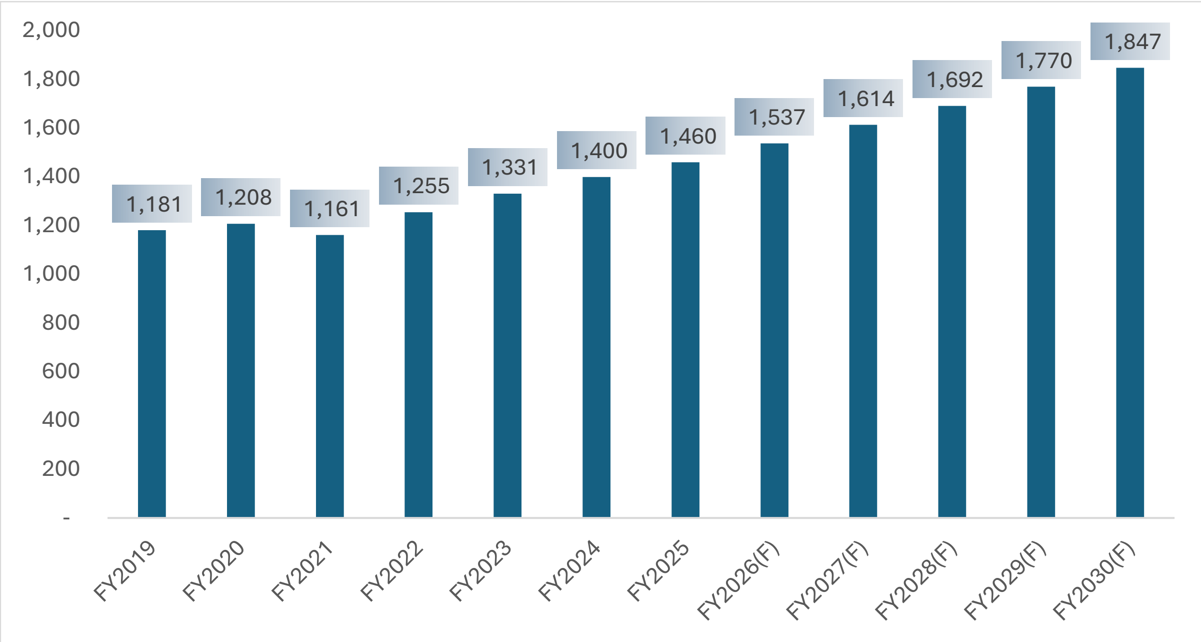
Source: Expert interactions, IMARC, ICRA Analytics

India's electricity demand has risen steadily from 1,209,972 GWh in FY2019 to 1,622,969 GWh in FY2025, driven by strong economic momentum, wider electrification, and growing industrial and commercial activity. Demand is expected to continue climbing, reaching 2,036,534 GWh by FY2030. This upward trend is supported by parallel growth in generation capacity, which is projected to remain comfortably above demand, ensuring a stable surplus and supporting reliable grid operations throughout the forecast period.

India's power supply has similarly expanded, increasing from 1,307,685 GWh in FY2019 to 1,724,204 GWh in FY2025. This growth reflects sustained capacity additions and improved performance across both conventional and renewable energy sources. Supply is projected to rise further to 2,142,470 GWh by FY2030, enabling the country to maintain a consistent surplus and ensuring dependable electricity availability as consumption continues to grow.

3.3.2 Overview of the Indian Power Generation Industry

Chart: India Power Sector: Per Capita Power Consumption (in kWh), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

Power remains a foundational component of national development, making continuous expansion of electricity infrastructure essential. India's energy mix includes traditional sources coal, lignite, natural gas, oil, hydro, and nuclear as well as non-conventional options such as solar, wind, and waste-based energy. The sector is undergoing rapid transformation, driven by rising consumption and the government's "Power for All" push, which has accelerated capacity growth. Even though electricity generation has increased more than a hundredfold since independence, fast-paced industrialization, urban expansion, and rising electrification have often pushed demand ahead of supply.

India is currently the world's third-largest producer and consumer of electricity, with installed capacity reaching about 505 GW as of October 2025. The country ranks fourth globally in renewable capacity and wind energy, and third in solar power. In August 2025, peak electricity demand hit 2,29,715 MW, with supply touching 15,047.2 crore units. During April–August FY2026 alone, India added a record 20.1 GW of renewable capacity an impressive 123% year-on-year jump.

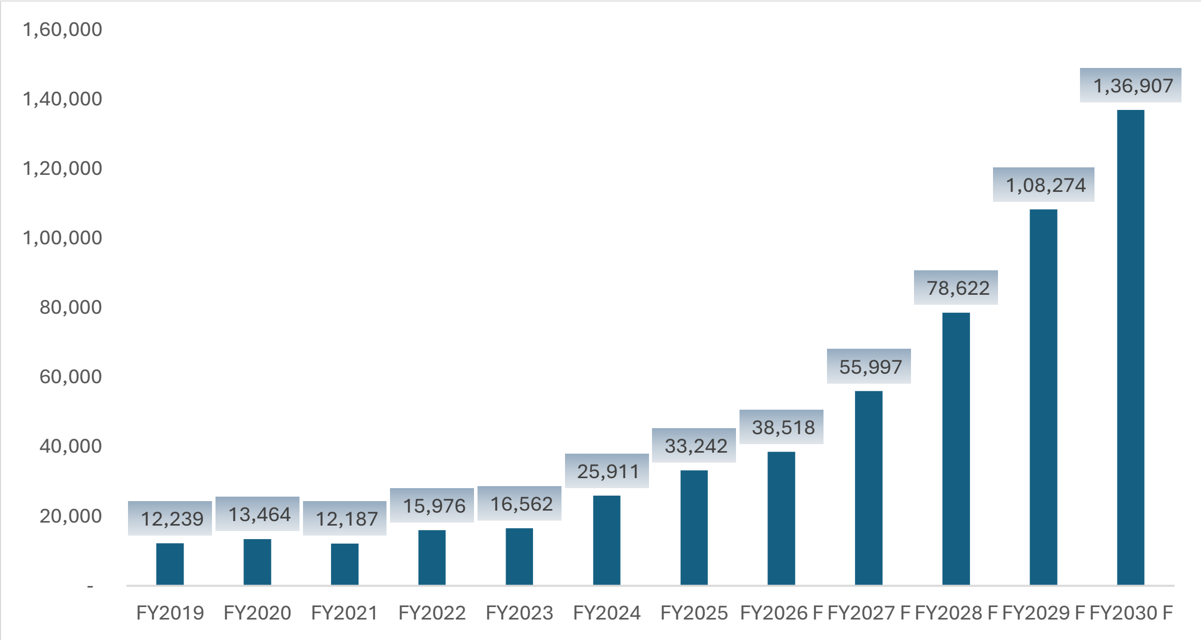
Industrial consumption remains the primary driver of electricity use. In FY2025, India added 29.52 GW of renewable capacity, taking total installed renewables to 234.24 GW (excluding the 8.78 GW of nuclear capacity) as of August 2025. This keeps the country firmly on course to achieve 500 GW of non-fossil capacity by FY2030, while the Nuclear Energy Mission aims for 100 GW of nuclear capacity by 2047. As of August 31, 2025, India's renewable portfolio included 123.13 GW of solar, 52.68 GW of wind, 10.74 GW of biomass, 5.12 GW of small hydro, 0.85 GW of waste-to-energy, and 50.11 GW of large hydro together accounting for nearly half of the total 475.59 GW installed capacity. The share of renewables in actual generation has risen sharply from just 6% in FY2015 to 28% FY2025 and storage-enabled renewable capacity is expected to reach 25–30 GW by FY2028.

Foreign investment has played a major role in this growth. The power sector attracted 2.7% of India's total FDI inflows up to March 2025. Between April 2000 and March 2025, non-conventional energy received INR 1,59,959 crore (USD 21.9 billion), while overall FDI into the power sector amounted to INR 1,20,986 crore (USD 19.72 billion). Renewables alone accounted for INR 1,09,557 crore (USD 12.67 billion) up to March 31, 2025. In FY25, Priority Sector Lending for renewable energy totalled INR 7,558 crore (USD 874.1 million), with plans to introduce a dedicated sub-target for solar, wind, green hydrogen, and hybrid technologies.

4. Outlook of The Power Sector (FY2019–FY2030F)

4.1 Outlook of Capacity Additions

Chart: India: Power Sector: Power Capacity Addition and Installed Capacity (in MW), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

India's power generation capacity is expected to grow rapidly in the coming years, increasing from 33,242 MW in FY2025 to 136,907 MW by FY2030. This substantial rise is driven by strong government backing for renewable energy, expansion of transmission networks, and escalating electricity demand fueled by industrial growth, urban development, and wider electrification across sectors.

4.2 India's Renewable Potential and Global Rank in Terms of Installed Capacity

Table: India: Renewable Energy Potential by Source in India (MW) – March 2025

Source Type	Renewable Energy Potential (in MW)
Solar Power	33,43,378
Wind Power	11,63,856
Large Hydro	1,33,410
Biomass Power	28,447
Small Hydro Power	21,134
Bagasse Cogeneration	13,818

Source: Expert interactions, IMARC, ICRA Analytics

India holds substantial renewable energy potential as of March 2025, with solar power leading at an estimated capacity of over 3.34 crore MW, followed by wind energy at approximately 1.16 crore MW.

Additional resources including large hydro, biomass, small hydro and bagasse cogeneration further strengthen the country's diverse renewable energy portfolio.

This extensive resource base underscores India's strong ability to scale up clean power generation, advance its energy transition objectives and reduce reliance on fossil fuels while meeting rapidly rising electricity demand.

Table: India: Installed Renewable Energy Capacity by Source in India with Global Rank (March 2025)

Source Type	Renewable Energy Installed Capacity (in MW)	Rank in the Global Market
Solar Power	1,05,646	3
Wind Power	50,038	4
Hydro Power	52,829	6
Bio-energy	11,583	3
Total	2,20,096	4

Source: Expert interactions, IMARC, ICRA Analytics

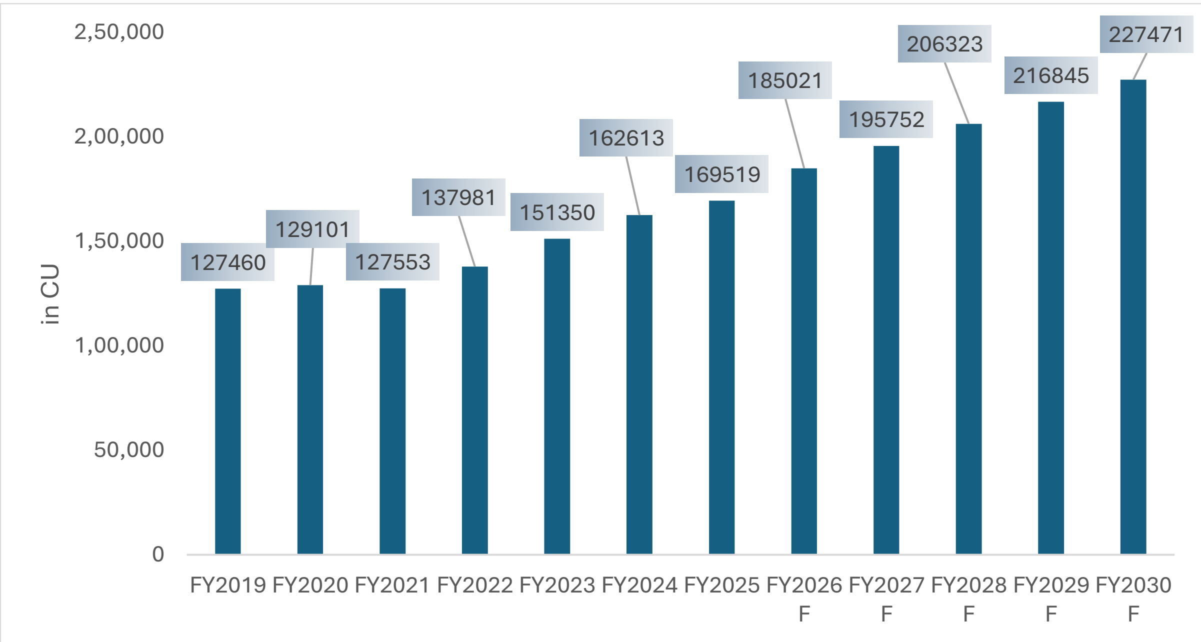
As of March 2025, India's total installed renewable energy capacity stood at 220.1 GW, positioning the country as the fourth-largest renewable energy market globally.

Solar energy led the portfolio with 105.6 GW (3rd globally), followed by wind at 50.0 GW (4th), hydro at 52.8 GW (6th), and bio-energy at 11.6 GW (3rd).

This balanced and rapidly expanding clean energy mix reflects India's strong progress toward its energy transition and decarbonization objectives.

4.3 Power Peak Demand Forecast, Energy Requirement and Supply Potential

Chart: India: Power Sector: Energy Requirements (in CU), FY2019-FY2030F

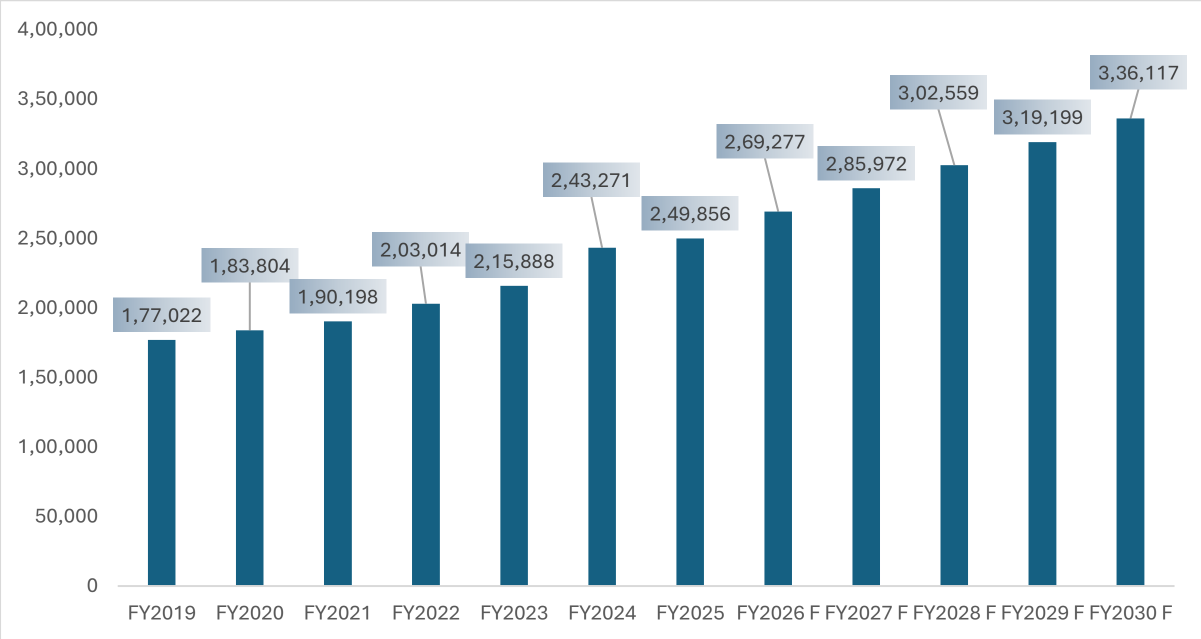


Source: Expert interactions, IMARC, ICRA Analytics

India's energy requirement rose from 1,27,460 CU in FY2019 to 1,69,519 CU in FY2025, and it is expected to further increase to 2,27,471 CU by FY2030.

This consistent upward trend is driven by strong economic growth, expanding industrial and commercial activity, rapid urbanization, greater electrification and rising electricity consumption across the country. Infrastructure development, digital adoption, growth in electric mobility and increasing cooling needs in residential and commercial sectors are also contributing significantly to this demand.

Chart: India: Power Sector: Power Peak Demand (in MW), FY2019-FY2030F

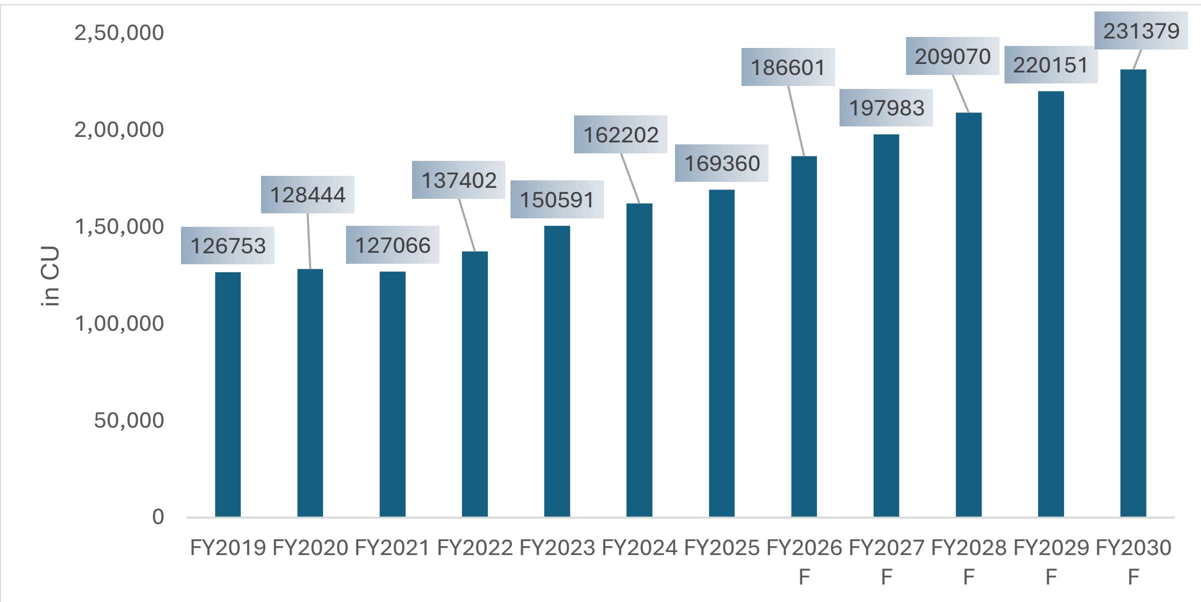


Source: Expert interactions, IMARC, ICRA Analytics

India's peak power demand rose from 177,022 MW in FY2019 to 249,856 MW in FY2025 and is expected to exceed 336,117 MW by FY2030.

The increasing peak load is driven by higher cooling needs during extreme weather conditions, expanding industrial activity, greater residential electricity consumption, and the growing electrification of transport and digital infrastructure intensifying the need for capacity augmentation and enhanced grid reliability.

Chart: India: Power Sector: Energy Supply Potential (in CU), FY2019-FY2030F



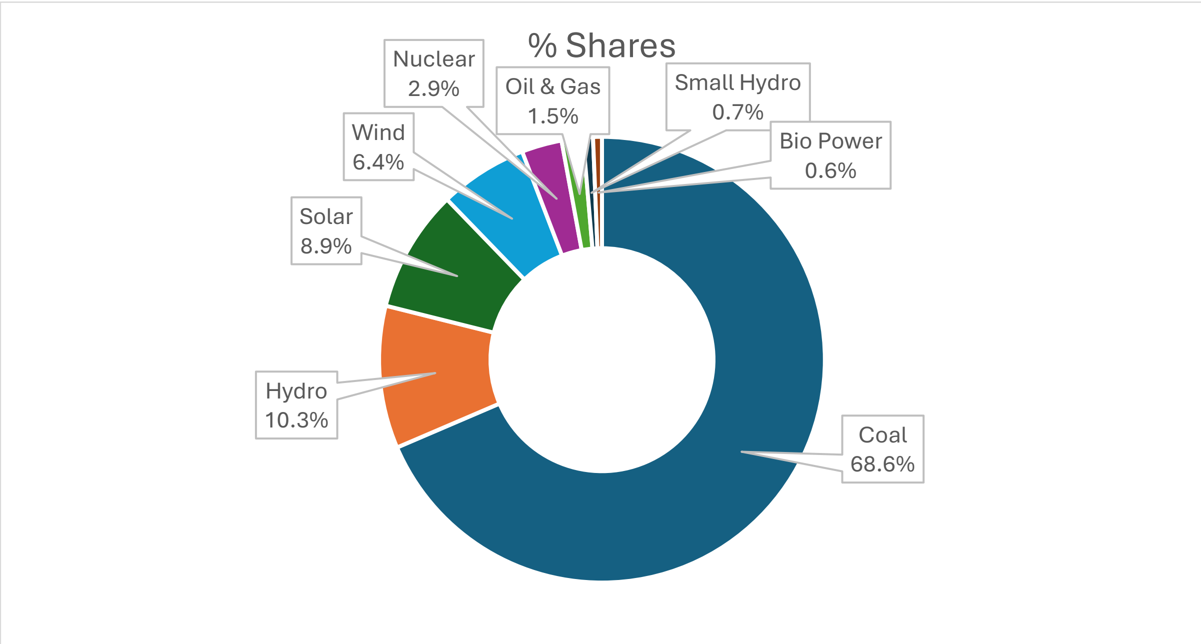
Source: Expert interactions, IMARC, ICRA Analytics

India's energy supply potential grew from 1,26,753 CU in FY2019 to 1,69,360 CU in FY2025 and is projected to reach 2,31,379 CU by FY2030.

This increase is driven by continuous capacity additions, enhanced transmission infrastructure, improved plant load factors and more efficient grid management to support the nation's steadily rising electricity demand.

4.4 Power Supply Mix of India

Chart: India: Source-wise Electricity Generation Mix (in %) (as on Dec 2025)



Source: Expert interactions, IMARC, ICRA Analytics

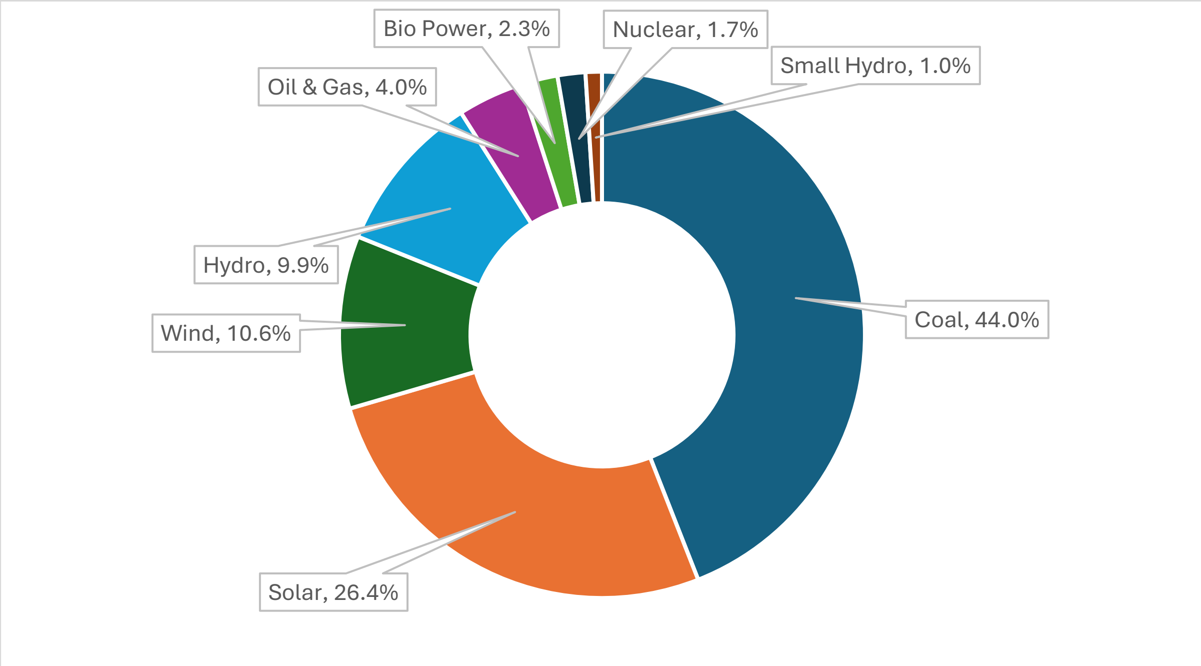
As of December 2025, coal remained the dominant source of electricity in India, supplying 68.6% of total generation and highlighting the country's continued dependence on thermal power for meeting base-load requirements.

Hydropower contributed 10.3%, while solar and wind provided 8.9% and 6.4% respectively, indicating the steady growth of renewable energy capacity.

Nuclear energy accounted for 2.9%, with oil and gas making up 1.5%. Small hydro and bio-power added only minimal shares.

Overall, the generation mix reflects a gradual but consistent shift toward cleaner energy sources, even as coal continues to play a crucial role in maintaining grid reliability and supporting rising electricity demand.

Chart: India: Source-wise Installed Electricity Generation Capacity (in %) (as on Dec 2025)



Source: Expert interactions, IMARC, ICRA Analytics

As of December 2025, India's installed power capacity was primarily driven by coal, which held a 44.0% share, underscoring its ongoing importance in supplying dependable base-load electricity. At the same time, renewable energy sources formed a substantial and expanding portion of the mix, with solar accounting for 26.4%, wind for 10.6% and hydropower for 9.9%, demonstrating the country's accelerating transition toward cleaner energy.

Oil and gas made up 4.0% of the installed capacity, while bio-power, nuclear and small hydro together contributed a smaller yet strategically relevant share.

Overall, the composition of installed capacity points to a gradual diversification of India's power mix, with rapid renewable capacity additions steadily reducing the relative dominance of conventional thermal sources.

4.5 Long-Term Drivers and Constraints for Demand Growth

4.5.1 Growth Drivers

Strong Economic & Population Growth

- India's robust economic performance and demographic strength remain fundamental long-term drivers of electricity demand. As one of the fastest-growing major economies globally, India became the world's fourth-largest economy in 2025 and is expected to rise to the third position within the next 2.5–3 years, with GDP projected to reach about INR 6,80,000 crore (USD 7.3 trillion) by 2030. Its aspiration to achieve high middle-income status by 2047 is underpinned by structural reforms, rapid infrastructure development, and resilient domestic consumption.
- Real GDP growth accelerated to 8.2% in Q2 FY 2025–26, driven by strong private consumption. Meanwhile, inflation remains contained, unemployment is improving, credit flows are healthy, and urban demand is strengthening. India's population reached

an estimated 146.39 crore in April 2025 and is expected to peak at around 170 crore in the coming decades, reinforcing its long-term consumption trajectory.
- Rapid urbanisation, infrastructure and housing development, rising incomes, and a growing middle class are accelerating the uptake of electricity-intensive appliances including air conditioners, refrigerators, digital devices and electric vehicles thereby supporting sustained electricity demand growth across residential, commercial and industrial segments.

Industrialisation and New Demand Sources

- Industrial growth and emerging high-intensity demand segments continue to bolster India's long-term electricity outlook. Expansion in energy-heavy industries such as steel, cement, and chemicals is contributing to rising base-load consumption, supported by manufacturing and infrastructure growth.
- Electric mobility is adding new load to the grid, with public EV charging stations consuming 59 CU during April–December FY25, according to CEA data led by Delhi, followed by Maharashtra, Gujarat, Haryana, and Andhra Pradesh.
- India's data centre industry entered an AI-driven expansion phase in 2025, with installed capacity reaching 1.3 GW across major metro markets (Cushman & Wakefield) and expected to grow nearly five-fold to 5 GW by 2030. Large investments including NTT Data's INR 2,400 crore campus near Bengaluru airport, a INR 10,500 crore AI cluster in Hyderabad, a 500 MW campus in Mumbai, and the multi-billion-dollar TCS-TPG venture for AI and sovereign data centres demonstrate the surging digital infrastructure demand. In addition, green hydrogen initiatives and industrial decarbonisation efforts are set to further increase electricity intensity in the coming decade.

Long-Term Capacity Expansion & Power Sector Planning

- India's long-term electricity demand outlook is reinforced by ambitious capacity expansion plans. The Central Electricity Authority (CEA) forecasts that the country will exceed 1 terawatt (1,000 GW) of installed power capacity by 2034–35, more than doubling from the current ~505 GW. The CEA has submitted the National Electricity Plan (NEP) 2034–35 and year-wise demand projections up to 2070 to NITI Aayog, while transitioning to an annually updated rolling planning framework instead of fixed five-year cycles reflecting sustained demand growth of 7–8% per year.
- Looking ahead to 2047, the indicative power mix includes 100 GW of nuclear, 97–100 GW of coal already in the pipeline, 116 GW of pumped hydro storage, 1,200 GW of solar, and 400–450 GW of wind, taking total renewable energy capacity to roughly 2,100 GW. The roadmap also stresses the need for grid expansion, faster renewable integration, standardisation and pre-manufacturing of critical equipment (such as transformers and reactors) to reduce project timelines, and the establishment of a proposed "Power University" to bridge skilled workforce gaps collectively supporting long-term demand and transition goals.

Rising Per Capita Electricity Consumption

- Per capita electricity consumption in India has shown a strong upward trajectory, reflecting higher living standards, deeper electrification, and wider adoption of appliances across households and businesses. Consumption rose from 957 kWh in 2013–14 to 1,395 kWh in 2023–24, and further to 1,460 kWh in 2024–25 a total increase of

503 kWh, or about 52.6% over the past decade. This sustained rise underscores expansion in residential usage, increased commercial activity, improved rural electrification, and broader use of energy-intensive appliances such as air conditioners, refrigerators, and digital devices, strengthening the structural growth in power demand.

Renewable Energy Growth & Policy Support

- India's power sector growth is heavily supported by an ambitious clean energy strategy targeting 500 GW of non-fossil capacity by 2030. As of 31 October 2025, total installed capacity stood at 505,023 MW, comprising 245,600 MW fossil-based and 259,423 MW non-fossil capacity (of which 250,643 MW is renewable). India achieved 50% non-fossil installed capacity in June 2025, five years ahead of its NDC target, reaffirming its net-zero 2070 commitment.
- Key policy measures include ISTS charge waivers for solar, wind, green hydrogen, and offshore wind; a 50 GW annual RE bidding trajectory (FY24–FY28); 100% FDI under the automatic route; expansion of the Green Energy Corridor; Renewable Purchase and Consumption Obligations through 2029–30; Solar Parks, PM-KUSUM, PM Surya Ghar; offshore wind VGF; and the National Green Hydrogen Mission targeting 5 MMT capacity with 125 GW associated renewable energy by 2030. Complementary initiatives include a INR 20,000 crore Nuclear Energy Mission targeting 100 GW nuclear by 2047, 43.22 GWh of BESS under VGF schemes, and 11,870 MW of pumped storage under construction strengthening grid readiness, investment momentum, and long-term energy transition.

Investment & Infrastructure Expansion

- India's power sector is expected to see cumulative investments of about INR 4,50,000 crore (INR 4.5 trillion) by 2032, driven by rising electricity demand, strong economic growth, and accelerated electrification, according to Union Power Minister Manohar Lal. These investments will support new generation capacity, modernisation and strengthening of transmission networks, and large-scale energy storage deployment to ensure reliable and sustainable supply while enabling the clean energy transition.
- Foreign investor interest remains strong, with the power sector accounting for 2.65–2.7% of total FDI inflows. Between April 2000 and June 2025, India received INR 1,21,734.99 crore (USD 19.8 billion) in power-sector FDI and INR 1,69,772.12 crore (USD 23.05 billion) in the non-conventional energy sector, reflecting sustained investor confidence and strong long-term growth prospects.

4.5.2 Constraints

Renewable Integration & Storage Challenges

- Although renewable energy capacity is expanding rapidly, the intermittency of solar and wind power combined with the limited availability of large-scale energy storage continues to constrain the ability to meet peak electricity demand using renewables alone. The variability in generation creates grid-balancing challenges, requiring flexible backup capacity, strong transmission networks, and faster deployment of battery energy storage systems (BESS) and pumped storage projects. Without sufficient storage infrastructure and modernised grid systems, higher renewable penetration can intensify system stability issues and impact supply reliability, particularly during peak-load hours.

Coal Dependency & Transition Risks

- Coal remains the dominant source of electricity in India, contributing roughly 70% of total generation and forming the core of reliable base-load supply. However, managing a gradual reduction in coal dependence while electricity demand continues to rise presents significant challenges related to planning, investment and energy security. India must carefully navigate this transition to prevent supply disruptions, avoid stranded assets, and maintain grid stability especially as renewable capacity expands but remains inherently intermittent. Ensuring dependable base-load availability while advancing decarbonisation represents a key long-term structural challenge for the power sector.

Transmission & Grid Integration Bottlenecks

- Large-scale integration of variable renewable energy sources such as solar and wind requires major upgrades to transmission networks, improved grid flexibility and expanded energy storage. Constraints such as inadequate transmission corridors, delays in substation capacity augmentation and limited balancing resources contribute to congestion and curtailment risks. Without timely grid modernisation and adequate flexible backup options, the rapid addition of renewable capacity can put pressure on system stability and jeopardise supply reliability particularly during peak demand periods or when renewable output is low.

4.6 Investments in the Power Generation, Transmission and Distribution Sector in India

India's power sector is rapidly emerging as one of the world's largest long-term investment opportunities, with an estimated potential exceeding USD 50,000 crore over the next seven years. This momentum is being fuelled by sharply rising electricity demand and sustained economic growth. At the curtain-raiser event for the Bharat Electricity Summit in New Delhi, Power Secretary Pankaj Aggarwal noted that India is currently adding 4–5 GW of new generation capacity every month reflecting an accelerated expansion cycle driven largely by renewable energy.

India's installed generation capacity has now crossed 514 GW, up from 509.74 GW in November 2025, demonstrating consistent and substantial capacity additions. To maintain this growth trajectory and meet future demand, major investments will be required across generation, transmission, and grid infrastructure. Union Power Minister Manohar Lal Khattar highlighted that the sector offers investment opportunities worth approximately USD 34,597 crore in power generation, USD 6,822 crore in transmission and distribution, and an additional USD 3,521 crore in energy storage illustrating the breadth of opportunities across the entire power value chain.

Investment activity is accelerating under national infrastructure initiatives. The National Infrastructure Pipeline (2019–25) allocates the largest share 24% of its planned capital expenditure of INR 111 lakh crore (USD 1.4 trillion) to energy sector projects. Looking ahead, India plans to nearly double its overall capital expenditure to INR 72,72,600 crore (USD 850 billion) by 2030, of which INR 25,66,800 crore (USD 300 billion) is earmarked specifically for power and transmission infrastructure.

Leading industry players such as NTPC, Tata Power, Power Grid Corporation, Hindustan Power and the Adani Group are spearheading this transition through large-scale investments. Tata Power intends to allocate 60% of its INR 1,46,000 crore (USD 16.96 billion) capex toward renewable energy, targeting the expansion of its green energy capacity to 23 GW by FY30. Similarly, the Adani Group has committed USD 6,000 crore by FY32 to develop 50 GW of renewable energy capacity, expand its transmission network to 30,000 km, and reinforce coal-based baseload capacity to ensure continued grid stability.

Table: India: Recent Major Investments in the Indian Power Sector

Date / Timeline	Company / Entity	Segment	Investment Value	Capacity / Project Details
By FY32 (Announced 2025)	Adani Group	Renewable Generation & Transmission and Distribution	INR 5,00,000 crore (USD 60 billion)	50 GW renewable capacity; 30,000 km transmission expansion; coal baseload strengthening
April, 2025 (Announced)	Avaada Group & Maharashtra Govt.	Pumped Storage (Renewable + Storage)	INR 15,100 crore (~USD 1.7 billion)	3,600 MW (Pawana Falyan & Sirsala projects)
April, 2025 (Announced)	DVC & Coal India Ltd	Thermal Generation	INR 16,500 crore (~USD 1.8 billion)	2x800 MW ultra-supercritical plant at Chandrapura
2025 (Inaugurated)	SJVN – Buxar Thermal Project	Thermal Generation	INR 13,757 crore (~USD 1.6 billion)	1,320 MW (660 MW unit inaugurated)
By FY30 (Capex Plan)	Tata Power	Renewable Generation	INR 1,46,000 crore (USD 16.96 billion) – 60% allocated to renewables	Expand renewable portfolio to 23 GW
2025	ONGC-NTPC Green JV	Renewable Generation	USD 2.3 billion (~ INR 19,000 crore)	Acquisition of Ayana Renewable Power

Source: Company News, IMARC, ICRA Analytics

4.7 Electricity Tariff Escalation vs Solar PPA Cost Competitiveness

The Indian power sector is witnessing a widening gap between rising grid electricity tariffs and the long-term cost competitiveness of solar Power Purchase Agreements (PPAs). While solar PPA prices are currently facing temporary upward pressure due to policy changes (such as Domestic Content Requirement (DCR) mandates) and rising raw material costs, the levelized cost of energy (LCOE) for solar remains significantly lower than conventional grid tariffs, which continue to increase annually.

Grid electricity tariffs for commercial and high-consumption residential users typically range between ₹7–₹11.5 per unit, and can go up to ₹12 per unit in higher consumption slabs. In contrast, solar LCOE remains in the range of approximately ₹2.2–₹2.8 per unit, making it a highly cost-competitive alternative. Additionally, rooftop solar systems—such as a 5 kW installation—require an investment of around ₹1.8–₹2.2 lakh after subsidies under schemes like PM Surya Ghar, further improving affordability and payback timelines.

Electricity costs in India continue to rise due to structural factors such as increasing fuel costs, coal import dependence, and the financial stress of state DISCOMs. These costs are ultimately passed on to consumers through tariff hikes and additional charges. The prevalent slab-based tariff system further increases the burden, as consumers with monthly usage above 300 units are charged at higher rates. Moreover, additional components such as fixed charges, Fuel Price and Power Purchase Cost Adjustment (FPPCA), and electricity duty significantly increase the effective cost of grid power beyond the base tariff.

Table 1: Grid Electricity Cost vs. Solar LCOE (2026 Estimates)

Parameter	Grid Electricity (DISCOM)	Solar Rooftop (Residential/C&I)
Average Cost per Unit	₹7.00 – ₹11.50	₹2.20 – ₹2.80
Price Stability	Volatile (8–10% annual increase)	Fixed for ~25 years
Additional Charges	Taxes, cess, fixed charges	Minimal maintenance costs
Long-term Trend	Increasing	Near-zero marginal cost after payback (~4–5 years)

Source: Bridgeway Power

Despite short-term fluctuations, solar power continues to offer a structurally lower and more stable cost of electricity compared to grid supply, making it increasingly attractive for both C&I and residential consumers.

Table 2: Electricity Tariff Escalation Trend (Projected)

Year	Grid Electricity Rate (Base ₹8/unit, ~8% annual increase)	Solar Rate (Locked-in LCOE)
Year 1 (2026)	₹ 8.00	₹ 2.50
Year 5 (2030)	₹ 11.71	₹ 2.50
Year 10 (2035)	₹ 18.86	₹ 2.50
Year 20 (2045)	₹ 48.91	₹ 2.50

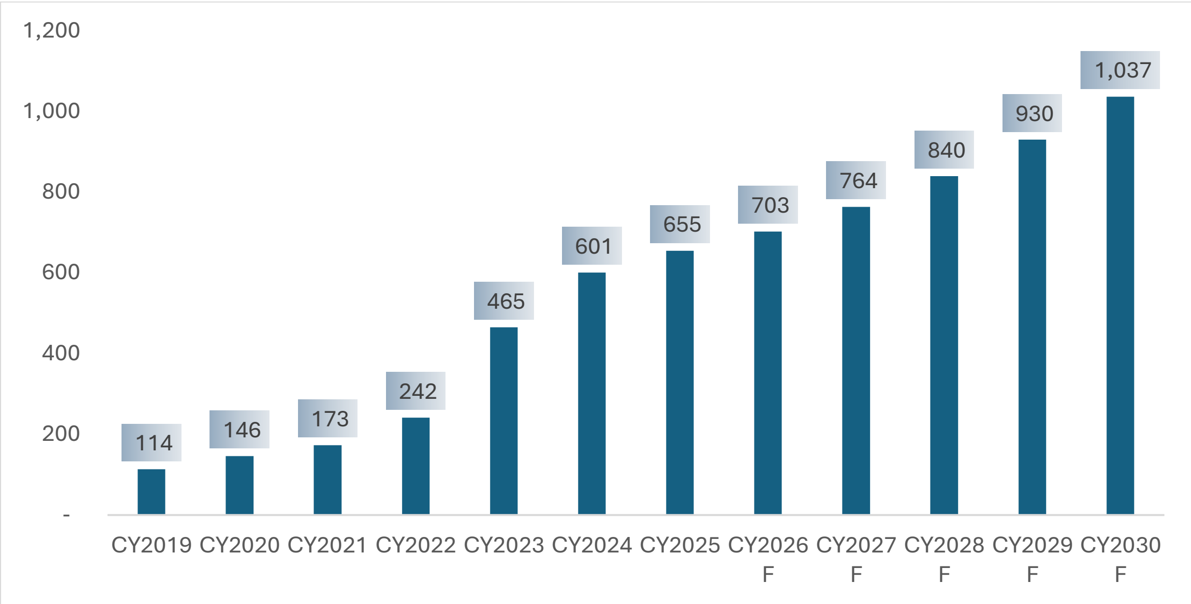
Source: Bridgeway Power

The table clearly illustrates the compounding impact of annual tariff escalation in grid electricity, compared to the fixed and predictable cost of solar power. While grid tariffs may increase significantly over time due to inflationary and structural factors, solar tariffs remain locked in, providing long-term cost visibility and substantial savings for consumers.

5. SOLAR SECTOR IN INDIA (FY2019–FY2030)

5.1 Global Consumption Trend

Chart: Global: Solar PV Sector: Annual PV Installations Trends and Forecast (in GW), CY2019-CY2030F



Source: IEA – International Energy Agency, Expert interactions, IMARC, ICRA Analytics

- Global yearly solar photovoltaic (PV) installations saw a remarkable rise from 114 GW in CY2019 to 655 GW in CY2025, marking a solid compound annual growth rate (CAGR) of 33.9% throughout the period of CY2019 to CY2025. This surge can be attributed to rapid declines in costs, supportive policy environments, and swift expansions of renewable capacity in major markets.
- Looking forward, it is projected that annual PV installations will approach around 1,037 GW by CY2030, with a CAGR of 10.2% from CY2026 to CY2030. This ongoing growth is expected to be fuelled by persistent decarbonization ambitions, large-scale utility solar initiatives, and a rising adoption of distributed and hybrid renewable energy solutions worldwide.
- The global PV installation sector is heavily impacted by falling technology prices, ambitious global net-zero targets, and strong policy incentives.

5.2 Indian Solar Power Sector

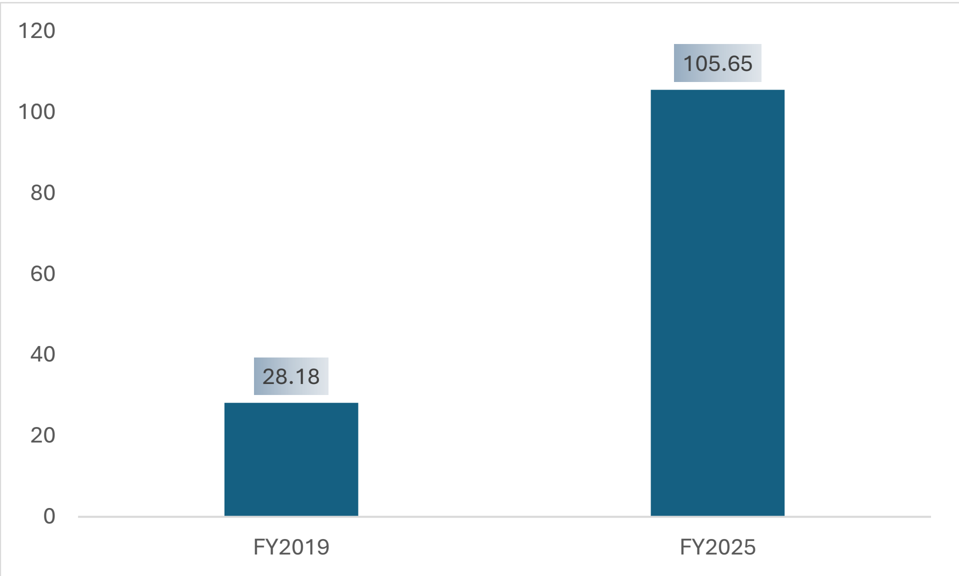
5.2.1 Overview of Solar Generation Capacity

India's solar power capacity has grown exponentially over the past decade, emerging as a key pillar of the country's renewable energy expansion. Installed solar capacity rose significantly from 28.18 GW in FY2019 to 105.65 GW by FY2025, driven by strong policy support, competitive tariffs, and large-scale deployment across both utility-scale and rooftop segments. This rapid expansion has substantially advanced India's clean energy transition, with non-fossil fuel sources accounting for over 50% of the total installed power capacity, indicating a structural shift in the country's energy mix.

Government initiatives have played a pivotal role in accelerating solar adoption. Under the PM Surya Ghar scheme, approximately 24 lakh households installed rooftop solar systems, adding around 7 GW of capacity by December 2025, supported by significant subsidy disbursements. Similarly, the PM-KUSUM programme facilitated the installation of nearly 9.2 lakh standalone solar pumps, promoting solar-powered irrigation and reducing dependence on conventional grid electricity in the agricultural sector.

Utility-scale development has also remained robust. As of October 2025, 55 solar parks across 13 states had been approved, with a cumulative sanctioned capacity of around 40 GW. These large-scale solar parks, alongside the growing adoption of rooftop and decentralized solar systems, have strengthened grid-connected capacity and enhanced regional energy access.

Chart: Growth of Solar Energy Capacity in India



Source: CEA & NPP, ICRA Analytics

India's shift toward solar energy is being propelled by a strong regulatory foundation, ambitious climate pledges, and extensive government-led programmes designed to accelerate renewable adoption. Anchored by its COP26 Panchamrit commitments including achieving 500 GW of non-fossil electricity capacity by 2030 and reaching net-zero emissions by 2070, the country has developed a robust policy ecosystem to scale solar deployment across utility, residential, agricultural, and manufacturing segments.

Key Policy and Regulatory Measures Enabling India's Solar Transition

PM Surya Ghar: Rooftop Solar Programme: Launched in February 2024 with a budgetary allocation of INR 75,021 crore, the PM Surya Ghar scheme aims to equip one crore households with rooftop solar installations, providing up to 300 units of free electricity each month. By December 2025, approximately 24 lakh households had adopted rooftop systems, adding nearly 7 GW of capacity, supported by subsidies exceeding INR 13,000 crore. This initiative fosters distributed solar generation, decreases reliance on grid power, improves energy affordability, and advances India's broader decarbonization agenda.

National Solar Mission (NSM): Established in 2010, the National Solar Mission serves as the cornerstone of India's solar policy architecture. It promotes large-scale solar deployment through ground-mounted plants, rooftop systems, hybrid installations, and off-grid solutions. Backed by the NSM and complementary policy efforts, solar capacity has grown rapidly across diverse segments, playing a critical role in meeting India's renewable energy goals and supporting its transition to a low-carbon economy.

Production-Linked Incentive (PLI) Scheme for Solar PV Manufacturing: To boost domestic manufacturing and reduce reliance on imports, the government launched the PLI scheme for high-efficiency solar PV modules with a total allocation of INR 24,000 crore. Implemented in two phases, the scheme supports gigawatt-scale integrated manufacturing and links incentives to module efficiency and local value addition. By September 2025, it had attracted investments exceeding INR 52,900 crore and generated significant employment, contributing to the development of a resilient domestic solar supply chain.

PM-KUSUM Scheme for Solarization of Agriculture: Introduced in 2019, the PM-KUSUM scheme encourages the adoption of solar energy in agriculture through grid-connected solar plants, standalone solar pumps, and solarization of existing agricultural pumps. By 2025, more than 9 lakh standalone solar pumps had been installed, improving energy access in rural areas and reducing dependence on conventional electricity for irrigation. The programme also enables farmers to sell surplus electricity to the grid, creating an additional revenue source while expanding decentralized solar capacity.

Solar Parks and Ultra-Mega Solar Power Projects: Launched in 2014 and later expanded to target 40 GW, the Solar Parks Scheme facilitates large-scale solar deployment by offering land support, transmission infrastructure, and shared facilities. As of October 2025, 55 solar parks across 13 states with nearly 40 GW of sanctioned capacity had been approved, with many projects already operational. The scheme has been extended to 2029 to ensure completion of ongoing developments and continued expansion of grid-connected solar capacity.

Basic Customs Duty (BCD): To protect domestic manufacturers from low-cost imports, India imposed BCD of 25% on solar cells and 40% on modules from April 1, 2022. Effective February 2, 2025, these were revised to 20% each, along with an Agriculture Infrastructure and Development Cess (AIDC) of 7.5% on cells and 20% on modules. Despite the adjustments, BCD remains a vital tool for strengthening the competitiveness of locally manufactured modules and reducing import dependence.

Domestic Content Requirement (DCR): The DCR mandate requires the use of domestically produced solar cells and modules in specified government-supported initiatives such as CPSU projects, PM Surya Ghar, and PM-KUSUM. This policy ensures assured demand for domestic manufacturers, enhances local production capacity, and aligns renewable energy development with industrial growth.

Approved List of Models and Manufacturers (ALMM): Following substantial capacity additions in FY2024, ALMM-I, previously deferred, was enforced from April 1, 2024, mandating the use of domestically produced modules for most solar projects except behind-the-meter and export-oriented green hydrogen projects. ALMM-II extends the requirement to domestic cells, with an approved list of nearly 13 GWp released on July 31, 2025. All utility-scale bids submitted after August 31, 2025 must source domestic cells, while open-access and net-metering projects commissioned on or after June 1, 2026 must comply as well.

Additionally, on September 12, 2025, the Ministry proposed ALMM-III for wafers, requiring DCR modules manufactured from domestic wafers once at least three manufacturers with a combined 15 GWp capacity are listed. Applicability will begin after a defined cutoff date for competitive bids and from June 1, 2028 for open-access and net-metering projects.

GST Rationalization: The GST Council reduced GST rates on solar cells and modules from 12% to 5% effective September 22, 2025. This reduction lowers the tax burden on turnkey EPC contracts from 13.8% to around 8.9%, improving project economics and accelerating deployment across both utility-scale and distributed solar markets.

These measures collectively have transformed India's solar sector from an emerging industry into one of the world's fastest-growing renewable markets. Together, they have driven rapid utility-scale capacity expansion, significant growth in rooftop installations, widespread agricultural solarization, and strengthened domestic manufacturing. This integrated policy framework remains central to India's efforts to decarbonize its power sector, enhance energy security, and achieve long-term clean energy and climate objectives.

5.2.3 Indian State Wise Solar Potential

Table: India: State-wise Solar Power Potential (MWp) (2025)

States	Solar Potential (MWp)
Andaman & Nicobar Islands	590
Andhra Pradesh	2,99,312
Arunachal Pradesh	468
Assam	19,173
Bihar	3,32,991
Chandigarh	22
Chhattisgarh	1,26,484
Dadra and Nagar Haveli and Daman and Diu (DNHDD)	498
Delhi	550
Goa	6,752
Gujarat	2,43,220
Haryana	6,468
Himachal Pradesh	21,502
Jammu and Kashmir	8,589
Jharkhand	51,831
Karnataka	2,23,279
Kerala	12,405
Ladakh	8,557
Madhya Pradesh	3,18,972
Maharashtra	4,86,679
Manipur	2,294
Meghalaya	14,674
Mizoram	612
Nagaland	191
Odisha	1,39,474
Puducherry	196
Punjab	9,210
Rajasthan	8,28,781
Sikkim	254
Tamil Nadu	2,04,765
Telangana	1,40,451
Tripura	9,106

States	Solar Potential (MWp)
Uttar Pradesh	97,843
Uttarakhand	4,436
West Bengal	22,742

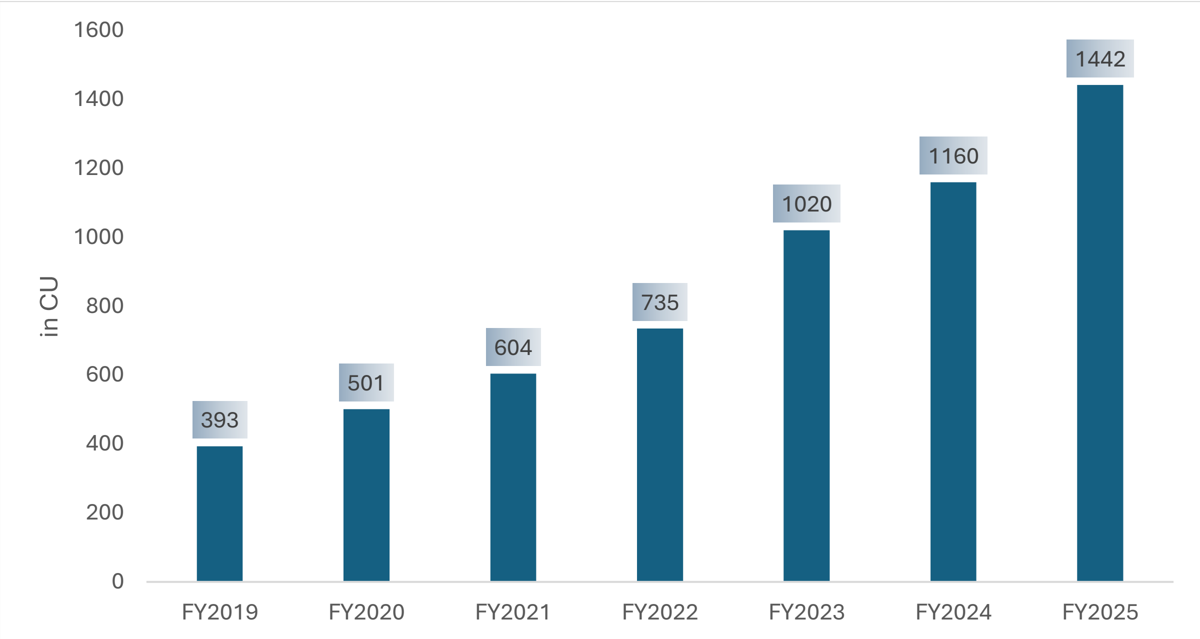
Source: Ministry of New and Renewable Energy, National Institute of Solar Energy (NISE), ICRA Analytics

5.2.4 Growth in Solar Energy Generation in India

India's solar electricity generation has recorded a strong and consistent upward trajectory in recent years, driven by rapid capacity additions, an enabling policy environment, and steadily declining solar tariffs. Output rose sharply from 393 CU in FY2019 to 1442 CU in FY2025, marking an almost fourfold increase over six years. The growth pace accelerated particularly after FY2022, with generation surpassing 1000 CU in FY2023 and further expanding to 1160 CU in FY2024 and 1442 CU in FY2025.

This sustained rise in solar generation is largely attributed to the large-scale rollout of utility-scale solar parks, expanding adoption of rooftop solar systems, and growing corporate procurement through long-term power purchase agreements (PPAs). Additionally, declining module prices, improved project development and execution capabilities, and stronger grid integration mechanisms have all contributed to higher annual generation levels.

Chart: India: Solar Electricity Generation Trends (in CU), FY2019-FY2025



Source: CEA & NPP, ICRA Analytics

5.2.5 Review of Overall Grid-Connected Solar Energy Capacity Additions

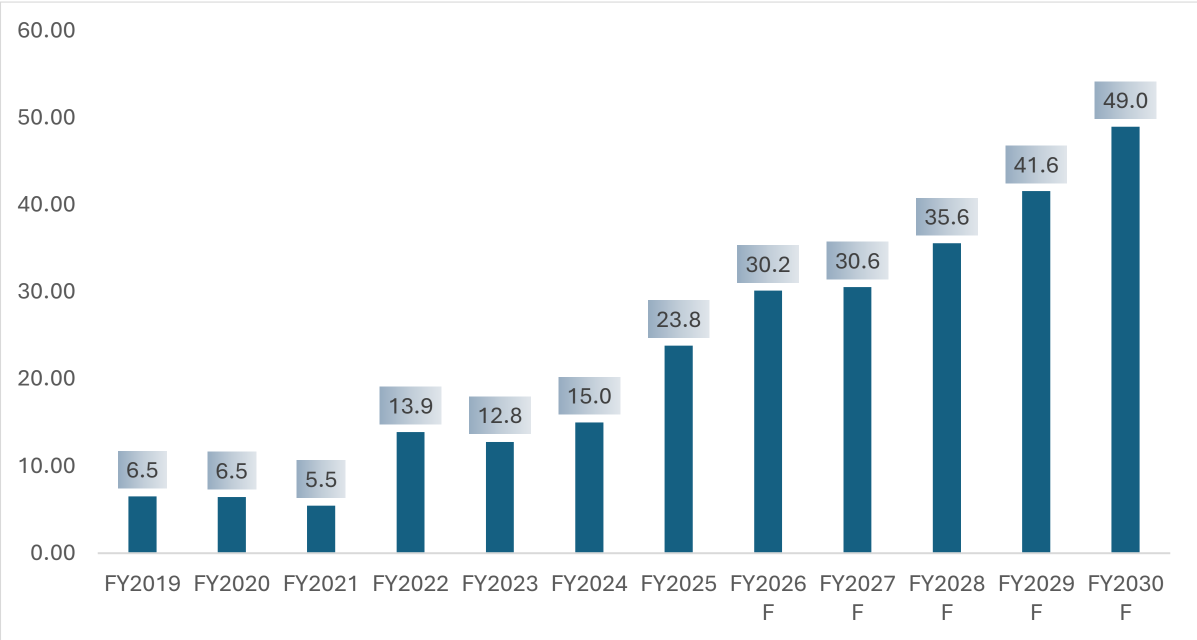
India's grid-connected solar capacity additions have increased substantially, rising from 6.53 GW in FY19 to 23.84 GW in FY2025, representing a strong CAGR of 20.3% over FY2019–FY2025. This expansion has been driven by rapid deployment of utility-scale solar projects, the growth of solar parks, supportive policy interventions, and continued declines in module prices, as reported by the Central Electricity Authority (CEA) and the National Power Portal (NPP).

According to the Press Information Bureau (PIB), the grid-connected solar segment recorded remarkable growth in 2025, with 34.98 GW added up to November 2025, compared to 20.85 GW during the same period in 2024. India crossed the 100 GW milestone in January 2025, and cumulative solar installations reached 132.85 GW by November 2025, marking a 41% year-on-year increase from 94.17 GW in November 2024. The accelerated rollout of utility-scale and solar park projects played a pivotal role in achieving this milestone.

In 2025 alone, roughly 3.08 GW of capacity was commissioned under the Solar Parks and Ultra-Mega Solar Power Projects scheme, while government entities added nearly 2.87 GW under CPSU Scheme Phase-II. Simultaneously, domestic manufacturing witnessed substantial expansion. ALMM-listed solar module manufacturing capacity climbed to approximately 144 GW per annum (including ~81 GW added in 2025), while ~24 GW of cell capacity was added under ALMM List-II. The PLI scheme further supported the creation of ~11 GW of module and ~5 GW of cell manufacturing capacity. Together, these developments have significantly strengthened India's integrated solar manufacturing ecosystem.

5.2.6 Capacity Addition Trend in India

Chart: India: Grid-Connected Solar Energy Capacity Additions (in GW), FY2019-FY2030F



Source: CEA & NPP, Expert Interactions, IMARC, ICRA Analytics

India's grid-connected solar energy capacity additions increased from 6.53 GW in FY2019 to 23.84 GW in FY2025, driven by large-scale utility solar projects, expansion of solar parks, supportive government policies, and declining module prices.

Going forward, annual additions are projected to reach about 48.99 GW by FY30 reflecting sustained momentum supported by aggressive renewable targets, growing demand for clean power, and rising adoption of rooftop and distributed solar across residential, commercial, and industrial segments.

5.2.7 Investment in Solar Sector

Rising capital investment in solar manufacturing and project development is strengthening India's domestic renewable energy ecosystem and steadily reducing dependence on imports. Significant inflows across modules, cells, wafers, and integrated manufacturing value chains reflect strong investor confidence in the long-term prospects of India's solar market bolstered by government incentives, Production-Linked Incentive (PLI) schemes, and the broader push for self-reliant clean energy supply chains.

These investments are driving the expansion of domestic manufacturing capacities, generating employment opportunities, and supporting the accelerated rollout of large-scale solar projects, all of which are crucial for meeting India's long-term renewable energy and decarbonization goals.

Table: India: Key Recent Investments in Solar Sector

Company	Investment (INR)	Capacity Addition / Project	Location
GREW Solar	INR 1,050 crore	Expansion from 3 GW to 8 GW cell capacity	Dudu (Rajasthan) & Madhya Pradesh
Jakson Engineers	INR 8,000 crore	6 GW integrated module, cell & wafer plant	Maksi, Madhya Pradesh
IB Solar	INR 3,000 crore	4 GW solar cell manufacturing facility	YEIDA, Uttar Pradesh
Shakti Pumps	INR 75 crore	2.2 GW DCR cell & PV module plant	Pithampur, Madhya Pradesh
ReNew Energy Global	~INR 870 crore (~USD100 million)	Expansion to ~6.4 GW modules & 6.4 GW cells	Jaipur (Rajasthan) & Dholera (Gujarat)
Emmvee Energy	INR 15,000 crore (phased)	5 GW initial PV manufacturing facility	Karnataka
SAEL Industries	INR 8,200 crore (~USD 953.78 million)	5 GW solar cell + 5 GW module manufacturing facility	Greater Noida
Waaree Energies	~INR 15,000 crore	6 GW integrated plant + 5.4 GW cell gigafactory	Gujarat, Maharashtra, Tamil Nadu
RP-Sanjiv Goenka Group	~INR 3,000 crore (within INR 3,500 crore YEIDA projects)	3 GW solar cell facility + 60 MW captive solar & storage	YEIDA, Uttar Pradesh

Source: IMARC, ICRA Analytics

Competition in India's Solar EPC (Engineering, Procurement & Construction) sector:

Solar EPC sector has become one of the most competitive clean-energy markets in the world, driven by aggressive capacity addition targets, falling technology costs, and rapid expansion in both utility-scale and rooftop solar installations. Government initiatives including PM Surya Ghar and utility-scale solar park tenders have spurred EPC bidding wars across states.

India: List of few Key Players in Solar EPC Sector

Sr No	Company	Approximate Installed EPC Capacity
1	Sterling and Wilson Renewable Energy Limited	~10+ GW
2	Adani Green Energy Limited	~7.5+ GW
3	Tata Power Solar Systems Limited	~6+ GW
4	ReNew Energy Global	~5+ GW
5	Larsen & Toubro Limited	~5+ GW

Source: Company filings, ICRA Analytics

5.2.8 Potential Long-Term Drivers and Constraints for Solar Sector in India

Drivers:

- **Growth of Large-Scale Solar Projects in India**
    - India has established itself as a global leader in solar energy, with installed solar capacity exceeding 130 GW as of late 2025, driven largely by rapid deployment of

utility-scale (large-scale) solar projects. The country hosts some of the world's largest solar parks, including Bhadla Solar Park (2,245 MW) and Pavagada Solar Park (2,050 MW), highlighting the scale and maturity of India's solar infrastructure. These large-scale projects form the backbone of India's renewable energy expansion, supported by strong government policies and increasing investor participation.

  - A key pillar of this growth is the government-led "Development of Solar Parks and Ultra Mega Solar Power Projects" scheme, which aims to streamline land acquisition, grid connectivity, and project execution for large installations. The program targets 40 GW of solar park capacity by March 2026, with 53 solar parks (≈39.3 GW) already approved across 13 states. As of August 2025, ~13.9 GW of capacity is already operational across 26 solar parks, while the remaining projects are under various stages of development. This indicates a robust project pipeline, ensuring sustained growth in the utility-scale solar segment over the next few years.

  - The country is witnessing strong growth in related segments such as solar open access, which added a record 7.8 GW in 2025, taking cumulative capacity beyond 30 GW, with an additional 45 GW pipeline under development. While open access serves commercial and industrial demand, it also reinforces the broader ecosystem supporting large-scale solar deployment, including grid infrastructure and project financing.

  - Looking ahead, the growth trajectory remains highly robust. According to projections by the Central Electricity Authority, India's solar capacity is expected to quadruple over the next decade, forming nearly 65% of the country's total non-fossil fuel capacity mix by 2035–36. Total non-fossil capacity is projected to reach ~786 GW, underlining the massive scale-up opportunity for solar, particularly utility-scale projects. This expansion is aligned with India's target of achieving 500 GW of non-fossil fuel capacity by 2030, positioning large-scale solar as a central component of the country's energy transition.

  Additionally, policy measures aimed at strengthening domestic manufacturing—such as mandating the use of locally produced solar cells by from June 2026 and proposed requirements for domestically manufactured ingots and wafers by 2028—are expected to enhance supply chain resilience and drive further investments in the sector. Leading companies such as Waaree Energies, Tata Power, and Indosol Solar are already planning significant capacity expansions, indicating strong industry confidence

- **Strong Government Targets and Long-Term Energy Transition Commitments**

  India's renewable energy transition is anchored in its ambitious national goals, including achieving 500 GW of non-fossil fuel capacity by 2030 and reaching net-zero emissions by 2070. These commitments provide long-term policy certainty and sustained visibility for solar expansion. Given its scalability, rapidly declining costs, and shorter construction timelines, solar energy is expected to contribute the largest share of future renewable capacity additions, forming the backbone of India's clean energy transition.

- **Sharp Decline in Solar Costs Enhancing Round-the-Clock Clean Power Competitiveness**

Solar photovoltaic module prices have fallen by nearly 95%, dropping from over INR 200/W in 2010 to below INR 9/W in 2024. This dramatic cost reduction has significantly improved the long-term competitiveness of solar energy. Analysis by the India Energy & Climate Center (University of California, Berkeley) shows that solar-plus-storage solutions can now supply 24×7 electricity with over 95% availability at under INR 6/kWh, while optimized configurations can deliver flat, round-the-clock clean power at INR 4–4.3/kWh. Even when backed by full reliability reserves, costs remain below INR 4.7/kWh, making these systems far more economical than average industrial tariffs and new coal-based power. This structural cost advantage will accelerate large-scale solar deployment in the coming years.

- **Rising Electricity Demand Driven by Rapid Economic Growth and Electrification**

  India's electricity demand is expected to grow sharply over the long term, driven by rapid urbanization, industrial expansion, adoption of electric mobility, and the growth of data centres and digital infrastructure. Solar power, with its modular installation, scalability, and short development timeline will be critical for meeting this rising demand, especially during daytime peak hours. This will help reduce dependence on fossil fuel imports and support India's path toward a cleaner, more secure energy system.

- **Expansion of Solar Parks and Ultra-Mega Solar Power Projects**

  The Solar Parks and Ultra-Mega Solar Power Projects Scheme, introduced by the Ministry of New and Renewable Energy in 2014 with an initial target of 20 GW, later expanded to 40 GW in 2017, has emerged as a central pillar of India's utility-scale solar development. As of October 2025, 55 solar parks with a sanctioned capacity of 39,973 MW had been approved across 13 states, of which 14,922 MW has already been commissioned, with the remaining capacity at various stages of execution. The scheme's extension until March 2029 ensures sustained project momentum. By offering ready-to-develop, plug-and-play infrastructure including land availability, grid evacuation systems, access roads, and water supply, the programme significantly reduces project risks, shortens development timelines, and enhances economies of scale, thereby accelerating India's large-scale solar capacity addition.

- **Massive Untapped Solar Potential Supporting Long-Term Sector Growth**

  India benefits from an exceptionally large untapped solar resource base, which strengthens the long-term growth outlook for the sector. A recent reassessment by The Energy and Resources Institute (TERI) estimates India's total solar potential at approximately 10,830 GW, nearly 15 times higher than earlier projections. This revised estimate incorporates emerging and decentralized applications such as urban and rural rooftop systems, floating solar, agri-voltaics, and infrastructure-integrated installations across railways and national highways.

  Further complementing this, an assessment led by the Ministry of New and Renewable Energy (MNRE) using analysis from the National Institute of Solar Energy (NISE) identifies over 3,300 GW of feasible ground-mounted solar PV potential derived from suitable wasteland areas, based on satellite imagery, meteorological data, and land-use mapping.

  Together, these studies underscore India's immense long-term solar deployment headroom and highlight the opportunities for both centralized and decentralized growth.

With supportive policies, region-specific resource assessments, and focused infrastructure investment, India is well positioned to scale solar installations across diverse geographies and applications, unlocking transformative clean energy expansion in the decades ahead.

- **Mitigating Reliance on Chinese Solar Imports and Enhancing Domestic Production:**

  China's significant role in the global solar supply chain representing approximately 80% of solar cell output and 70–80% of module production has historically posed import dependency challenges for India. Nevertheless, policy measures such as the Approved List of Models and Manufacturers (ALMM) have markedly diminished reliance on Chinese imports, with module imports decreasing from over 90% in FY2022 to around 56% in FY2024, and PV cell imports dropping to about 65%. The forthcoming implementation of ALMM List-II for solar cells starting June 2026 is anticipated to further localize the supply chain and promote domestic capacity expansions. Despite these advancements, structural obstacles persist as India continues to rely on imported upstream raw materials like polysilicon and wafers, while domestic manufacturing utilization remains constrained at approximately 40–45%, yielding around 7 GW and fulfilling only about one-third of national demand. Prominent integrated manufacturers such as Adani Group and Waaree Energies are investing in backward integration throughout the solar value chain to foster self-sufficiency, bolster supply security, and enhance the long-term competitiveness of India's solar industry.

- **Increasing Corporate Renewable Procurement via PPAs:** Corporate power purchase agreements (PPAs) are becoming a significant long-term growth catalyst for India's solar industry. Major commercial and industrial consumers are progressively entering into long-term solar PPAs to minimize carbon emissions, adhere to ESG and sustainability obligations, and mitigate the impact of fluctuating grid tariffs. This rising corporate demand accelerates the addition of solar capacity, especially in the open-access and captive sectors, while offering developers reliable revenue streams and enhanced project bankability, thus drawing increased private and institutional investment into the solar power landscape.

Constraints

- **Land Acquisition and Infrastructure Bottlenecks**

  Utility-scale solar projects require large, contiguous land parcels, which often lead to significant delays due to complex land acquisition processes, competing agricultural and industrial land uses, and lengthy environmental approval procedures. Additionally, inadequate transmission infrastructure and the slow pace of developing evacuation corridors from high-potential solar states such as Rajasthan and Gujarat continue to constrain timely grid integration.

  In 2025, for example, around 4.3 GW of solar capacity in Rajasthan experienced complete daytime curtailment due to transmission constraints, jeopardizing projects worth nearly INR 20,000 crore as developers waited for associated transmission systems to be commissioned. These challenges underscore how grid bottlenecks can directly affect generation utilization, investor returns, and the long-term pace of utility-scale solar deployment.

- **Increase in Raw Material Costs**

  The solar power industry is currently facing a significant constraint in the form of rising raw material costs, which are putting pressure on manufacturing and overall project economics. Key inputs used in solar photovoltaic (PV) systems particularly silver, copper, and aluminium have witnessed substantial price increases in recent years. Silver, a critical component in cell metallisation, has seen one of the sharpest hikes, while copper (used in wiring and interconnections) and aluminium (used in module frames and mounting structures) have also recorded considerable price surges.

  In January 2026, according to Kalpesh Kalthia, solar modules account for nearly 50% of the total cost of a solar project, making them highly sensitive to fluctuations in raw material prices such as silver, copper, and aluminium. He noted that over the past 5-6 months, production costs of solar modules have already increased by approximately 8-10% and are expected to rise by a further 8-10% due to recent price hikes by Chinese solar cell suppliers.

- While strong demand for solar installations continues to support market growth, rising material costs may lead to higher upfront installation expenses for consumers, including increased prices for panels, inverters, and associated components. This could moderate short-term adoption rates, especially in price-sensitive markets, and compress margins for developers and manufacturers. Overall, volatility in raw material prices remains a critical challenge, potentially affecting cost competitiveness and project viability in the solar sector

- **Financial Stress of DISCOMs and Payment Delays**

  The persistent financial fragility of state distribution companies (DISCOMs) remains a major structural challenge for the solar sector. Chronic payment delays, attempts to renegotiate already-signed power purchase agreements (PPAs), and instances of curtailing renewable power adversely impact project cash flows and heighten counterparty risk. Such financial uncertainty among offtakers can erode investor confidence and impede long-term solar capacity addition, despite strong demand fundamentals and falling clean-energy costs.

- **Dependence on Imported Components and Supply Chain Risks**

  Despite domestic manufacturing incentives and protective import duty structures, India continues to rely heavily on imported solar modules, cells, and wafers. This dependence exposes the sector to global supply chain disruptions, geopolitical trade restrictions, and currency-related cost volatility. Delays in importing critical components can affect project timelines and raise overall system costs. This structural vulnerability may undermine India’s long-term cost competitiveness and energy-supply security unless domestic manufacturing ecosystems scale up more rapidly.

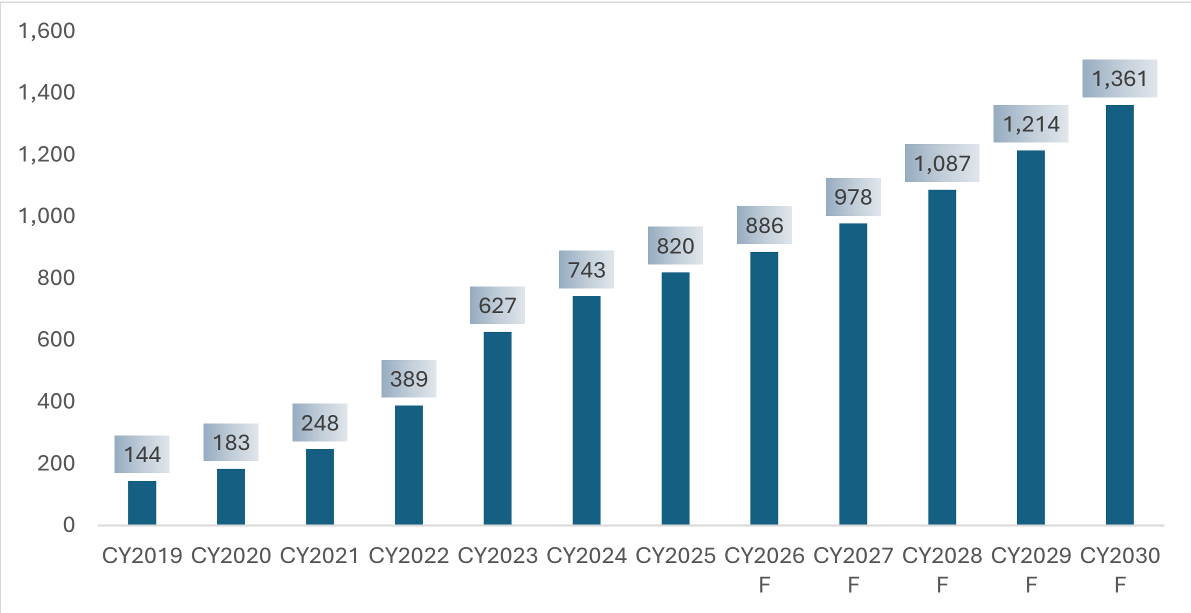
- **Intermittency and Grid Integration Challenges**

  Solar power is inherently variable and weather-dependent, posing operational challenges for grid stability as renewable penetration increases. Ensuring reliable round-the-clock electricity supply requires substantial investments in energy storage systems, flexible thermal generation, advanced forecasting tools, and real-time grid balancing capabilities. Without these complementary systems, rising solar penetration could lead to higher curtailment levels, reduced utilization of installed capacity, and greater operational uncertainty for developers over the long term.

5.3 Global Consumption Trend in Solar Cell and Module Sector

5.3.1 Solar Cell Market

Chart: Global: Solar Cell Market: Consumption Trends (in GW), CY2019-CY2030F



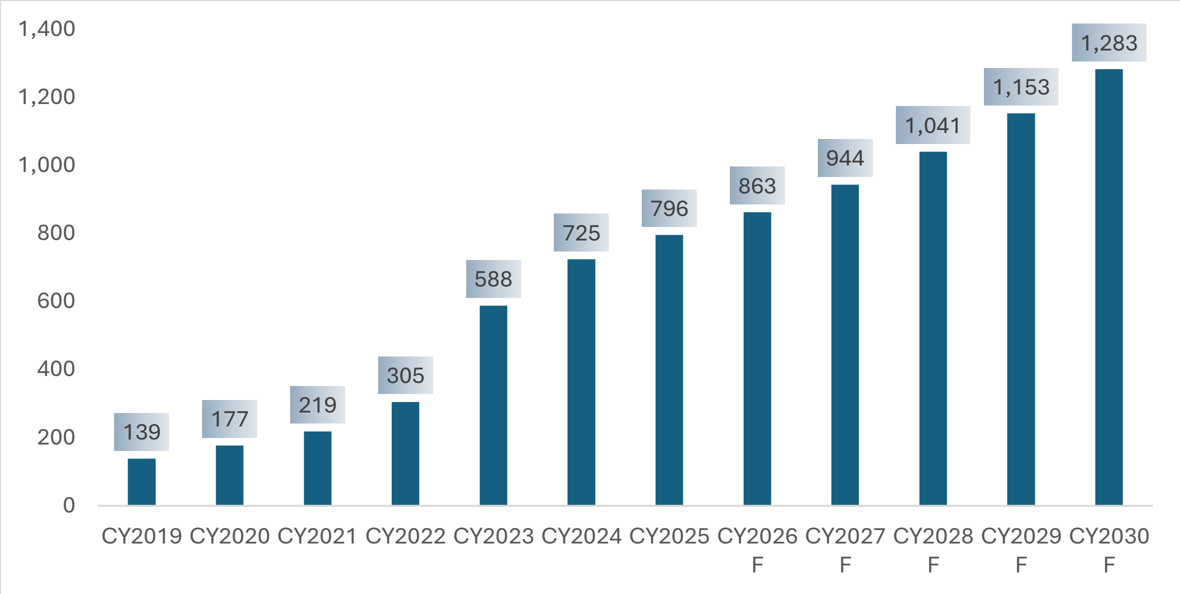
Source: IEA - International Energy Agency, Expert Interactions, IMARC, ICRA Analytics

Global solar cell consumption rose sharply from 144 GW in CY2019 to 820 GW in CY2025, registering a robust CAGR of 33.6% during CY2019–CY2025, driven by rapid expansion of global solar PV installations, strong demand for high-efficiency cells, and scaling of integrated manufacturing capacity across key markets. Going forward, solar cell consumption is projected to reach about 1,361 GW by CY2030, growing at a CAGR of 11.3% over CY2026–CY2030, reflecting sustained demand supported by accelerating energy transition goals, expansion of utility-scale and distributed solar projects, and increasing adoption of advanced cell technologies worldwide.

In August 2025, JinkoSolar and IBC SOLAR completed an 8.5 MW Agri-PV project in Veringenstadt, Germany, integrating solar power generation with agricultural land use and promoting efficient dual land utilization, highlighting emerging application-driven demand for advanced solar cells.

5.3.2 Solar Module Market

Chart: Global: Solar Module Market: Consumption Trends (in GW), CY2019-CY2030F



Source: IEA - International Energy Agency, Solar Power Europe, Expert Interactions, IMARC, ICRA Analytics

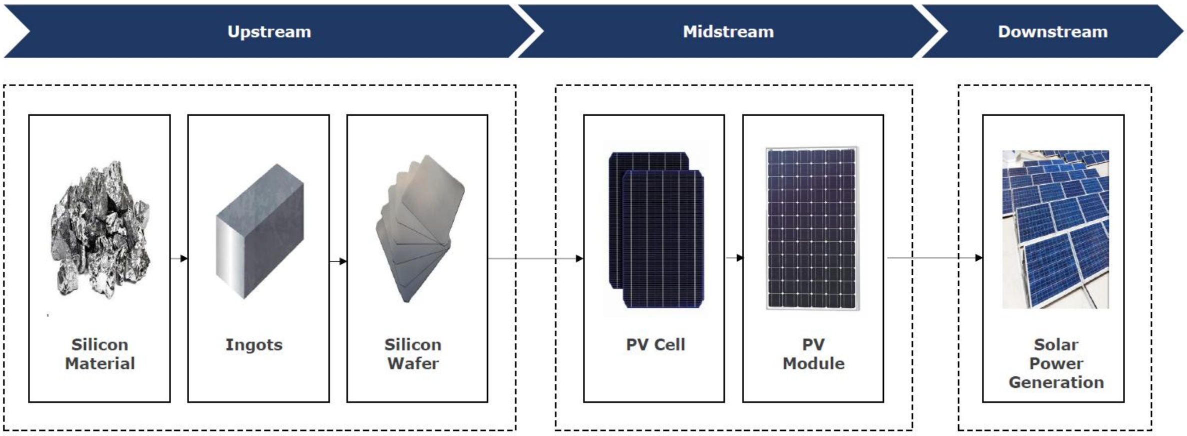
Global solar module consumption increased significantly from 139 GW in CY2019 to 796 GW in CY2025, registering a strong CAGR of 33.8% during CY2019–CY2025, driven by rapid expansion of utility-scale solar projects, falling module prices, supportive policy frameworks, and accelerated renewable energy adoption across major markets. Going forward, global module consumption is projected to reach about 1,283 GW by CY2030, growing at a CAGR of 10.4% over CY2026–CY2030, reflecting sustained demand supported by decarbonization targets, large-scale capacity additions, and increasing deployment of distributed and hybrid solar energy systems worldwide.

Recent industry developments also indicate strengthening upstream supply chains, such as the three-year agreement signed in February 2026 between NextPower and JinkoSolar to supply US-made steel module frames, highlighting growing localization and resilience in global solar manufacturing ecosystems.

5.4 Solar Cell and Module Sector in India

5.4.1 Solar PV Value Chain

Chart: India: Solar PV Industry: Value Chain Analysis Upstream



The solar PV industry value chain is divided into three primary segments: upstream, midstream and downstream. The upstream segment covers the procurement and processing of raw materials such as polysilicon, ingots and wafers that serve as essential inputs for producing solar cells. The midstream segment focuses on PV cell production and module assembly, where technologies are leveraged to enhance efficiency, durability and performance. The downstream segment includes system integration and the deployment of solar projects across residential, commercial, and industrial applications for electricity generation.

- **Upstream:** The upstream stage consists of raw material processing and early manufacturing steps required to create solar wafers, which are the fundamental building blocks of photovoltaic cells. This part of the value chain is highly capital-intensive and technologically demanding, and India currently has limited domestic capabilities in this area. Key components include:

    - **Silicon Material (Polysilicon):** High-purity polysilicon is the core raw material used to manufacture solar wafers.
    - **Silicon Ingots:** Polysilicon is melted and cast into ingots that form the basis for wafer slicing.
    - **Silicon Wafers:** Thin wafers cut from ingots, serving as the substrate for fabricating photovoltaic cells.

Due to constraints in domestic manufacturing, India remains heavily dependent on imports for these upstream inputs.

- **Midstream:** The midstream segment involves transforming silicon wafers into photovoltaic (PV) cells and assembling these cells into complete solar modules. This stage largely determines the final system's performance, reliability and efficiency. India has been expanding its presence in this segment especially in module assembly supported by government incentives and increased private investment. Key activities include:

    - **PV Cell Manufacturing:** Converting silicon wafers into operational solar cells through processes like diffusion, coating, metallization and passivation.
    - **PV Module Manufacturing:** Linking multiple solar cells and encapsulating them into robust modules using glass, EVA sheets, backsheets and junction boxes.

- **Downstream:** The downstream segment covers system integration, project development, installation and the generation of electricity from solar power assets. This is the most established and competitive part of India's solar sector, driven by strong EPC capabilities and large-scale renewable deployment. Key activities include:

    - **EPC and Project Development:** Engineering, procurement, and construction of solar projects, including site evaluation, financing, and installation.
    - **Balance of System (BoS) Components:** Incorporation of inverters, mounting structures, cables, transformers, and monitoring equipment necessary for plant operations.
    - **Solar Power Generation:** Implementation and operation of solar systems across utility-scale plants, commercial and industrial setups, and residential rooftop installations.

5.4.2 Demand for Solar Cell and Module in India

Domestic solar module consumption in India has risen sharply, growing from 7.84 GW in FY2019 to 29.07 GW in FY2025, according to the India Climate & Energy Dashboard. This increase reflects strong momentum in solar installations across both utility-scale and rooftop segments. Following a brief slowdown during FY2020–FY2021, demand rebounded significantly from FY2022 onward, driven by faster project execution, ALMM-linked reliance on domestic modules, and the expansion of solar parks and distributed solar initiatives.

As reported by SolarPower Europe, domestic solar cell consumption also grew substantially from 4.0 GW in FY2019 to 69.6 GW in FY2025. This surge highlights the rapid scaling of domestic module manufacturing and growing backward integration among solar manufacturers. Policies such as the PLI scheme and the ALMM-II requirement for domestic cell usage have strengthened local sourcing, leading to higher demand for advanced, high-efficiency cell technologies.

The simultaneous rise in domestic consumption of both solar cells and modules underscores the strong underlying demand fundamentals in India's solar sector. This growth is supported by rapid capacity additions, localization policies, and wider adoption of technologies such as TOPCon and bifacial modules. Continued expansion of utility-scale projects, increasing rooftop solar uptake, and agricultural solarisation programs are expected to sustain high demand for solar cells and modules in the years ahead.

5.4.3 Overview of Domestic Solar Cell and Module Manufacturing Capacity

As indicated by policy announcements from the Ministry of New and Renewable Energy (MNRE) and various industry reports, India has rapidly strengthened its domestic solar manufacturing ecosystem in recent years. This expansion has been driven by initiatives such as the Production Linked Incentive (PLI) scheme, the Approved List of Models and Manufacturers (ALMM) framework, and a broader policy focus on reducing import dependence. India's solar module manufacturing capacity has now exceeded 100 GW and continues to grow with several integrated manufacturing facilities being commissioned across multiple states.

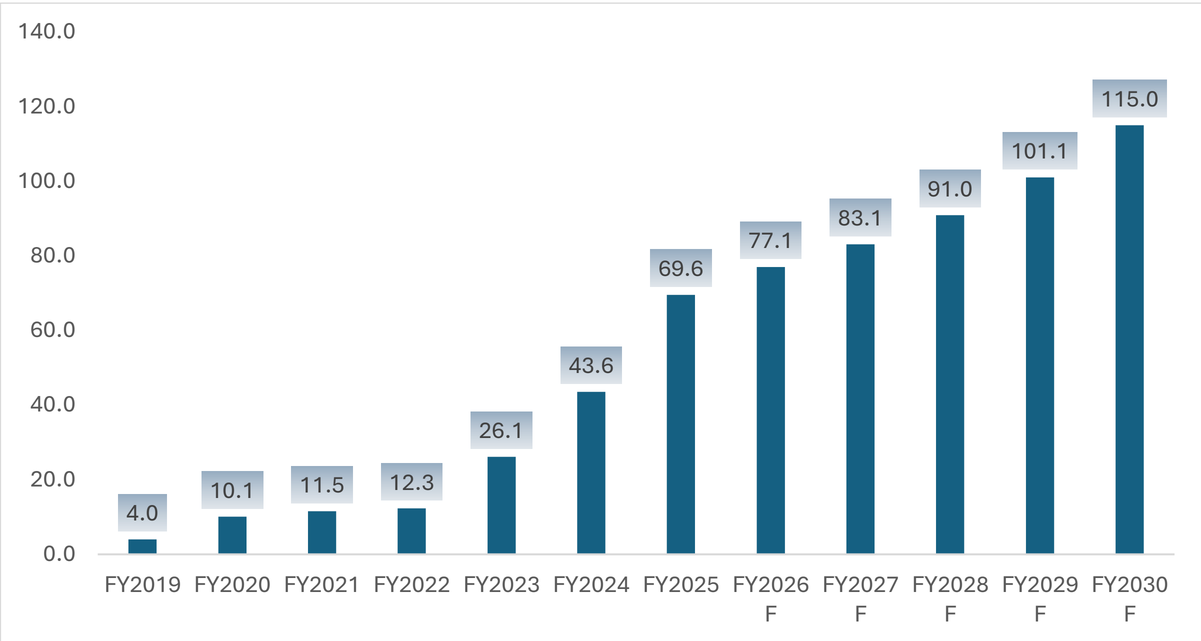
Industry estimates and MNRE data show that India's solar cell manufacturing capacity is also rising steadily, supported by the ALMM List-II for solar cells and increased backward integration by domestic manufacturers. Although cell production capacity has historically lagged behind module assembly, new investments under the PLI scheme and the establishment of large-scale giga-factories are expected to significantly close this gap, strengthening India's ability to build a self-reliant solar value chain.

India is moving from high import dependence toward establishing a fully integrated solar manufacturing ecosystem that includes polysilicon, wafers, cells, and modules. This expansion is aimed at meeting growing domestic demand, reducing reliance on imports particularly from China and supporting national renewable energy targets as well as global export aspirations within the solar supply chain.

Continued government support through incentives, domestic content requirements, and ALMM mandates is further encouraging large-scale investments in end-to-end manufacturing lines covering wafers, cells and modules. With multiple gigawatt-scale facilities under construction and additional expansions planned by major domestic players, India is poised to significantly deepen its upstream manufacturing capabilities in the coming years.

5.4.4 Solar Cell and Solar Module Consumption in India

Chart: India: Solar Cell Market: Consumption Trends and Forecast (in GW), FY2019-FY2030F



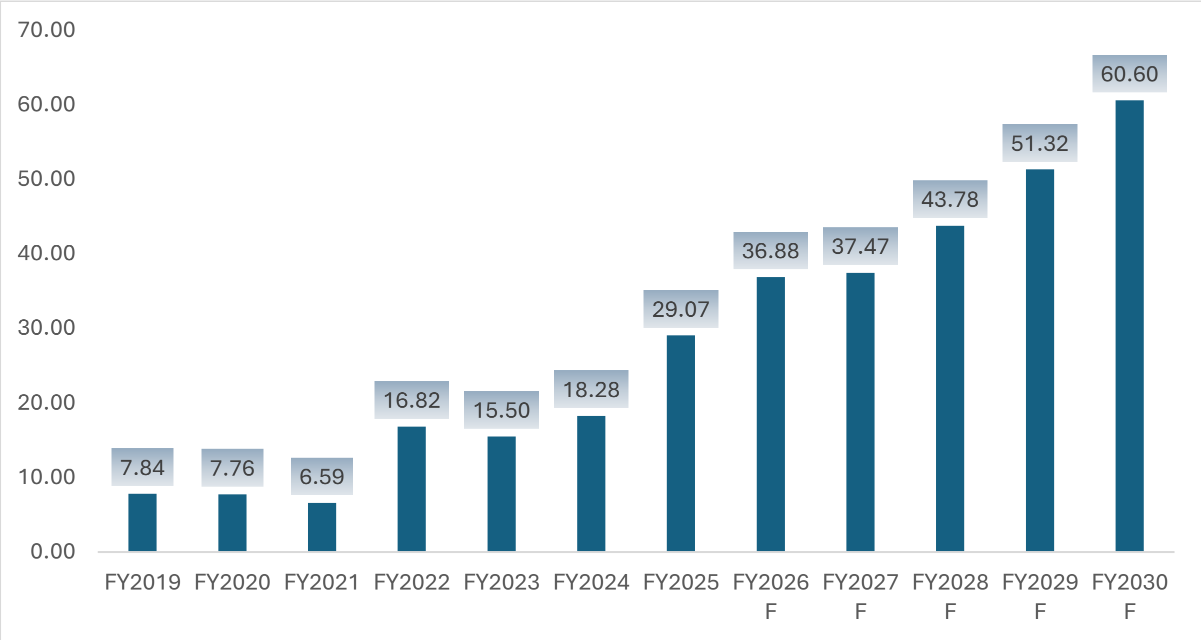
Source: SolarPower Europe, Expert interactions, IMARC, ICRA Analytics

India's solar cell consumption surged from 4.0 GW in FY2019 to 69.6 GW in FY2025, reflecting a robust CAGR of 60.9% over the period. This growth was driven by the rapid commissioning of grid-connected solar projects, rising demand from EPC developers, and an increasing shift toward domestically manufactured cells under the Make in India initiatives.

Looking ahead, solar cell consumption is expected to reach approximately 115.0 GW by FY2030, expanding at a CAGR of 10.5% during FY2026–FY2030. This outlook is supported by the continued development of integrated gigawatt-scale manufacturing hubs, escalating demand for advanced high-efficiency cell technologies, and the growing deployment of solar-plus-storage and hybrid renewable energy projects.

5.4.5 Market Size and Opportunity for Solar Cell and Modules Manufacturing

Chart: India: Solar Cell Manufacturing Capacity Trends and Forecast (in GW), FY2019-FY2030F

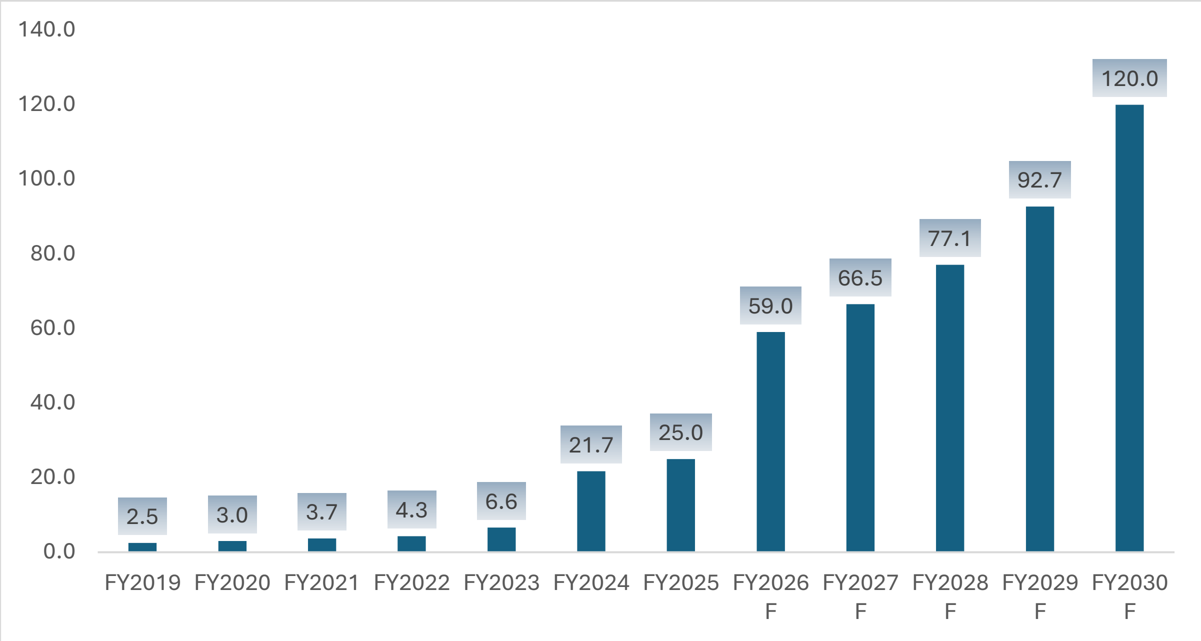


Source: Expert interactions, IMARC, ICRA Analytics

India's solar cell manufacturing capacity expanded significantly from 2.5 GW in FY2019 to 25.0 GW in FY2025, driven by investments in vertically integrated production lines, technology collaborations with leading global equipment suppliers and concerted efforts to reduce reliance on imported upstream components.

Looking ahead, solar cell manufacturing capacity is expected to reach nearly 120.0 GW by FY2030, supported by the scaling up of wafer-to-cell integration, accelerated adoption of advanced technologies such as TOPCon and HJT, and the development of a stronger domestic ecosystem for polysilicon, ingot, and wafer production.

Chart: India: Solar Module Manufacturing Capacity Trends and Forecast (in GW), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

India's solar module manufacturing capacity grew substantially from 6.0 GW in FY2019 to 100.0 GW in FY2025, supported by the development of large-scale manufacturing parks, capacity expansions by major domestic players, and a rise in export-oriented production aimed at global markets.

Looking ahead, solar module manufacturing capacity is expected to reach nearly 160.0 GW by FY2030, driven by continued investments in next-generation module technologies, greater automation and efficiency gains from scale and expanding export opportunities as global solar supply chains undergo diversification.

5.4.6 Overview of Integrated Solar Cell & Module Manufacturing Plants in India

- **Policy-Driven Expansion of Integrated Manufacturing:** India's integrated solar cell and module manufacturing landscape has witnessed substantial growth, supported by key policy interventions such as the Approved List of Models and Manufacturers (ALMM) framework and the Production Linked Incentive (PLI) schemes. The successive revisions to ALMM List-II for Solar PV Cells released by the Ministry of New & Renewable Energy between July 2025 and February 2026 offer a clear view of the rapidly evolving domestic manufacturing ecosystem. These updates reflect the accelerated scale-up of solar cell manufacturing across multiple states and the industry's increasing shift toward advanced cell architectures including Mono-PERC and N-type TOPCon bifacial designs.

- **Geographically Diverse Manufacturer Base Across Key States:** The initial ALMM List-II published in July 2025 featured several prominent domestic manufacturers with significant production capacities, including Emmvee Energy, Premier Energies, Mundra Solar entities, ReNew Photovoltaics, Jupiter International and FS India Solar Ventures. These manufacturing facilities are located across major industrial hubs such as Karnataka, Telangana, Gujarat, Himachal Pradesh and Tamil Nadu, illustrating a geographically diversified domestic manufacturing base. Most of these plants produce bifacial mono-crystalline PERC cells, while an increasing number have begun integrating

TOPCon technology signaling the industry's transition to higher-efficiency cell designs suited for next-generation solar modules.

- **Steady Capacity Expansion Reflected in ALMM Revisions:** Subsequent revisions from September 2025 to February 2026 highlighted continued expansion in integrated solar cell manufacturing capabilities, with the addition of new manufacturers and significant capacity upgrades. Major facilities such as TP Solar Ltd. (Tamil Nadu), Websol Energy System Ltd. (West Bengal), Waaree Energies (Gujarat), Evervolt Solar Technology India (Andhra Pradesh) and Fujiyama Power Systems (Uttar Pradesh) were included or expanded, with annual capacities ranging from several hundred megawatts to multi-gigawatt scale. The increasing inclusion of TOPCon and bifacial cell models across these revisions points to deeper technological integration and notable improvements in manufacturing efficiency across the country.

- **Emergence of Vertically Integrated Manufacturing Clusters:** The ALMM updates also reveal a strong movement toward vertically integrated manufacturing clusters, particularly in Gujarat (Mundra and Dholera), Telangana (Fab City) and the industrial corridors of Tamil Nadu and Andhra Pradesh. Within these clusters, manufacturers are increasingly aligning solar cell fabrication with module assembly and upstream component sourcing, creating integrated ecosystems that reduce dependence on imported wafers and cells. This shift strengthens supply-chain resilience, enhances operational efficiency, and supports India's long-term goal of building a self-reliant solar manufacturing base.

- **Shift Toward Advanced Cell Technologies:** Technologically, the integrated manufacturing facilities listed under ALMM are largely focused on producing bifacial Mono-PERC and N-type TOPCon solar cells, with efficiency levels generally exceeding 22% and designed to meet the performance requirements of high-efficiency modules. The presence of multiple operational and expanding TOPCon lines alongside continued Mono-PERC production underscores India's ongoing transition from conventional P-type technologies to next-generation, higher-efficiency architectures, positioning the country competitively in the global solar manufacturing landscape.

5.4.7 Prices of Solar PV Components

In 2025, the average market prices across the solar value chain stand at INR 1,482.7 per kg for solar ingots, INR 15.6 per unit for solar wafers, INR 4.7 per watt for solar cells, and INR 17.6 per watt for solar modules.

Table: India: Prices of Solar PV Components, 2025

Particulars	Unit	Price (in INR), 2025
Ingots	INR/Kg	1482.7
Solar Wafers	INR/Unit	15.6
Solar Cells	INR/Watt	4.7
Solar Modules	INR/Watt	17.6

Source: IMARC, ICRA Analytics

5.4.8 Solar Cell Technologies Used in India Currently and in Future

- **Mono-PERC (P-type):** Mono-crystalline Passivated Emitter and Rear Cell (Mono-PERC) technology continues to be the most widely used solar cell technology in India. It delivers higher efficiency than traditional multi-crystalline cells and is suitable for both utility-scale and rooftop installations. A large number of domestic manufacturers listed under the ALMM framework currently produce bifacial Mono-PERC cells owing to their proven reliability, cost-effectiveness and seamless compatibility with existing module production lines.

- **Bifacial Mono-PERC:** Bifacial Mono-PERC variants are increasingly preferred in utility-scale solar parks, as they can harness reflected light from the rear side, thereby boosting overall energy output. This technology is particularly advantageous in India's high-irradiance zones and ground-mounted projects, where albedo gains enhance system performance without significantly increasing costs.

- **N-type TOPCon:** Tunnel Oxide Passivated Contact (TOPCon) solar cells are rapidly gaining traction across new manufacturing facilities being established in India. Known for their higher efficiencies, reduced degradation and stronger high-temperature performance, TOPCon cells are well-suited to India's climatic conditions. Several newly listed ALMM manufacturers are transitioning toward N-type TOPCon bifacial cells, signalling an industry-wide move toward more advanced cell architectures.

- **Transition from P-type to N-type Technologies:** India's solar manufacturing sector is currently undergoing a gradual shift from conventional P-type Mono-PERC to more efficient N-type technologies such as TOPCon. This transition is driven by the growing need for higher module efficiencies, extended operational lifespans and enhanced energy yields particularly for large-scale solar parks and high-performance rooftop applications.

- **Heterojunction (HJT):** Heterojunction (HJT) solar cells are expected to gain momentum in India due to their superior efficiency and strong bifacial performance. Although still in early stages of adoption, commercial-scale initiatives have begun. Notably, Reliance Industries Limited has introduced its first 200 MW batch of HJT solar modules at the Dhirubhai Ambani Giga Energy Complex in Jamnagar, Gujarat. The facility is designed to manufacture high-efficiency modules of up to ~720 W, with plans to scale production to multi-gigawatt levels.

5.4.9 Comparison of MonoPerc, TopCon and HJT

Table: Comparison of Mono PERC, TOPCon, and HJT Solar Cell Technologies

Parameter	Mono PERC (Passivated Emitter Rear Cell)	TOPCon (Tunnel Oxide Passivated Contact)	HJT (Heterojunction Technology)
Technology Generation	Mature, conventional crystalline silicon upgrade	Next-generation evolution of PERC using passivated contacts	Advanced hybrid of crystalline + amorphous silicon layers
Commercial Efficiency	20–22%	22–24%	24–26% (premium range)

Parameter	Mono PERC (Passivated Emitter Rear Cell)	TOPCon (Tunnel Oxide Passivated Contact)	HJT (Heterojunction Technology)
Module Output Potential	Moderate	High	Very High
Temperature Performance	Moderate; higher losses in heat	Better heat tolerance; stable in hot climates	Best temperature coefficient; minimal heat losses
Low-Light Performance	Moderate	Better than PERC	Excellent performance in cloudy/low-light conditions
Degradation Rate	Relatively higher (LID/LeTID risks)	Lower degradation and better longevity	Very low degradation; >90% efficiency retention over long term
Manufacturing Complexity	Simple, established supply chain	Moderate; can retrofit existing PERC lines	Highly complex, requires new production lines
Cost Level	Lowest, most affordable	Moderate; good balance of cost vs efficiency	Highest upfront cost (premium technology)
Land/Space Efficiency	Moderate power density	Higher output per m^2	Highest output per m^2 (ideal for limited roof space)
Typical Applications	Budget residential and small commercial projects	Mainstream choice for residential, C&I, and utility-scale projects	Premium rooftops, industrial plants, space-constrained or high-performance installations
Market Trend (India)	Gradually declining share	Rapidly becoming mainstream technology	Growing in premium and industrial segments

Source: IMARC, ICRA Analytics

5.4.10 Complexities Involved in Solar Cell Manufacturing in India

- **Supply Chain Concentration and Import Dependence:** India remains significantly dependent on imported upstream materials such as polysilicon, ingots, and wafers, due to limited domestic manufacturing capacity in these segments. While solar cell and module production have expanded rapidly, the upstream value chain still lags, creating structural vulnerabilities. This dependence exposes manufacturers to global price fluctuations, exchange-rate movements, and potential supply-chain disruptions during periods of geopolitical tension or trade restrictions.

- **Certification Bottlenecks and Policy Uncertainty:** Regulatory compliance requirements particularly under the Approved List of Models and Manufacturers (ALMM) and the Bureau of Indian Standards (BIS) certification framework can create delays in product approvals and extend the time-to-market for new manufacturing capacities. Additionally, frequent adjustments in import duties, safeguard tariffs, and procurement policies have contributed to market uncertainty for both developers and manufacturers, complicating long-term investment decisions and project execution timelines.

- **Logistics and Infrastructure Gaps:** High logistics and transportation costs continue to pose significant operational challenges, particularly for manufacturing clusters located far from major ports or industrial corridors. Delivering modules, equipment, and balance-of-system components to remote project sites increases distribution expenses and puts additional pressure on project margins. Shortcomings in warehousing facilities and last-mile connectivity further hinder efficient supply-chain operations.

- **Capital-Intensive and Technology-Driven Manufacturing Requirements:** Solar cell manufacturing demands advanced semiconductor-grade infrastructure, such as diffusion furnaces, PECVD systems, metallization tools, and controlled clean-room environments. These capital-intensive requirements create high entry barriers and elevate financing risks for domestic firms. Moreover, rapid technological evolution from PERC to more advanced N-type technologies like TOPCon and HJT necessitates frequent production line upgrades. This continuous reinvestment heightens operational complexity and challenges the ability of manufacturers to remain globally competitive on efficiency and cost metrics.

6. Government Initiatives For Solar Sector in India

6.1 Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan (PM-KUSUM)

The PM-KUSUM scheme is a flagship initiative of the Government of India designed to promote solar energy adoption in the agricultural sector, reduce dependence on diesel for irrigation, and enhance farmers' income through decentralised renewable power generation. The scheme allows inter-se transfer of quantities between Component B and Component C and aims to add around 34,800 MW of solar capacity by March 2026, with total central financial assistance of INR 34,422 crore. It is implemented through designated state government departments and DISCOMs.

The scheme comprises three major components:

Component A envisages the establishment of 10,000 MW of decentralised, grid-connected renewable energy power plants (ranging from 500 kW to 2 MW) on barren or fallow land owned by farmers, cooperatives, panchayats, FPOs, or WUAs. These plants supply electricity to DISCOMs at feed-in tariffs determined by the respective State Electricity Regulatory Commissions. DISCOMs are eligible for Performance-Based Incentives (PBI) of INR 0.40 per unit purchased or INR 6.6 lakh per MW (whichever is lower) for a period of five years.

Component B supports the installation of 14 lakh standalone solar agricultural pumps in off-grid areas. Central Financial Assistance (CFA) of 30% of the benchmark or tender cost is provided, along with a minimum 30% subsidy from state governments. The remaining share of up to 40% is borne by farmers, typically supported through bank loans, thereby reducing their upfront contribution to around 10%. In special category states and regions (Northeastern States, J&K, Ladakh, Himachal Pradesh, Uttarakhand, Lakshadweep, and Andaman & Nicobar Islands), the CFA is increased to 50%, limiting the farmer contribution to a maximum of 20%.

Component C targets the solarisation of 35 lakh grid-connected agricultural pumps through two sub-components: Individual Pump Solarisation (IPS) and Feeder Level Solarisation (FLS). Under IPS, farmers can install solar PV capacity of up to twice the pump rating, enabling them to meet irrigation requirements and sell surplus power to DISCOMs. Under FLS, entire agricultural feeders are solarised under CAPEX or RESCO models for a period of 25 years, ensuring reliable daytime power supply. CFA of 30% (up to INR 1.05 crore per MW) is available for feeder solarisation, which increases to 50% (up to INR 1.75 crore per MW) in special category states.

As of 31 January 2026, implementation progress indicates that Component A has achieved installation of approximately 7.7% of the sanctioned 10,000 MW capacity. Under Component B, about 75.6% of the sanctioned 13.3 lakh standalone solar pumps have been installed. For Component C, nearly 22.2% of the targeted pumps have been solarised under IPS, while around 36.9% progress has been achieved under FLS. These Charts highlight strong progress in standalone pump deployment, while feeder-level and decentralised plant solarisation continue to scale up across states.

6.2 Magel Tyala Saur Krushi Pump Scheme (Maharashtra)

The Magel Tyala Saur Krushi Pump Yojana is a flagship initiative by the Government of Maharashtra aimed at promoting solar-powered irrigation and ensuring reliable daytime electricity for farmers. The scheme supports the installation of feeder-separated solar agricultural pumps, enabling farmers to shift from grid or diesel-based irrigation to clean, renewable energy.

On January 30, 2026, the Maharashtra government approved INR 1,105.58 crore as state subsidy for the 2025-26 financial year, to be disbursed through the Maharashtra State Electricity Distribution Company Limited (MSEDCL). The subsidy forms part of a larger plan to implement 5 lakh solar agricultural pumps over five years. As of October 2025, 1.52 lakh solar pumps had already been installed across the state.

The project is financed through a combination of state budgetary support and international funding, with 60% of the total project cost raised as market loans from the Asian Infrastructure Investment Bank (AIIB). The remaining cost is covered through government subsidy. For the period 2024–28, the state has approved a total subsidy outlay of INR 4,817.97 crore. Repayment of the AIIB loans, along with interest, is planned between 2029 and 2043, through additional electricity duty collections and the Green Energy Fund.

The scheme has already demonstrated record-breaking implementation capabilities. In December 2025, Maharashtra installed 45,911 off-grid solar agricultural pumps within 30 days, a feat recognised as a new world record by the Guinness World Records. This milestone reflects both the scale of demand and the operational efficiency of the program.

The scheme targets farmers across the state, providing them with off-grid solar pumps ranging in capacity to meet irrigation needs. These pumps help ensure uninterrupted daytime power supply, eliminate reliance on diesel pumps, reduce electricity costs, and promote sustainable agricultural practices

6.3 Grid Connected Rooftop Solar Programme

❖ The Grid Connected Rooftop Solar Programme, implemented by the Ministry of New and Renewable Energy (MNRE), seeks to achieve a cumulative rooftop solar capacity of 40 GW by 31 March 2026, with a strong emphasis on accelerating adoption within the residential segment across India.

❖ Under Phase II of the programme, Central Financial Assistance (CFA) is extended to residential consumers. In general-category states, CFA of INR 14,588 per kW is provided for the first 3 kW and INR 7,294 per kW for additional capacity beyond 3 kW up to 10 kW. For special-category states and Union Territories, higher CFA rates of INR 17,662 per kW for the first 3 kW and INR 8,831 per kW for capacity beyond 3 kW are applicable.

❖ The subsidy is transferred directly to the beneficiary's bank account upon successful commissioning and verification of the installation, ensuring transparency in disbursement while significantly lowering the upfront investment required from households.

❖ The programme is administered through a dedicated national online portal in coordination with state DISCOMs, enabling a seamless process for application submission, technical approval, installation, and subsidy release, thereby enhancing ease of access and expediting rooftop solar deployment.

❖ In addition to reducing electricity expenses for consumers, the programme advances India's clean energy objectives by lowering carbon emissions, expanding distributed renewable generation, and strengthening long-term energy security through deeper integration of solar power into the grid.

6.4 PM Surya Ghar: Muft Bijli Yojana

PM Surya Ghar: Muft Bijli Yojana is a flagship initiative of the Government of India, launched on 13 February 2024, with a total financial allocation of INR 75,021 crore. The scheme seeks to equip one crore households nationwide with rooftop solar systems, allowing beneficiaries to access up to 300 units of free electricity each month. It represents a key component of India's clean energy transition and aligns with the country's broader goals of lowering carbon emissions and progressing toward net-zero commitments. Under the programme, households receive capital subsidies for installing rooftop solar systems, with financial assistance covering up to 40% of the installation cost, depending on system capacity. By encouraging decentralized solar power generation at the household level, the initiative reduces reliance on conventional grid electricity, decreases consumer electricity expenses, and helps lower the government's long-term subsidy burden. Additionally, it promotes the expansion of distributed solar capacity and enhances energy security through localized renewable power generation.

As of December 2025, the scheme has demonstrated substantial progress. Approximately 23.9 lakh households have installed rooftop solar systems, creating nearly 7 GW of clean energy capacity. Subsidy disbursements have reached around INR 13,464.6 crore, reflecting consistent scaling of the programme and positioning it well to meet its objective of covering one crore homes.

The initiative delivers several advantages, such as providing free electricity to participating households, easing the government's electricity subsidy load, encouraging greater adoption of residential renewable energy, and significantly cutting carbon emissions. Through a combination of financial support and rooftop solar expansion, PM Surya Ghar is steadily establishing itself as a major catalyst for the growth of distributed renewable energy within India's power sector.

Suitable Rooftop Solar Plant Capacity for Households

Average Monthly Electricity Consumption (units)	Suitable Rooftop Solar Plant Capacity	Subsidy Support
0-150	1-2 kW	INR 30,000 - INR 60,000
150-300	2-3 kW	INR 60,000 - INR 78,000
>300	Above 3 kW	Up to INR 78,000

6.4 Production Linked Incentive (PLI) Scheme for Solar PV Modules

6.4.1 Progress of PLI Scheme

The Production Linked Incentive (PLI) Scheme for Solar PV Modules, administered by the Ministry of New and Renewable Energy (MNRE), is a major industrial initiative designed to establish giga-watt scale domestic manufacturing capacity for high-efficiency solar PV modules and to reduce India's dependence on imports. Introduced under the National Programme on High Efficiency Solar PV Modules, the scheme carries a total financial allocation of INR 24,000 crore. It offers performance-based incentives for five years post-commissioning, linked to actual sales of modules, their efficiency standards, and the degree of domestic value addition. This framework promotes the development of integrated manufacturing capabilities across the entire solar value chain within the country.

The programme has been implemented in two phases. Tranche I, sanctioned in April 2021 with an allocation of INR 4,500 crore, aimed at creating an initial base of high-efficiency module manufacturing capacity. Tranche II, approved in September 2022 with a larger outlay of INR

19,500 crore, broadened the scope to encourage fully integrated facilities encompassing polysilicon, ingots, wafers, cells, and modules. Through a transparent competitive bidding process, Letters of Award have been granted for establishing nearly 48,337 MW of integrated and semi-integrated solar PV manufacturing capacity, representing a significant move toward strengthening India's self-reliant solar manufacturing ecosystem.

Progress of the PLI Scheme

Since its inception, the PLI scheme has attracted substantial investment interest and firm capacity commitments. As of June 2025, total investments under the scheme amounted to approximately INR 48,120 crore, generating around 38,500 jobs across manufacturing units. By September 2025, cumulative investments had risen to nearly INR 52,900 crore, while employment creation increased to about 44,400 jobs, indicating rapid project execution and expansion of integrated production facilities.

The incentive mechanism is directly tied to efficiency benchmarks and domestic content requirements, encouraging manufacturers to adopt advanced technologies and enhance value addition within India's solar PV supply chain. As projects under both tranches advance toward commissioning, the scheme is expected to substantially boost domestic production of high-efficiency solar cells and modules, reinforce supply chain resilience, and contribute to long-term energy security, while positioning India as a competitive global hub for solar PV manufacturing.

6.4.2 Focus of PLI Scheme (Majorly for Integrated Facilities like Cells, Modules and Wafers)

- The PLI Scheme for High Efficiency Solar PV Modules has been strategically structured to encourage end-to-end integration within the solar manufacturing value chain—covering polysilicon, wafers, cells, and modules. This approach is intended to enhance domestic value addition and curb reliance on imports. Under Tranche-II, bidding categories were clearly defined into integration "baskets" according to the level of backward integration: Polysilicon + Wafer + Cell + Module (P+W+C+M), Wafer + Cell + Module (W+C+M), and Cell + Module (C+M). Proposals demonstrating deeper integration were accorded higher incentives and preferential ranking, thereby incentivizing comprehensive manufacturing capabilities.

- The scheme offers performance-based incentives for a period of five years following commissioning, linked to actual sales of high-efficiency solar modules, thus promoting sustained large-scale production. Existing brownfield facilities are eligible to receive incentives at 50% of the rate applicable to greenfield projects, encouraging the expansion and modernization of current manufacturing units alongside the development of new integrated plants.

- In alignment with MNRE's broader policy objectives, the initiative seeks to establish giga-watt scale domestic manufacturing capacity for high-efficiency solar PV modules. It aims to attract advanced, technology-neutral manufacturing processes and support the creation of integrated facilities that improve quality assurance, strengthen supply chain robustness, and enhance global cost competitiveness. Additionally, the scheme is designed to foster a domestic supply ecosystem for raw materials and components, create employment opportunities, and advance technological self-reliance within India's renewable energy landscape.

Table 8: Capacity Awarded under PLI Scheme (Tranche-II)

P+W+C+M Basket (Polysilicon + Wafer + Cell + Module)		

Sr. No.	Name of Bidder	Manufacturing Capacity (MW)
1	Indosol	6,000
2	Reliance	6,000
3	First Solar	3,400
Total		**15,400**
W+C+M Basket (Wafer + Cell + Module)		
Sr. No.	**Name of Bidder**	**Manufacturing Capacity (MW)**
1	Waaree	6,000
2	Avaada	3,000
3	ReNew	4,800
4	JSW	1,000
5	Grew	2,000
Total		**16,800**

C+M Basket (Cell + Module)		
Sr. No.	**Name of Bidder**	**Manufacturing Capacity (MW)**
1	Vikram	2,400
2	AMPIN	1,000
3	Tata Power Solar	4,000
Total		7,400
Grand Totals		**39,600**

Source: Press Information Bureau (PIB), ICRA Analytics

6.5 State-wise Solar Subsidy Scheme

6.5.1 Rajasthan

- In Rajasthan, rooftop solar deployment is largely driven by the central financial assistance available under the PM Surya Ghar: Muft Bijli Yojana. The state primarily adheres to the national framework and does not provide a comprehensive, independent capital subsidy of its own.

- While a substantial standalone capital subsidy is not offered at the state level, the government facilitates implementation through expedited approval procedures, simplified net-metering processes, and improved coordination with DISCOMs such as Jaipur Vidyut Vitran Nigam Limited. These measures have helped accelerate rooftop solar uptake, particularly in urban centres like Jaipur.

- Net-metering mechanisms are active across Rajasthan, allowing consumers to feed surplus power back into the grid. This enhances project viability by shortening payback periods and encourages broader participation from residential, commercial, and industrial consumers alike.

- Furthermore, the state government provides targeted assistance of approximately INR 17,000 to eligible households installing rooftop solar systems under its free electricity scheme (150 units per month). This support is extended in addition to the central subsidy of up to INR 78,000, substantially reducing the effective installation cost. As a result, small residential systems (around 1–1.1 kW) can be installed with minimal or near-zero upfront expenditure, thereby promoting solar adoption and advancing Rajasthan's clean energy and emission reduction objectives.

6.5.2 Gujarat

- Gujarat ranks among the top states in India in terms of rooftop solar adoption, driven by a combination of central financial assistance under the PM Surya Ghar: Muft Bijli Yojana and an additional state-level subsidy programme. The state offers support of approximately INR

10,000 per kW (up to 3 kW), which supplements the central subsidy (up to around 40% for smaller residential systems), thereby substantially reducing the initial installation cost for households.

- The state's forward-looking renewable energy policies, well-developed solar ecosystem, and strong consumer awareness have facilitated quicker rooftop solar expansion compared to many other regions. By complementing MNRE incentives with state-level assistance, Gujarat enhances affordability and improves project payback periods, making rooftop solar a financially compelling option for residential users.
- Well-established net metering regulations further enhance the attractiveness of rooftop solar in the state, enabling consumers to feed surplus power into the grid and earn bill credits. Simplified approval and grid interconnection procedures help shorten installation timelines and encourage wider adoption, particularly across urban and semi-urban areas.
- Support from the Gujarat Energy Development Agency (GEDA) is instrumental in effective implementation, public awareness initiatives, and vendor empanelment. However, as the state subsidy is subject to limited annual allocations, prospective applicants are generally encouraged to apply early to secure eligibility and timely approval of benefits.

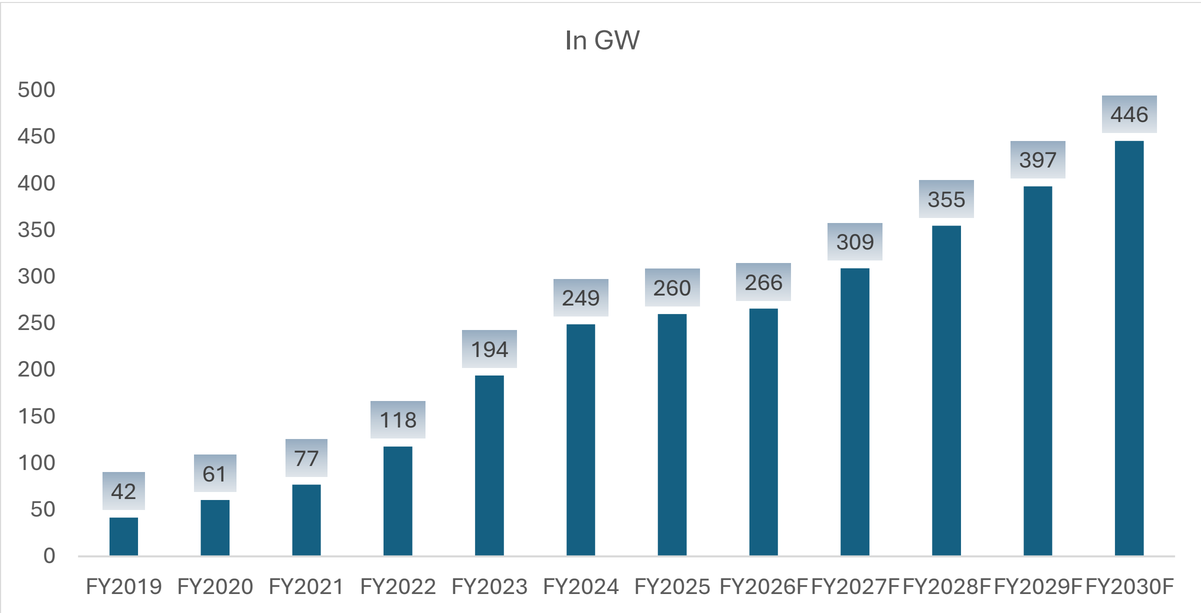
6.5.3 Tamil Nadu

- In Tamil Nadu, the growth of rooftop solar installations is largely supported by central incentives under the PM Surya Ghar: Muft Bijli Yojana, which provides subsidies of up to around 40% for smaller residential systems. With earlier state-specific subsidies having been reduced, central financial assistance now serves as the primary catalyst for residential rooftop solar adoption in the state.
- State support is currently more indirect in nature, with benefits largely channelled through group housing societies and community-based solar projects rather than individual household subsidies. This strategy promotes collective participation and efficient use of rooftop space, particularly in densely populated urban areas.
- On-ground implementation is overseen by state DISCOMs, especially the Tamil Nadu Generation and Distribution Corporation (TANGEDCO), which handles application processing, grid connectivity, and subsidy disbursement in alignment with central solar schemes.
- Operational net metering provisions further enhance rooftop solar uptake by enabling consumers to supply excess power to the grid in exchange for billing credits. The proactive involvement of DISCOMs and streamlined interconnection processes have contributed to maintaining consistent growth in residential rooftop solar installations, even in the absence of substantial direct state-level capital subsidies.

7. Rooftop Solar Market

7.1 Global consumption trend

Chart: Global: Rooftop Solar Market: Installation Trends (in GW), CY2019-CY2030F



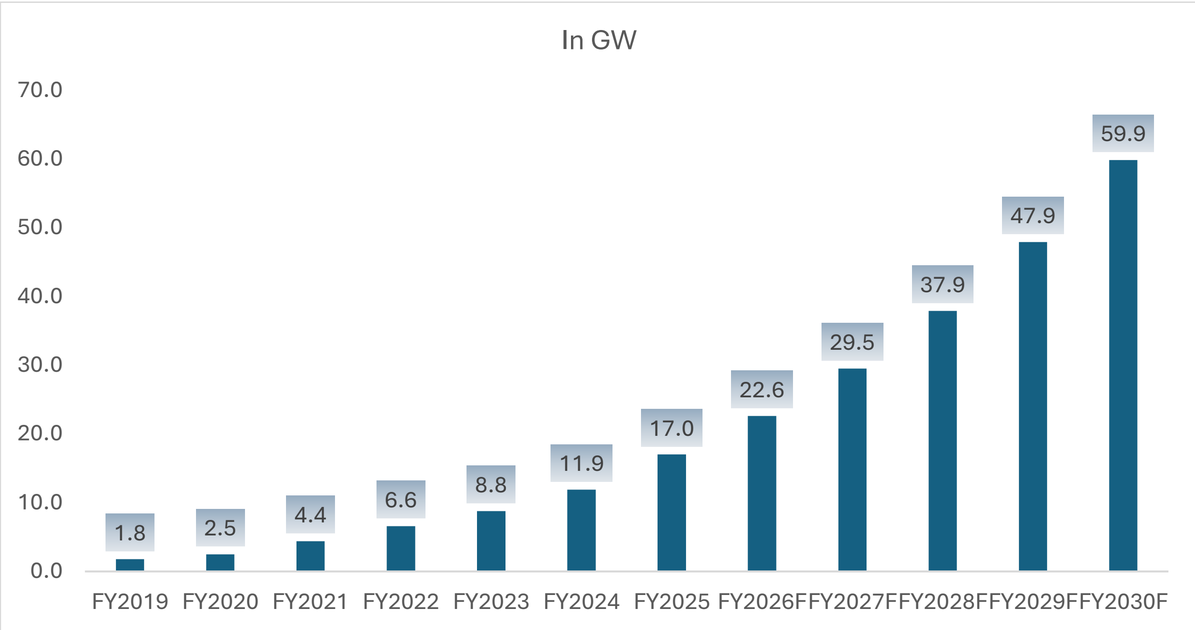
Source: SolarPower Europe, Expert interactions, IMARC, ICRA Analytics

India's per capita electricity consumption has climbed from 1,181 kWh in FY2019 to 1,460 kWh in FY2025, and it is expected to rise further to 1,847 kWh by FY2030. This steady increase reflects broader electrification, near-universal household connectivity, rapid urban development, and growing industrial and commercial usage. Rising incomes, more frequent and intense heatwaves boosting cooling, and increasing adoption of home appliances and electric vehicles are also contributing to this sustained upward trend.

Looking ahead, continued economic growth, large-scale infrastructure development, expansion of digital services, and deeper electrification in manufacturing and transportation are likely to push electricity consumption even higher. These factors collectively reinforce the long-term growth trajectory of India's per capita power usage.

7.2 Market size of Rooftop Solar in India

Chart: India: Rooftop Solar Market: Installed Capacity Trends (in GW), FY2019-FY2030F



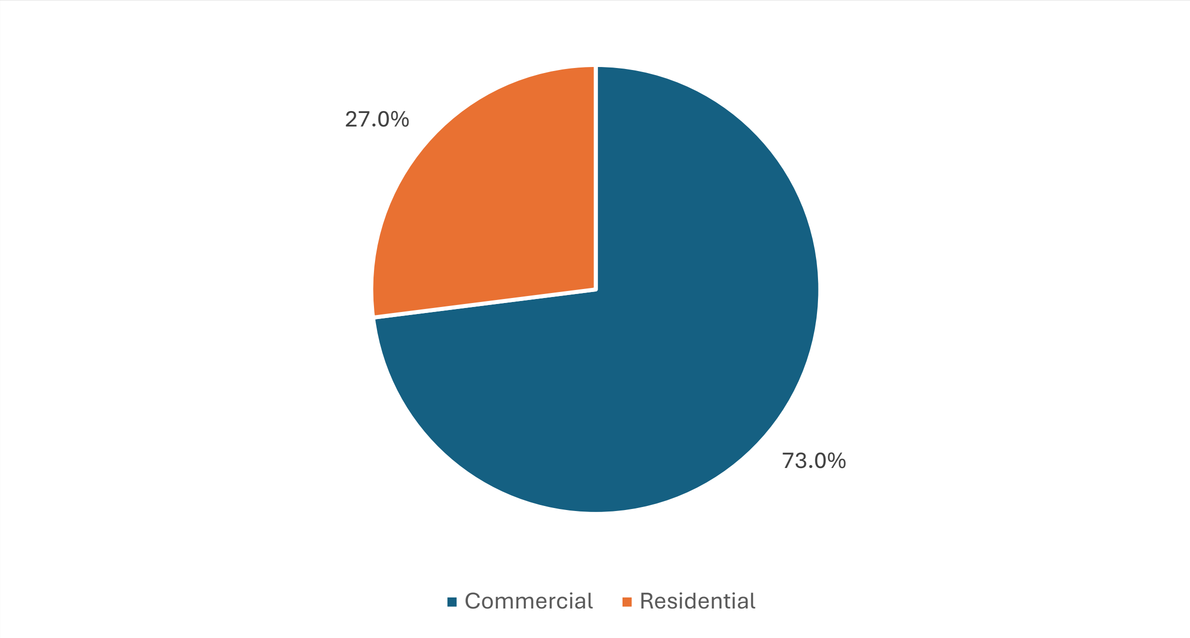
Source: SolarPower Europe, Expert interactions, IMARC, ICRA Analytics

Rooftop solar installations in India have grown rapidly, increasing from 1.8 GW in FY2019 to 17.0 GW in FY2025, reflecting a strong CAGR of 45.4% over the period. This surge has been supported by government-led initiatives such as Ministry of New and Renewable Energy (MNRE's) rooftop schemes and the PM Surya Ghar programme, alongside rising retail power tariffs, improved net-metering policies, and growing consumer awareness about long-term savings from on-site solar generation.

Looking ahead, rooftop solar capacity in the country is expected to reach about 59.9 GW by FY2030, implying a CAGR of 27.5% during FY2026-FY2030. The optimistic growth outlook is underpinned by continued policy support, fast-paced urban development, expanding rooftop potential across commercial and industrial buildings, and the increasing uptake of distributed renewable systems paired with energy storage and smart management technologies.

7.3 Market split by commercial and residential applications

Chart: India: Rooftop Solar Market: Breakup by Commercial and Residential Applications (in %), FY2025



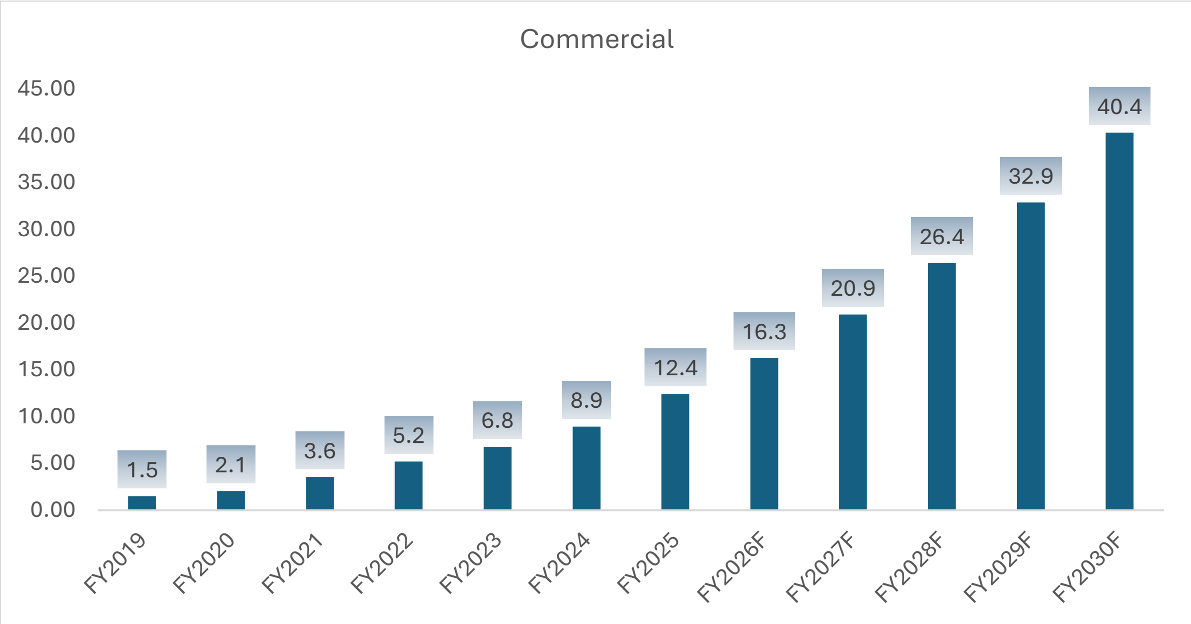
Source: Ministry of New and Renewable Energy (MNRE), IMARC, ICRA Analytics

In FY2025, commercial represented the largest application for rooftop solar market in India, accounting for a share of 73.0% (12.42 GW) of the total market.

On the other hand, residential accounted for the remaining 27.0% (4.60 GW) of the total market.

7.3.1 Commercial

Chart: India: Rooftop Solar (Commercial) Market: Installed Capacity Trends (in GW), FY2019-FY2030F



Source: Ministry of New and Renewable Energy (MNRE), IMARC, ICRA Analytics

Rooftop solar installed capacity in the commercial segment in India increased from 1.51 GW in FY2019 to 12.42 GW in FY2025, registering a strong CAGR of 42.1% during FY2019-FY2025. Growth has been driven by rising grid tariffs for C&I consumers, corporate decarbonization and ESG commitments, and the need for reliable and cost-competitive captive power solutions.

Going forward, commercial rooftop installed capacity is projected to expand to 40.36 GW by FY2030, growing at a CAGR of 25.5% during FY2026-FY2030. The growth is supported by increasing renewable procurement targets of large enterprises, expansion of MSME and commercial infrastructure, and favourable net-metering and open-access frameworks improving project economics.

7.3.2 Residential

Chart: India: Rooftop Solar (Residential) Market: Installed Capacity Trends (in GW), FY2019-FY2030F

Source: Ministry of New and Renewable Energy (MNRE), IMARC, ICRA Analytics

The residential rooftop solar segment grew from 0.29 GW in FY2019 to 4.60 GW in FY2025, recording a higher CAGR of 58.2% during FY2019-FY2025. This growth has been primarily supported by central subsidy schemes such as PM Surya Ghar, direct benefit transfers, and rising consumer awareness of long-term electricity bill savings.

The segment is projected to reach 19.52 GW by FY2030, growing at a CAGR of 32.4% during FY2026-FY2030. The market is expected to be driven by continued policy incentives, digitalized DISCOM approval processes, increasing urban housing development, and the adoption of distributed solar-plus-storage solutions to enhance household energy independence.

7.4 Long term drivers for growth

Large-scale National Missions and Subsidy-backed Residential Adoption: India's rooftop solar growth continues to be propelled by major national missions and strong policy momentum. Flagship initiatives like PM Surya Ghar are central to this push, aiming to equip one crore households with rooftop solar systems and offer up to 300 units of free electricity per month. Supported by substantial budget allocations and direct benefit transfers, the programme has already enabled lakhs of households to adopt rooftop solar by late 2025. This widespread uptake signals a strong project pipeline and ensures steady residential-segment growth in the coming decade.

Strong Policy Push and Innovation-led Ecosystem: Policy momentum and innovation are further strengthening the sector. Ongoing efforts by the Ministry of New and Renewable Energy including the INR 2.3 crore Startup Innovation Challenge for rooftop and distributed renewables are fostering affordability, resilience, and inclusive clean-energy solutions. These initiatives work in tandem with major programmes such as the PM Surya Ghar: Muft Bijli Yojana and the National Solar Mission, offering subsidies, incubation support, pilot deployments, and simplified approval procedures to accelerate rooftop solar adoption at scale.

Rising Electricity Tariffs and Consumer Focus on Energy Savings: Rising electricity prices across residential, commercial, and industrial categories are making rooftop solar increasingly attractive. Consumers are turning to solar installations as a long-term hedge against escalating tariffs, benefiting from shorter payback periods and substantial lifetime cost savings. This shift is reinforcing the economic case for distributed solar solutions nationwide.

Urbanization, ESG Commitments, and Commercial Rooftop Potential: Rapid urban expansion, growing ESG commitments, and untapped capacity in the commercial and industrial (C&I) rooftop segment are also driving adoption. The growth of housing societies, commercial complexes, MSME clusters, and industrial parks is expanding available rooftop space. Meanwhile, corporations with decarbonization and sustainability goals are increasingly deploying captive solar solutions. For example, Coal India Limited has set a target to install 3,000 MW of renewable solar capacity by FY2028 to achieve net-zero status. By December 2025, it had commissioned about 247 MW, with capacity expected to increase to 675 MW by the end of the fiscal year, supported by major upcoming installations such as a 100 MW plant in Patan and a 300 MW project in Khavda, Gujarat.

India's rooftop solar growth continues to be propelled by major national missions and strong policy momentum. Flagship initiatives like PM Surya Ghar are central to this push, aiming to equip one crore households with rooftop solar systems and offer up to 300 units of free electricity per month. Supported by substantial budget allocations and direct benefit transfers, the programme has already enabled lakhs of households to adopt rooftop solar by late 2025. This widespread uptake signals a strong project pipeline and ensures steady residential-segment growth in the coming decade.

Net Metering Reforms and DISCOM-led Implementation Support: Policy momentum and innovation are further strengthening the sector. Ongoing efforts by the Ministry of New and Renewable Energy including the INR 2.3 crore Startup Innovation Challenge for rooftop and distributed renewables are fostering affordability, resilience, and inclusive clean-energy solutions. These initiatives work in tandem with major programmes such as the PM Surya Ghar: Muft Bijli Yojana and the National Solar Mission, offering subsidies, incubation support, pilot deployments, and simplified approval procedures to accelerate rooftop solar adoption at scale.

Declining Technology and Installation Costs: Rising electricity prices across residential, commercial, and industrial categories are making rooftop solar increasingly attractive. Consumers are turning to solar installations as a long-term hedge against escalating tariffs, benefiting from shorter payback periods and substantial lifetime cost savings. This shift is reinforcing the economic case for distributed solar solutions nationwide.

Affordable Financing-led Rooftop Solar Models: Rapid urban expansion, growing ESG commitments, and untapped capacity in the commercial and industrial (C&I) rooftop segment are also driving adoption. The growth of housing societies, commercial complexes, MSME clusters, and industrial parks is expanding available rooftop space. Meanwhile, corporations with decarbonization and sustainability goals are increasingly deploying captive solar solutions. For example, Coal India Limited has set a target to install 3,000 MW of renewable solar capacity by FY2028 to achieve net-zero status. By December 2025, it had commissioned about 247 MW, with capacity expected to increase to 675 MW by the end of the fiscal year, supported by major upcoming installations such as a 100 MW plant in Patan and a 300 MW project in Khavda, Gujarat.

7.5 Utility-Led Aggregation (ULA) Scheme Driving Rooftop Solar Adoption

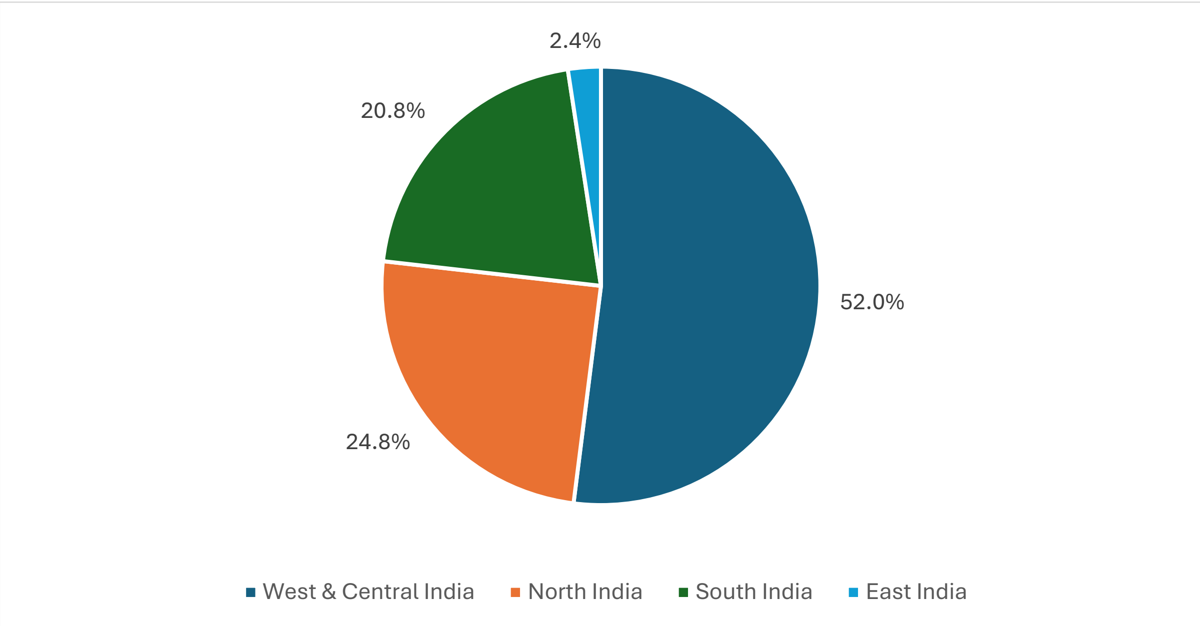
The Utility-Led Aggregation (ULA) model is a key initiative aimed at accelerating rooftop solar (RTS) adoption, particularly in the residential segment. Under this model, state entities such as government agencies and DISCOMs are empowered to install rooftop solar systems on behalf of individual consumers by leveraging existing funds and resources. The structure of the model including ownership (customer-owned or developer-owned), asset transfer after a defined period (typically five years), and billing mechanisms is determined by the respective DISCOM.

The ULA framework enables aggregation of dispersed residential demand, allowing projects to be implemented at scale through an Engineering, Procurement, and Construction (EPC) approach. This aggregation helps achieve economies of scale, reduce installation costs, and streamline execution. Additionally, it allows DISCOMs to source power from a distributed network of prosumers without fully owning or maintaining the assets.

The model is conceptually similar to large-scale power procurement mechanisms used in utility-scale solar and wind projects, with competitive bidding playing a central role. By introducing standardized procurement and execution processes, the ULA scheme enhances transparency, efficiency, and scalability in rooftop solar deployment.

The ULA model is expected to provide a significant push to rooftop solar adoption in India by simplifying implementation, improving accessibility for residential users, and enabling DISCOM participation in distributed renewable energy expansion

7.6 Geographical Analysis of Rooftop Solar Market in India



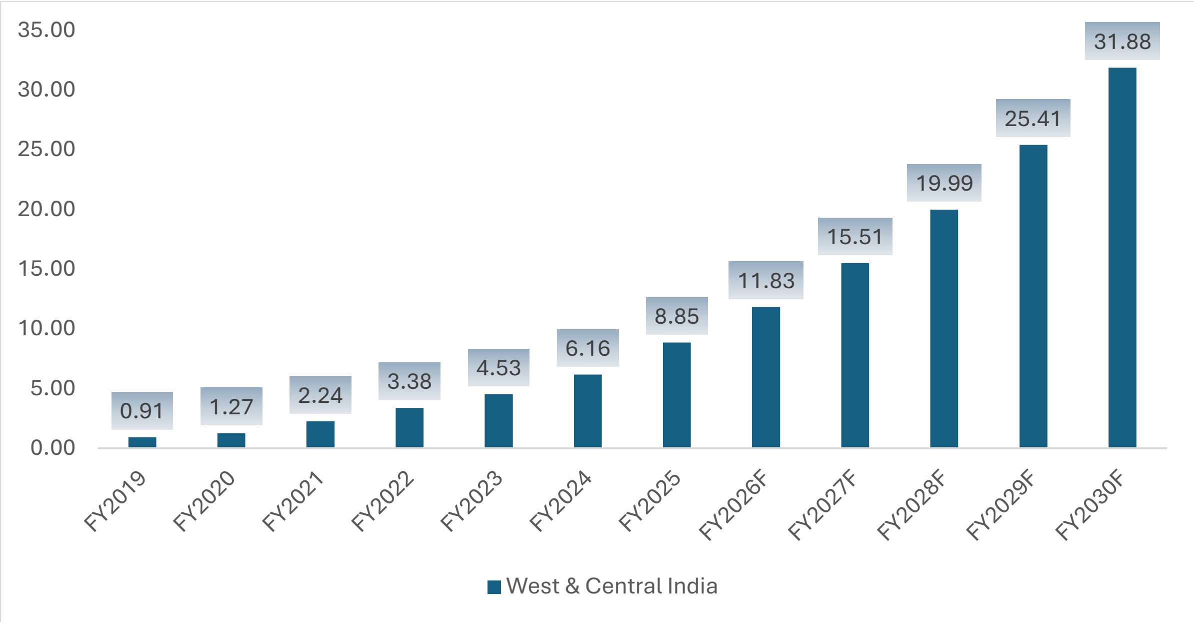
Source: Ministry of New and Renewable Energy (MNRE), IMARC, ICRA Analytics

In FY2025, West & Central India represented the largest market for rooftop solar market in India, accounting for a share of 52.0% (8.85 GW) of the total market.

West & Central India was followed by North India (24.8%) (4.22 GW), South India (20.8%) (3.54 GW), and East India (2.4%) (0.41 GW).

7.6.1 West & Central India

Chart: West & Central India: Rooftop Solar Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



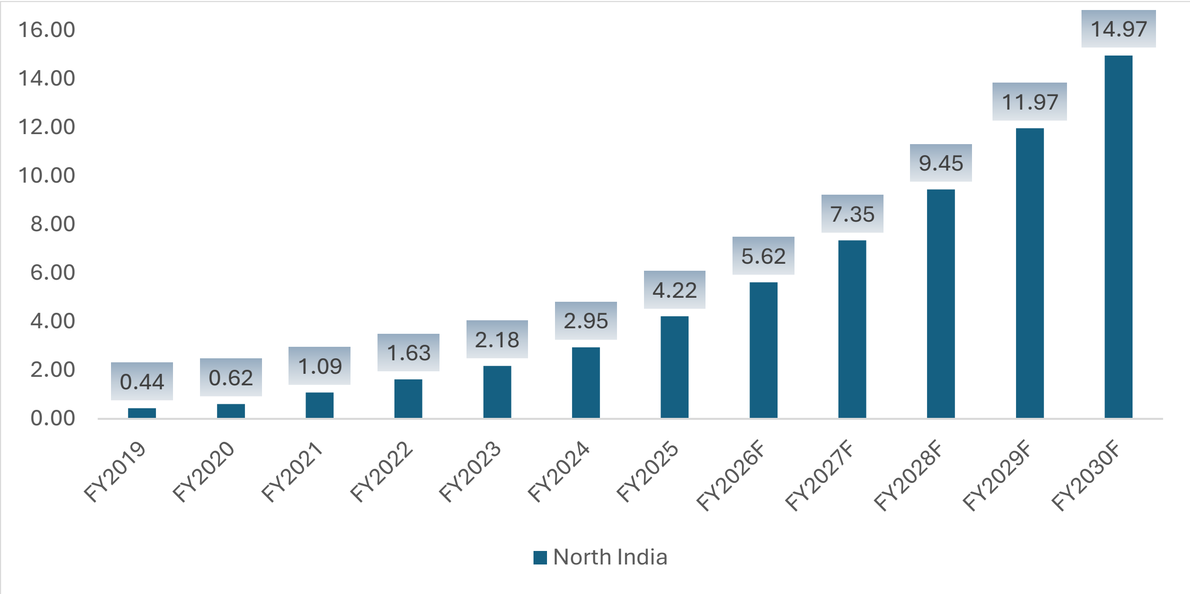
Source: Ministry of New and Renewable Energy (MNRE), Expert interactions, IMARC, ICRA Analytics

Rooftop solar installed capacity in West & Central India increased from 0.91 GW in FY2019 to 8.85 GW in FY2025, recording a CAGR of 46.1% during FY2019-FY2025. The region leads due to high solar irradiance, strong industrial and commercial presence, and supportive state policies in Gujarat and Maharashtra. Going forward, capacity is projected to reach 31.88 GW by FY2030, expanding at a CAGR of 28.1% during FY2026-FY2030, driven by rising C&I adoption, large rooftop availability, and continued policy support.

Initiatives such as the Surya Gujarat scheme have positioned Gujarat as a powerhouse in residential rooftop solar adoption. Strong state subsidies, DISCOM support, and high consumer awareness across western states are accelerating distributed solar deployment, reinforcing West & Central India's leadership in rooftop capacity additions.

7.6.2 North India

Chart: North India: Rooftop Solar Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



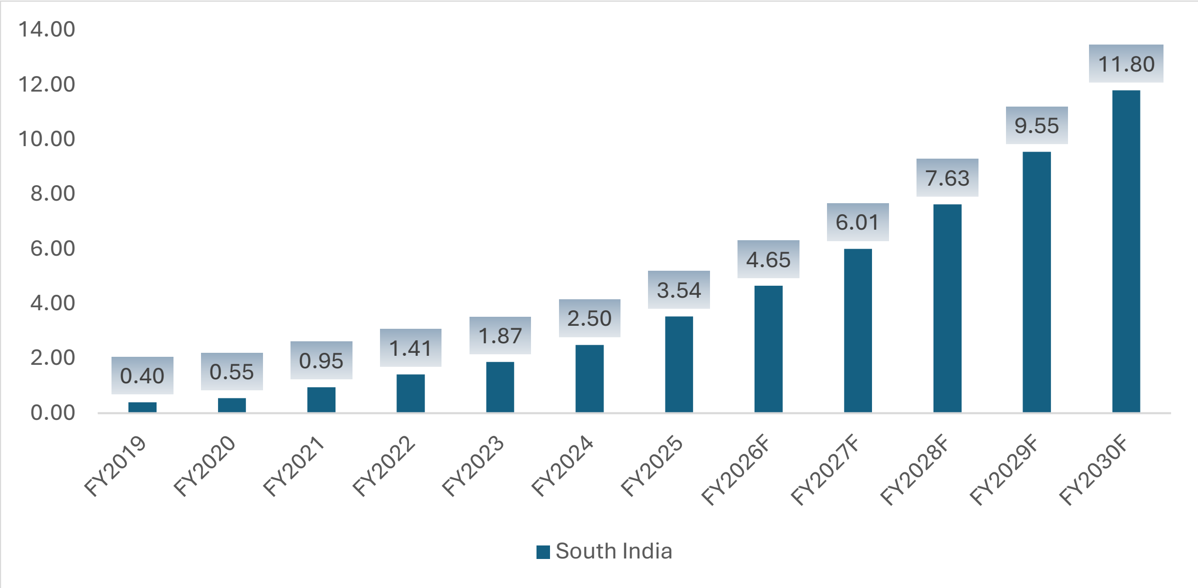
Source: Ministry of New and Renewable Energy (MNRE), Expert interactions, IMARC, ICRA Analytics

North India's rooftop solar installed capacity rose from 0.44 GW in FY19 to 4.22 GW in FY2025, growing at a CAGR of 45.6% during FY2019-FY2025. Growth has been supported by increasing residential adoption, government rooftop schemes, and rising electricity tariffs encouraging self-consumption. The market is expected to reach 14.97 GW by FY2030, registering a CAGR of 27.7% during FY2026-FY2030, supported by urban rooftop expansion and DISCOM-led implementation under central schemes.

Government-led solarization drives in northern states, exemplified by the recent plan to install rooftop solar across ~1,000 public buildings in Delhi by the Government of Delhi, are accelerating institutional rooftop demand. Such large-scale public sector deployments enhance grid-connected distributed capacity while creating strong demonstration effects for residential and commercial adoption across North India.

7.6.3 South India

Chart: South India: Rooftop Solar Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



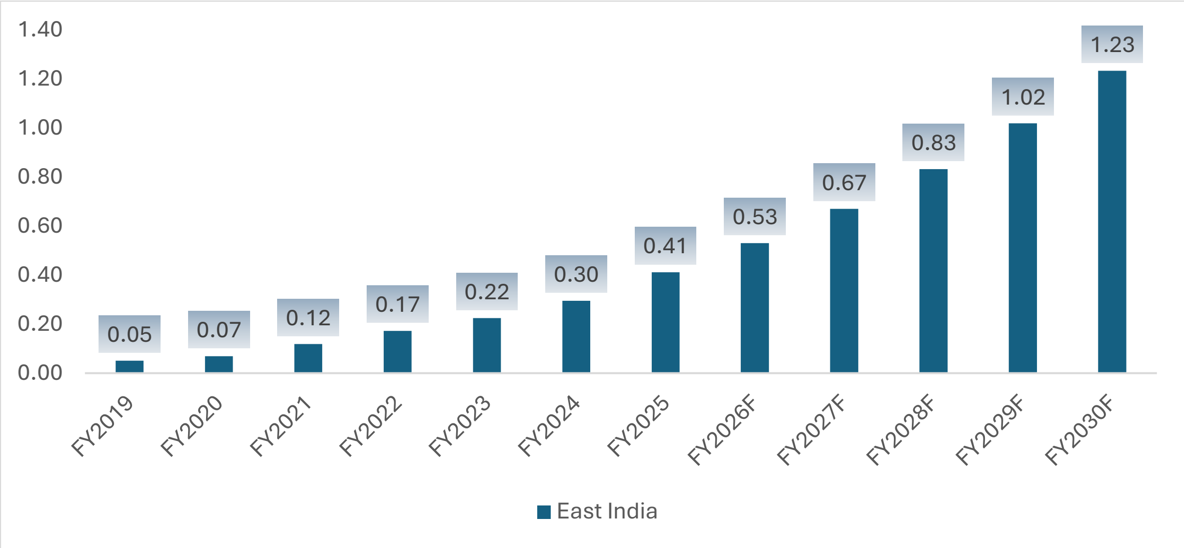
Source: Ministry of New and Renewable Energy (MNRE), Expert interactions, IMARC, ICRA Analytics

Rooftop solar installed capacity in South India expanded from 0.40 GW in FY2019 to 3.54 GW in FY2025, reflecting a CAGR of 43.9% during FY2019-FY2025. The region benefits from strong commercial infrastructure, IT parks, and high consumer awareness of renewable adoption. Capacity is projected to reach 11.80 GW by FY2030, growing at a CAGR of 26.2% during FY2026-FY2030, driven by corporate decarbonization goals and sustained C&I demand.

Village-level solarization models such as Kondareddypalli in Telangana- South India’s first fully solar-powered village with 1.5 MW rooftop capacity demonstrate the viability of decentralized solar for rural electrification. Grid export revenues and strong government-led missions are encouraging replication of such community solar projects, accelerating rooftop adoption across the region.

7.6.4 East India

Chart: East India: Rooftop Solar Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



Source: Ministry of New and Renewable Energy (MNRE), Expert interactions, IMARC, ICRA Analytics

East India remains an emerging market, with installed capacity rising from 0.05 GW in FY2019 to 0.41 GW in FY2025, recording a CAGR of 41.6% during FY2019-FY2025. Although adoption has been slower due to lower policy traction and awareness, the market is expected to reach 1.23 GW by FY2030, expanding at a CAGR of 23.5% during FY2026-FY2030, supported by gradual policy push, improving grid infrastructure, and distributed solar adoption in developing urban centres.

Affordable financing-led rooftop initiatives are boosting adoption in East India; for example, Tata Power Renewable Energy Limited launched low-cost rooftop solutions in Odisha with minimal upfront payments and subsidy support. Partnerships with Odisha Renewable Energy Development Agency and PM Surya Ghar incentives are improving affordability and accelerating distributed solar uptake in emerging urban centres.

7.7 Upcoming Potential for States of Rooftop Solar Market in India

India's rooftop solar sector is experiencing strong upward momentum under the PM Surya Ghar: Muft Bijli Yojana, which aims to equip one crore households with rooftop solar systems by March 2027, backed by a total allocation of INR 75,021 crore. Since its launch in February 2024, around 23.68 lakh rooftop installations with a combined capacity of about 8,691 MW have been completed as of February 2026, supported by subsidy disbursements totalling INR 16,932.4 crore. When state-level schemes are included, nationwide installations are estimated at around 0.3 crore systems, reflecting a rapidly expanding pipeline and a large unexploited market.

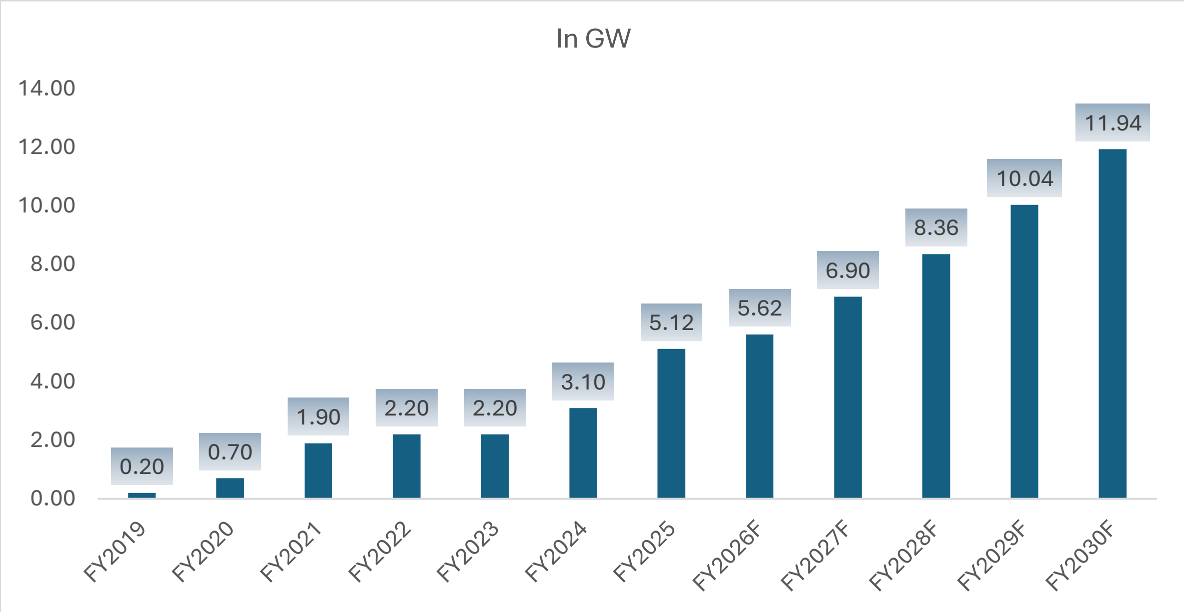
State-level data shows that adoption is heavily concentrated in a handful of high-performing states, indicating significant room for growth elsewhere. Gujarat leads with roughly 5.6 lakh installations, followed by Maharashtra (~4.5 lakh), Uttar Pradesh (~3.7 lakh), and Kerala (~1.9 lakh). These states have benefited from proactive policies, active DISCOM participation, and higher consumer awareness positioning them as relatively mature rooftop solar markets with steady incremental growth ahead, driven by system replacements, capacity upgrades, and deeper household penetration.

In contrast, several major states and regions continue to see limited deployment, highlighting substantial growth potential. The Northeastern states including Arunachal Pradesh, Sikkim, Meghalaya, Mizoram, Manipur, Nagaland, and Tripura collectively account for just 4,174 installations, showing very low market penetration despite favourable solar resources. Similarly, urbanised regions such as Delhi (6,209 installations), Goa (1,721), West Bengal (1,265), and Chandigarh (1,050) have achieved only modest adoption so far.

Overall, nearly 75% of all rooftop installations are concentrated in only 10-11 states, underscoring uneven regional distribution and the vast untapped opportunity across underpenetrated markets. With monthly installations rising dramatically from around 15,000 at the scheme's launch to over 2,00,000 per month and with supportive measures such as streamlined financing, virtual net-metering, and continued subsidies, rooftop solar adoption is set to accelerate across lagging states. This points to strong future potential, particularly in populous regions with low current penetration, as awareness grows, financing becomes easier, and rooftop solar evolves into a mainstream household energy choice.

7.8 Rooftop Solar Capacity Additions

Chart: India: Rooftop Solar Market: Capacity Addition Trends and Forecast (in GW), FY2019-FY2030F



Source: Ministry of New and Renewable Energy (MNRE), Expert interactions, IMARC, ICRA Analytics

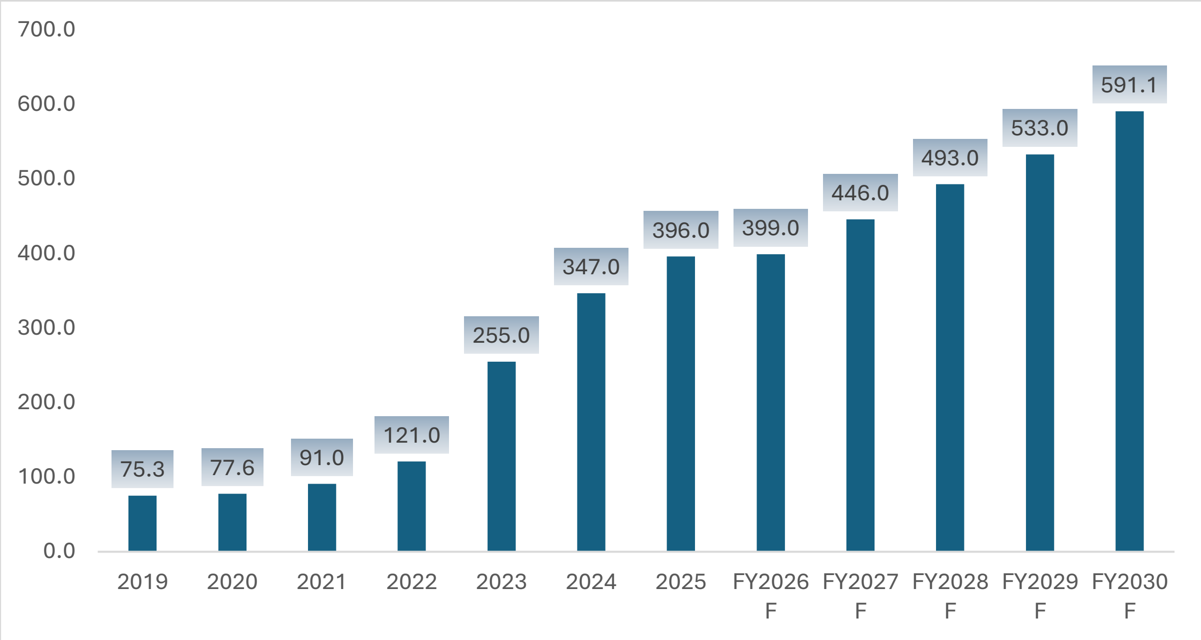
Rooftop solar capacity additions in India increased from 0.20 GW in FY19 to 5.12 GW in FY2025, driven by policy support under MNRE rooftop programmes, improved net-metering regulations, and rising commercial and residential adoption.

Additions are projected to accelerate further from 5.62 GW in FY26 to 11.94 GW by FY2030, supported by the PM Surya Ghar initiative, declining system costs, expanding C&I rooftop deployments, and integration of storage-backed distributed energy solutions.

8. Ground Mounted Solar Market

8.1 Global Consumption Trend

Chart: Global: Ground Mounted Solar Market: Installation Trends and Forecast (in GW), FY2019-FY2030F



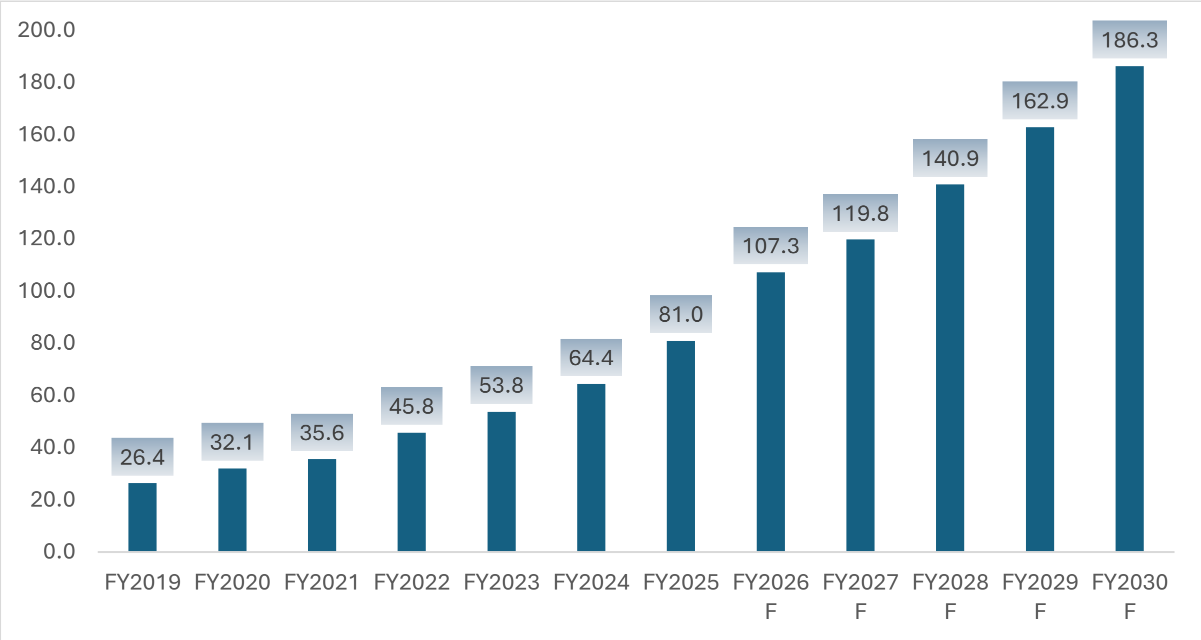
Source: SolarPower Europe, Expert interactions, IMARC, ICRA Analytics

Global ground-mounted solar installations have surged from roughly 75 GW in FY2019 to about 396 GW in FY2025, reflecting a robust CAGR of approximately 31.9% over FY2019–FY2025. This rapid expansion has been largely fueled by utility-scale solar developments, falling module and EPC costs, the availability of extensive land parcels for solar parks, and supportive government-led auctions and long-term PPAs. Growing investments from utilities and independent power producers along with the ongoing shift away from coal-based generation and rising electricity demand have further propelled the rollout of ground-mounted solar farms across both advanced and emerging markets.

Looking ahead, global ground-mounted solar capacity is expected to reach nearly 591 GW by FY2030, increasing at a CAGR of around 10.3% during FY2026–FY2030. This next phase of growth will be underpinned by strong decarbonization goals, ambitious grid-scale renewable integration targets, and the rise of hybrid renewable projects combining solar, wind and battery storage.

8.2 Market Size of Ground Mounted Solar in India

Chart: India: Ground Mounted Solar Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F

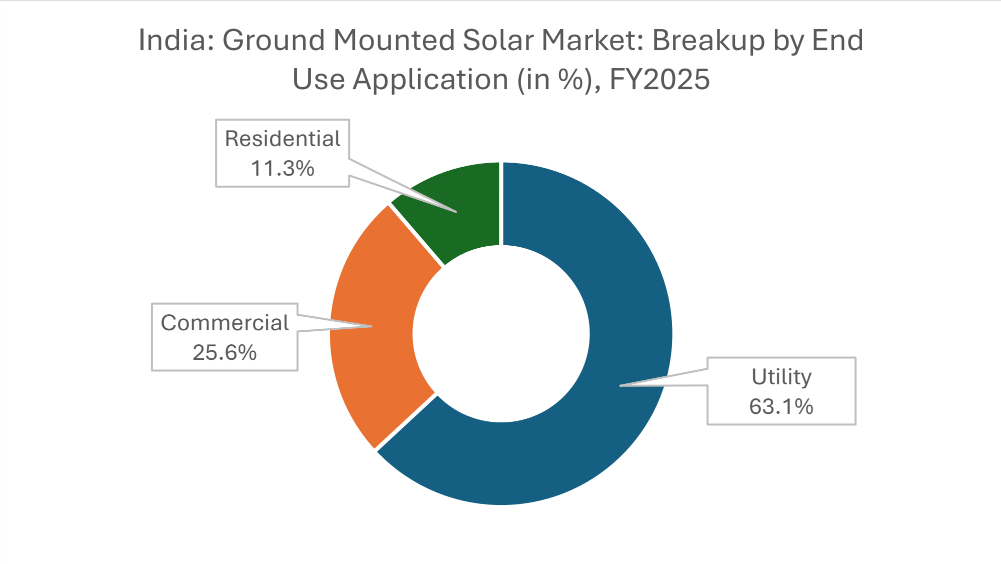


Source: Ministry of New and Renewable Energy (MNRE), Expert interactions, IMARC Group

Ground-mounted solar installed capacity in India rose sharply from about 26 GW in FY2019 to nearly 81 GW in FY2025, reflecting a strong CAGR of around 20.6% during FY2019–FY2025. This significant growth has been propelled by large-scale utility solar parks, competitive reverse-bidding auctions, falling module and EPC costs, and robust policy support from institutions such as the Ministry of New and Renewable Energy. Additionally, the availability of sizeable land parcels for ultra-mega solar parks, long-term PPAs with distribution companies, and the push to decarbonize India's coal-dominated power mix have accelerated ground-mounted solar development across states including Rajasthan, Gujarat and Karnataka.

Looking ahead, India's ground-mounted solar capacity is expected to reach approximately 186 GW by FY2030, expanding at a CAGR of roughly 14.8% during FY2026–FY2030. This sustained growth will be driven by a steady pipeline of government auctions, rising demand for cost-effective utility-scale renewable energy, and increased investments in grid integration and supporting infrastructure.

8.3 Market Split by End Use Application



Source: Expert interactions, IMARC, ICRA Analytics

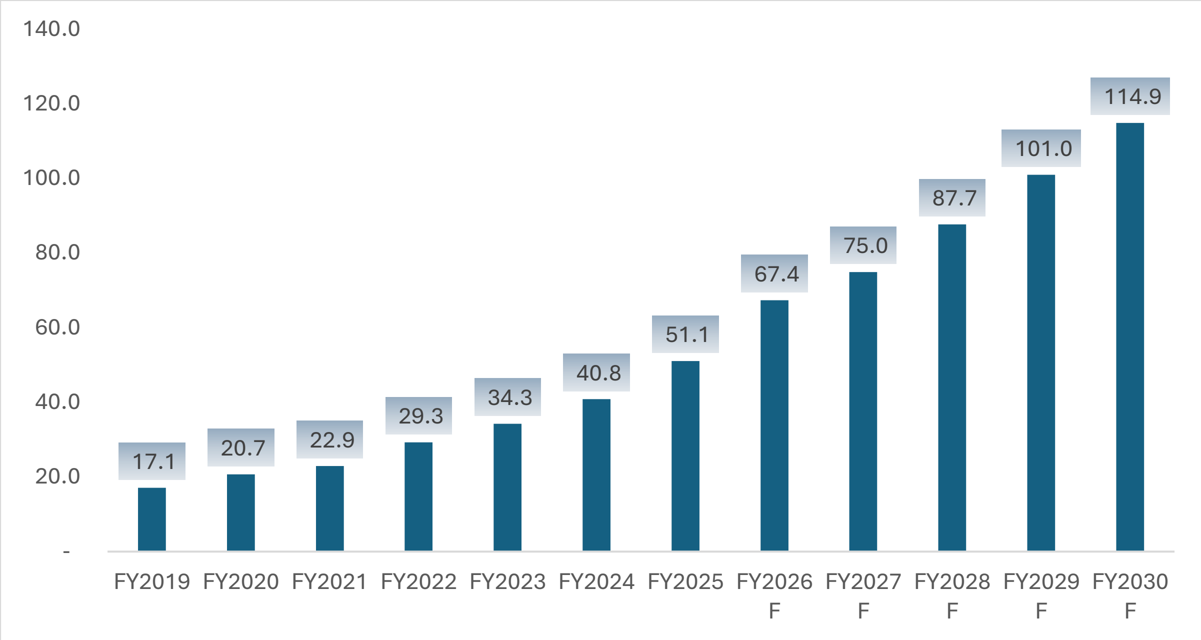
In FY25, the utility segment accounted for the largest share of India's ground-mounted solar market, representing 63.1% of total installations, equivalent to 51.12 GW.

This was followed by the commercial segment, which held a 25.6% share (20.74 GW), while the residential segment contributed the remaining 11.3% (9.15 GW).

Ground mounted solar photovoltaic ("PV") installations constitute one of the largest segments of the renewable energy infrastructure ecosystem globally and in India. These projects typically involve large-scale solar power plants installed on land parcels and connected to utility grids to supply electricity under long-term power purchase agreements ("PPAs") or open access frameworks. Ground mounted installations benefit from economies of scale, centralized operations, and higher generation efficiency due to optimized panel orientation and maintenance practices.

8.3.1 Utility

Chart: India: Ground Mounted Solar (Utility) Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



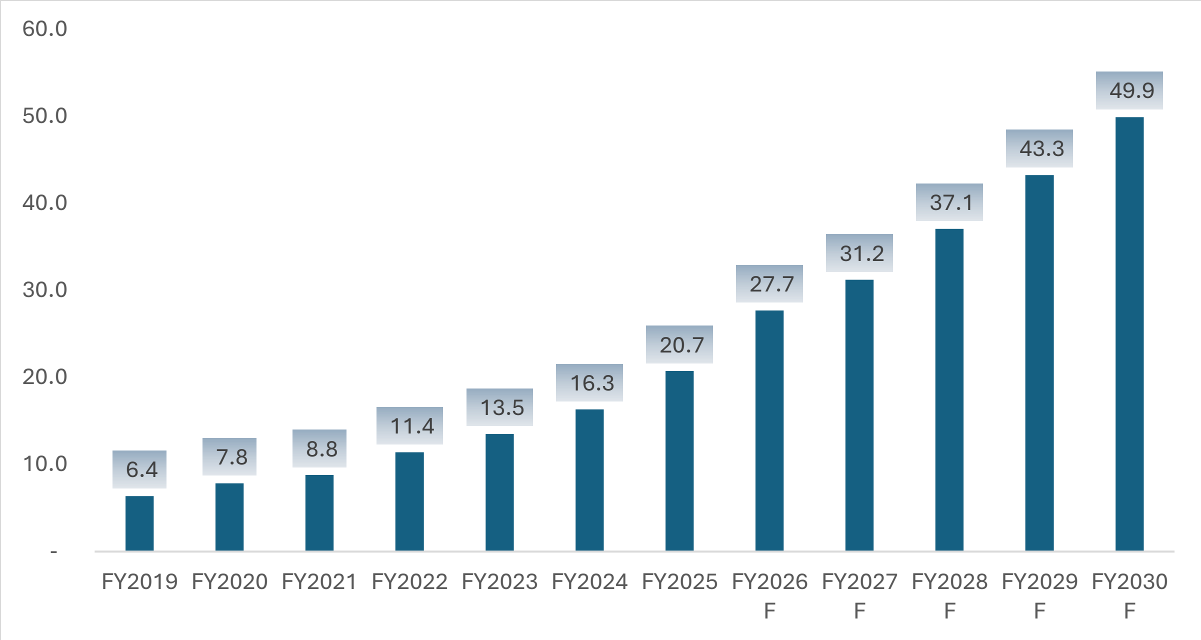
Source: Expert interactions, IMARC, ICRA Analytics

Ground-mounted solar installed capacity in India's utility segment rose from 17.10 GW in FY2019 to 51.12 GW in FY2025, recording a strong CAGR of 20.0% during FY2019–FY2025. This robust expansion has been supported by the development of large-scale solar parks, competitive reverse-bidding mechanisms, long-term PPAs with utilities, and consistent policy momentum aimed at accelerating utility-scale renewable capacity additions.

Looking ahead, utility-scale ground-mounted solar capacity is projected to reach 114.94 GW by FY2030, growing at a CAGR of 14.3% during FY2026–FY2030. The next phase of growth will be driven by rising power demand, national decarbonization objectives, expansion of transmission corridors, and sustained emphasis on centralized large-scale solar projects to meet India's renewable energy targets.

8.3.2 Commercial

Chart: India: Ground Mounted Solar (Commercial) Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



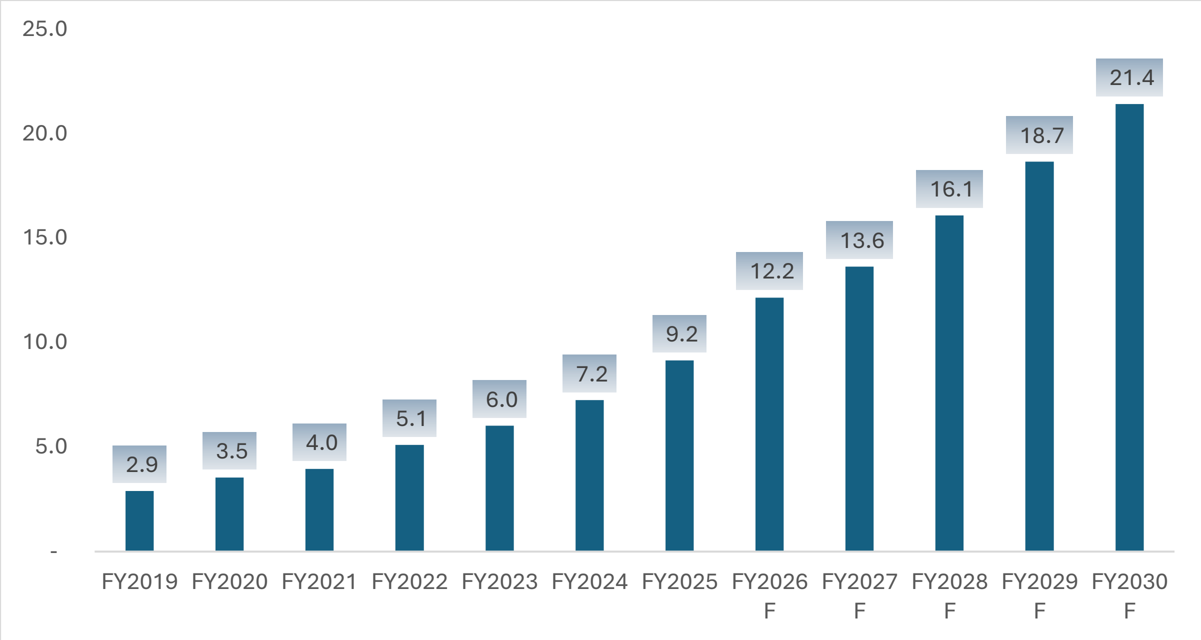
Source: Expert interactions, IMARC, ICRA Analytics

Ground-mounted solar installed capacity in the commercial segment increased from 6.39 GW in FY2019 to 20.74 GW in FY2025, registering a strong CAGR of 21.7% over FY2019–FY2025. This growth has been driven by rising adoption of captive solar plants among commercial and industrial (C&I) consumers seeking to lower electricity costs, enhance energy reliability and fulfil corporate sustainability and ESG commitments.

Looking ahead, commercial ground-mounted solar capacity is expected to reach 49.93 GW by FY2030, expanding at a CAGR of 15.9% during FY2026–FY2030. Key growth enablers will include the expansion of industrial corridors, increasing open-access renewable procurement, and favorable cost economics associated with captive solar installations.

8.3.3 Residential

Chart: India: Ground Mounted Solar (Residential) Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

Ground-mounted solar capacity in the residential segment increased from 2.90 GW in FY2019 to 9.15 GW in FY2025, reflecting a CAGR of 21.1% over this period. This expansion has been supported by the rising uptake of distributed solar solutions across residential townships, rural housing clusters and community-based installations aimed at lowering electricity costs and reducing dependence on the grid.

Looking ahead, residential ground-mounted solar capacity is projected to reach 21.42 GW by FY2030, growing at a CAGR of 15.2% during FY2026–FY2030. Continued momentum in this segment is expected to be driven by increasing awareness of clean energy, supportive government incentives and rising demand for reliable and sustainable household power solutions.

8.4 Long Term Drivers for Growth

- **Abundant Land-Based Solar Resource Potential:** India's extensive solar resource base offers a strong structural foundation for sustained growth across both ground-mounted and rooftop segments. According to an assessment by the National Institute of Solar Energy under the Ministry of New and Renewable Energy, the country has an estimated feasible ground-mounted solar PV potential of around 3,343 GWp spread across 27,571 sq km of wasteland, underscoring the vast untapped capacity beyond traditional desert landscapes. This significant land availability supports the development of utility-scale solar parks and captive open-access projects, while urban structures facilitate broad rooftop adoption together ensuring long-term, robust expansion of the solar market.

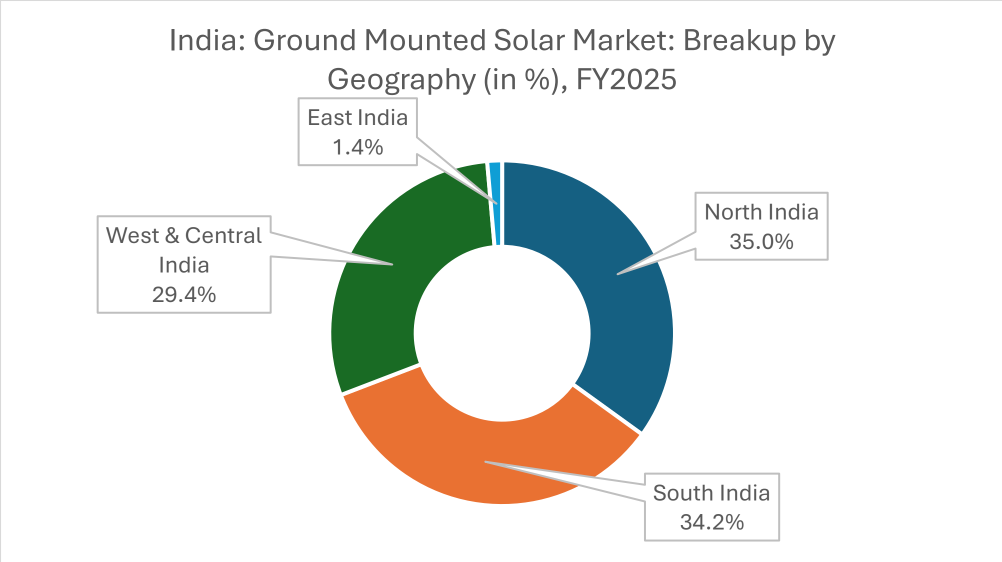
- **Falling Solar Module Costs and Efficiency Improvements:** Ongoing advances in photovoltaic manufacturing and balance-of-system technologies are driving down installation costs and enhancing module efficiency. Higher-efficiency panels allow more energy generation within the same land or rooftop footprint, benefiting large ground-mounted solar farms as well as space-limited rooftop systems. As the levelized cost of electricity (LCOE) from solar continues to decline, project economics strengthen further, making solar increasingly competitive with conventional power sources. This trend is expected to sustain adoption across utility-scale, commercial, industrial and residential segments.

- **Utility-Scale Solar Expansion and Grid Decarbonization Goals:** India's long-term renewable energy commitments and decarbonization goals are accelerating the rollout of large ground-mounted solar installations that are critical for meeting rising electricity demand while reducing reliance on fossil fuels. Large EPC-driven projects such as the INR 232.3 crore turnkey ground-mounted solar project (170 MW AC / 255 MW DC) awarded to Waaree Renewable Technologies Ltd in 2025 demonstrate the rapid scaling of centralized solar capacity nationwide. These projects typically encompass full engineering, procurement, construction, and long-term O&M services, highlighting the role of utility-scale solar in delivering cost-competitive power at scale. Supported by economies of scale, higher plant load factors and continued module cost reductions, utility-scale ground-mounted capacity additions are expected to remain central to India's grid decarbonization pathway over the long term.

- **Growing Demand for Captive and Open-Access Solar from Industries and SMEs:** Industrial consumers and SMEs especially those with high electricity consumption but limited rooftop space are increasingly turning to off-site ground-mounted solar parks under captive and group-captive models to lower long-term power costs and enhance sustainability performance. Companies such as Orb Energy have played a pioneering role in SME-focused solar parks, including a 35 MW (DC) ground-mounted facility in Arsikere, Karnataka, spanning roughly 110 acres and generating about 5.24 crore units of green electricity annually while reducing nearly 45,000 tonnes of CO_2 emissions each year. Orb Energy aims to develop approximately 400 MW of similar SME-centric solar parks across India by the end of the decade with an estimated investment of INR 2,000 crore. These parks allow enterprises to purchase individual plots and own dedicated solar sub-arrays within a larger park, supported by in-house collateral-free financing, offering stable tariffs of around INR 3.5–4.0 per unit, significantly lower than grid tariffs of INR 8–9 per unit. This model is poised for strong growth as industries increasingly seek cost efficiency, energy security and carbon footprint reduction.

8.5 Geographical Analysis of Ground Mounted Solar Market in India

Chart: India: Ground Mounted Solar Market: Breakup by Geography (in %), FY2025



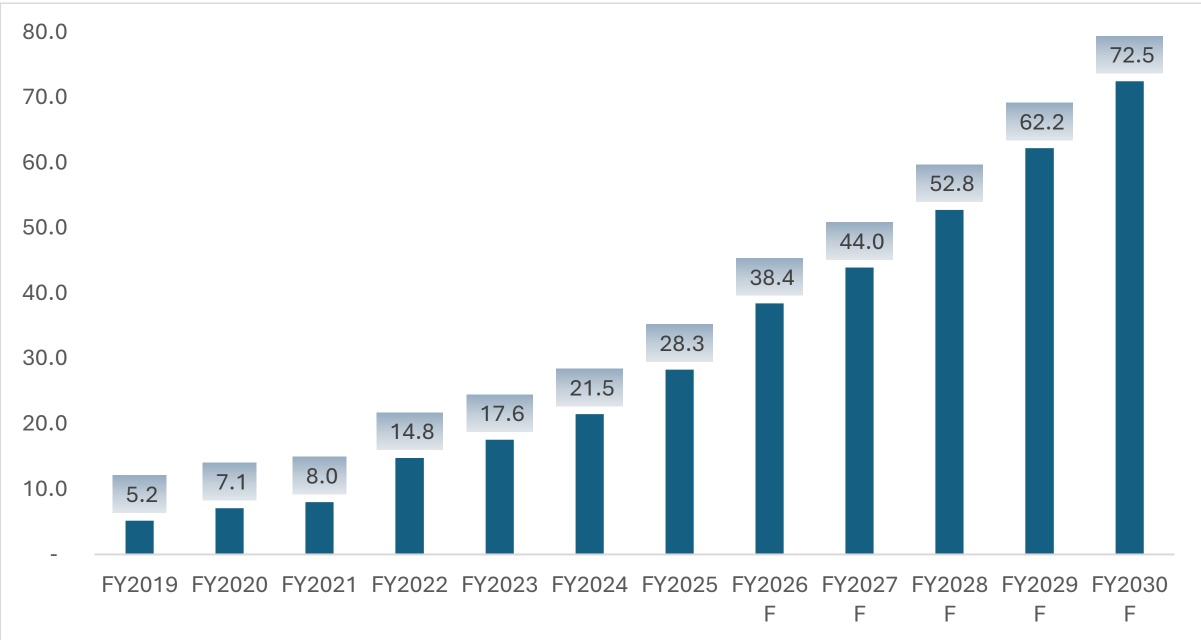
Source: Expert interactions, IMARC, ICRA Analytics

In FY25, North India emerged as the largest regional market for ground-mounted solar in India, contributing 35.0% of the total installed capacity, equivalent to 28.32 GW.

It was followed by South India with a 34.2% share (27.72 GW), West & Central India with 29.4% (23.85 GW) and East India, which accounted for 1.4% (1.12 GW).

8.5.1 North India

Chart: North India: Ground Mounted Solar Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



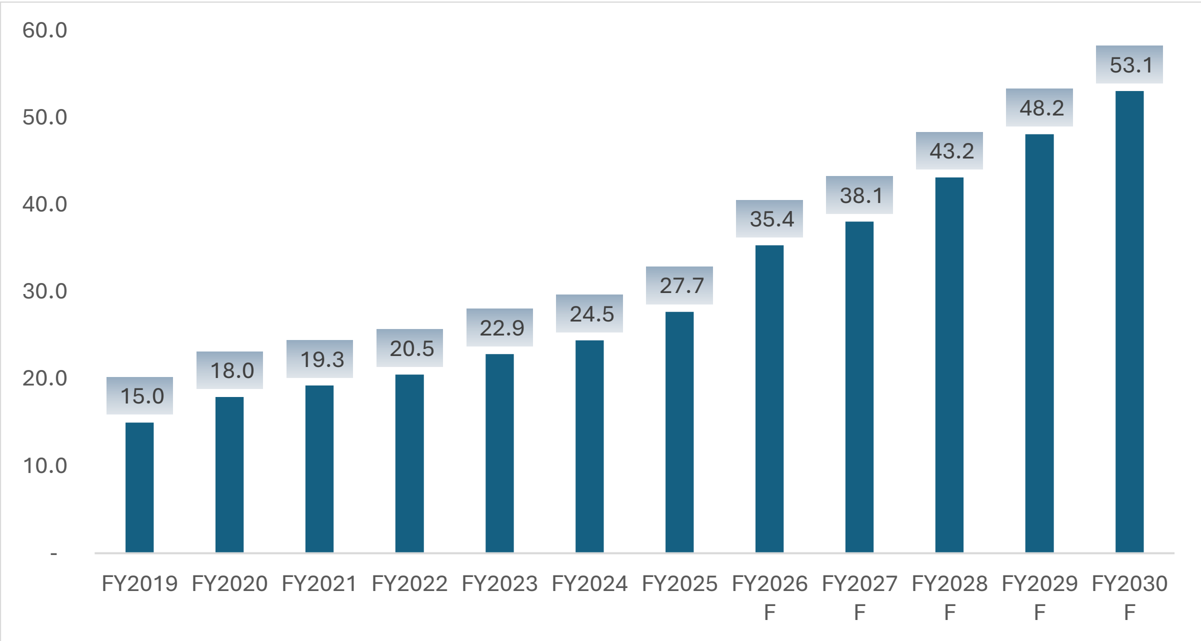
Source: Expert interactions, IMARC, ICRA Analytics

Ground-mounted solar capacity in the residential segment rose from 2.90 GW in FY2019 to 9.15 GW in FY2025, reflecting a CAGR of 21.1% over FY2019–FY2025. This expansion has been supported by greater adoption of distributed solar solutions across residential townships, rural housing clusters and community-based installations designed to lower grid dependence and reduce electricity expenses.

Looking ahead, residential ground-mounted solar capacity is projected to reach 21.42 GW by FY2030, growing at a CAGR of 15.2% during FY2026–FY2030. Increasing awareness of clean energy options, supportive government incentives, and rising demand for reliable and sustainable household power solutions are expected to drive continued growth in this segment.

8.5.2 South India

Chart: South India: Ground Mounted Solar Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



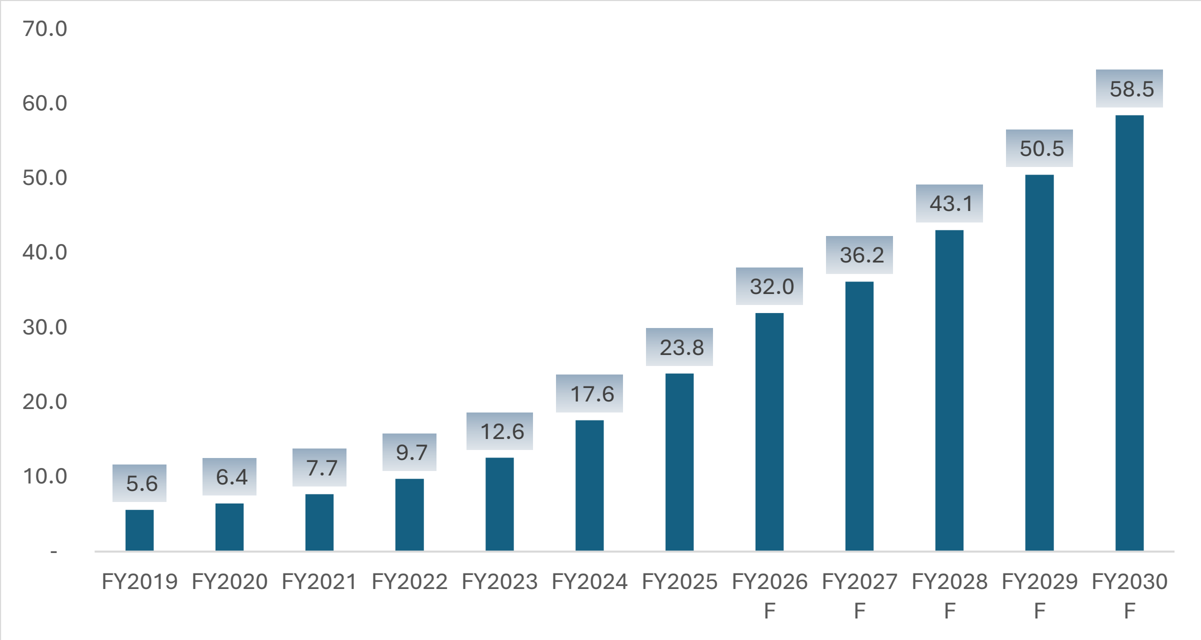
Source: Expert interactions, IMARC, ICRA Analytics

South India's ground-mounted solar installed capacity increased from 15.02 GW in FY2019 to 27.72 GW in FY2025, achieving a CAGR of 10.7% over FY2019–FY2025. This growth has been driven by the strong renewable energy ecosystems in Karnataka, Telangana, Andhra Pradesh and Tamil Nadu, supported by proactive state-level renewable policies and robust C&I solar adoption.

Looking forward, the region's capacity is expected to rise to 53.09 GW by FY2030, registering a CAGR of 10.7% during FY2026–FY2030. Continued demand for open-access solar, the development of hybrid renewable projects and increasing integration of solar with storage technologies to enhance grid stability are anticipated to support sustained expansion.

8.5.3 West & Central India

Chart: West & Central India: Ground Mounted Solar Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



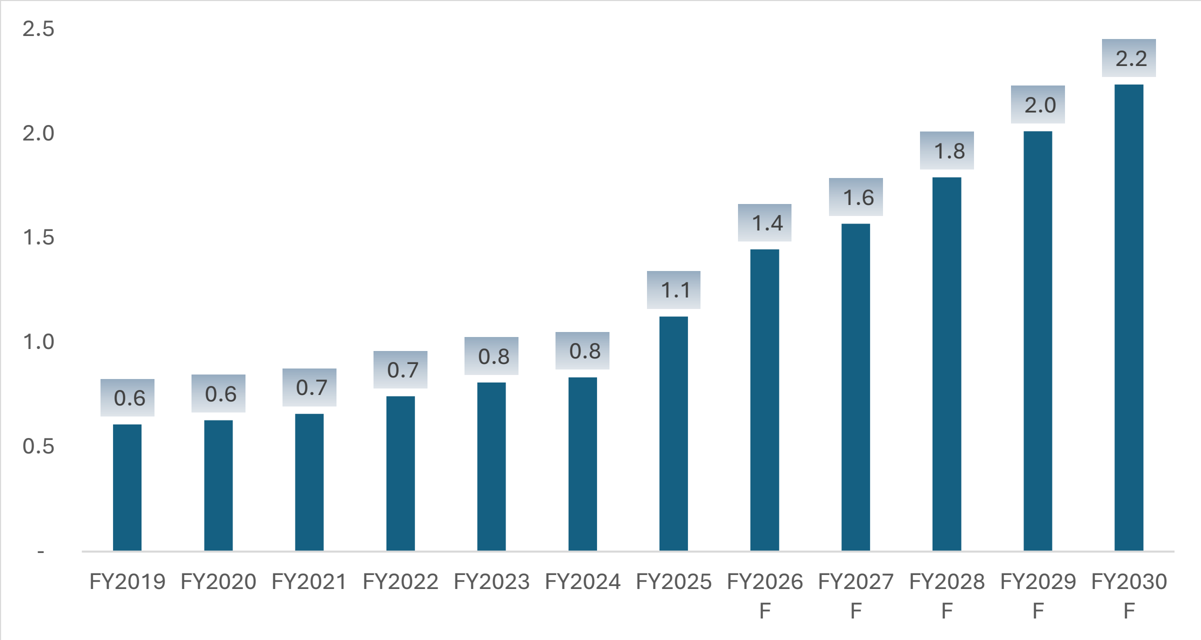
Source: Expert interactions, IMARC, ICRA Analytics

Ground-mounted solar capacity in West & Central India increased from 5.60 GW in FY2019 to 23.85 GW in FY2025, registering a robust CAGR of 27.3% during FY2019–FY2025. The growth has been led by large solar installations in states such as Gujarat, Maharashtra, and Madhya Pradesh, supported by strong industrial demand, favorable solar irradiation levels and progressive renewable procurement policies.

Capacity in this region is expected to reach 58.50 GW by FY2030, growing at a CAGR of 16.3% during FY2026–FY2030. Expansion of green energy corridors, industrial decarbonization initiatives and increasing captive solar adoption are likely to drive future capacity growth.

8.5.4 East India

Chart: East India: Ground Mounted Solar Market: Installed Capacity Trends and Forecast (in GW), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

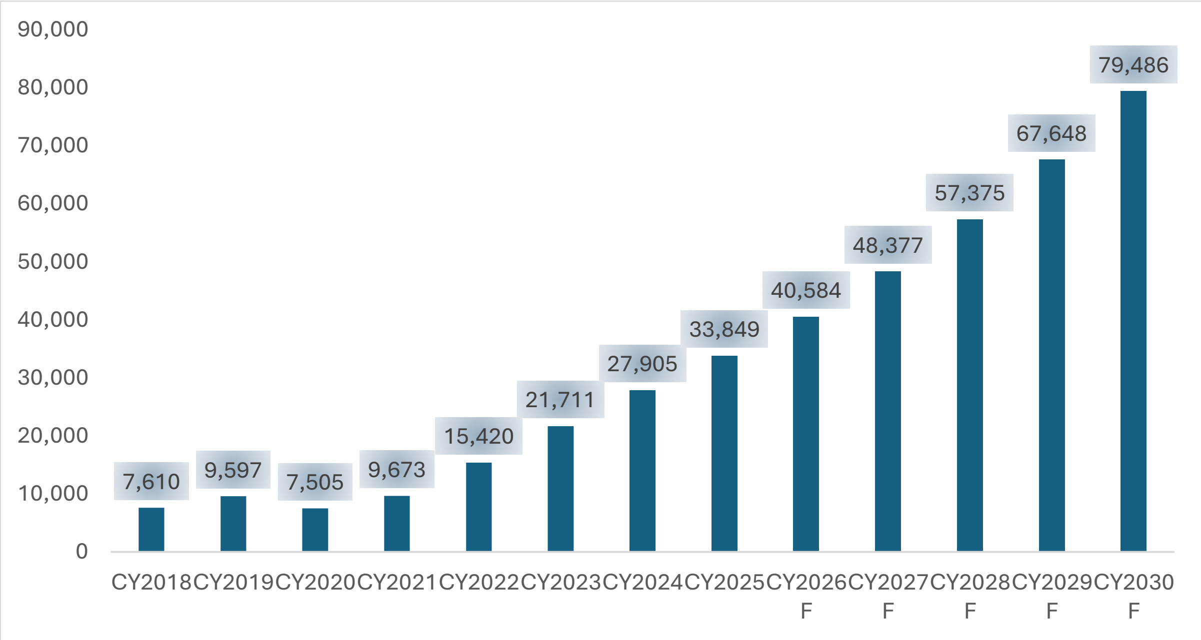
East India's ground-mounted solar installed capacity increased gradually from 0.61 GW in FY2019 to 1.12 GW in FY2025, registering a CAGR of 10.8% over FY2019–FY2025. Growth has remained relatively modest due to land availability challenges, lower industrial-sector solar uptake, and evolving policy frameworks across the eastern states.

Looking ahead, East India's capacity is expected to reach 2.24 GW by FY2030, expanding at a CAGR of 11.5% during FY2026–FY2030. Rising electrification requirements, strengthening policy support and emerging solar deployment in states such as Odisha and West Bengal are anticipated to drive steady regional growth.

9 Solar Pump Market in India

9.1 Global Consumption Trend

Chart: Global: Solar Pump Trends and Forecast (in INR Crore), CY2018-2030F



Source: Expert interactions, IMARC, ICRA Analytics

The global solar pump market size was valued at INR 33,849 crore in 2025 and is projected to reach INR 79,486 crore by 2030, growing at a CAGR of 18.3% from 2026 to 2030.

The agricultural sector remains a primary growth driver for the global solar pumps market, as these systems provide a reliable and sustainable irrigation solution, particularly in regions with limited or unreliable grid electricity access. The integration of Internet of Things (IoT)-enabled sensors and remote monitoring platforms further enhances operational efficiency, enabling real-time performance tracking, predictive maintenance, and optimized water management. In off-grid and rural locations, solar pumps offer a dependable alternative for agricultural and community water supply needs, ensuring consistent daytime pumping without dependence on fossil fuels or grid infrastructure.

At the macro level, global climate commitments and renewable energy targets are significantly accelerating adoption. The United Nations has set ambitious net-zero emission goals by 2050, prompting member countries to scale investments in clean energy technologies, including solar-powered irrigation solutions. Governments across developing and emerging economies are actively promoting renewable energy adoption through capital subsidies, favorable policies, and rural electrification initiatives, thereby improving affordability and accessibility of solar pumps.

Additionally, rapid advancements in photovoltaic technology and declining solar module costs have improved system economics, making solar pumps a more cost-effective solution over the long term. The broader global transition toward decarbonization and energy security is also encouraging the replacement of diesel-powered pumping systems with solar alternatives, helping reduce greenhouse gas emissions and dependence on volatile fossil fuel supplies while aligning with long-term sustainability and climate resilience goals.

9.2 Adoption of Solar Energy–Based Irrigation and Rooftop Electricity Generation will help Reduce Carbon Footprint & Achieve Climate Goals

- The rapid expansion of rooftop solar installations and solar-powered irrigation in India is significantly lowering carbon emissions and supporting national climate targets by reducing reliance on coal-based electricity and diesel-powered pumps across residential and agricultural sectors.

- Under the PM Surya Ghar Muft Bijli Yojana, states such as Uttar Pradesh have accelerated rooftop solar adoption, installing over 3.57 lakh systems and achieving more than 50 lakh units of green electricity generation daily as of 31st January 2026, which has contributed to an estimated annual reduction of 13–15 lakh tonnes of CO_2 emissions while also lowering household electricity consumption and costs.

- Solar irrigation systems replace diesel- and grid-powered pumps, eliminating fuel consumption and significantly cutting carbon emissions while also improving irrigation efficiency and farm productivity. With over 3.0 crore irrigation pumps in India, including lakhs of diesel-operated units, large-scale solarisation of irrigation infrastructure can substantially reduce emissions and support India's target of achieving 500 GW of non-fossil fuel energy capacity by 2030.

Advantages of Solarisation of Irrigation and Rooftops in India

- Reduced greenhouse gas emissions: Solar-powered irrigation pumps and rooftop photovoltaic systems operate without fossil fuels, directly lowering greenhouse gas emissions and supporting India's clean energy transition and climate mitigation targets.

- Significant reduction in carbon emissions: Large-scale solarisation of agricultural pumps and rooftop systems can help India reduce carbon emissions by nearly 3.2 crore tonnes, contributing meaningfully to national decarbonisation goals and renewable energy commitments.

- Improved energy accessibility in remote areas: Solar pumps and rooftop solar systems provide reliable electricity in rural and remote regions with weak grid connectivity, reducing dependence on erratic power supply and improving irrigation reliability and household energy access.

- Easing government financial burden: Solarising irrigation reduces the need for high electricity subsidies for agriculture (estimated at over INR 1 lakh crore annually) and cuts diesel consumption, lowering oil import dependence by around 138 crore litres per year and easing fiscal pressures.

- Cost-effective over lifecycle: Although initial installation costs are higher, solar irrigation pumps and rooftop solar systems have low operating and maintenance expenses, making them economically viable and cost-saving over their long operational life.

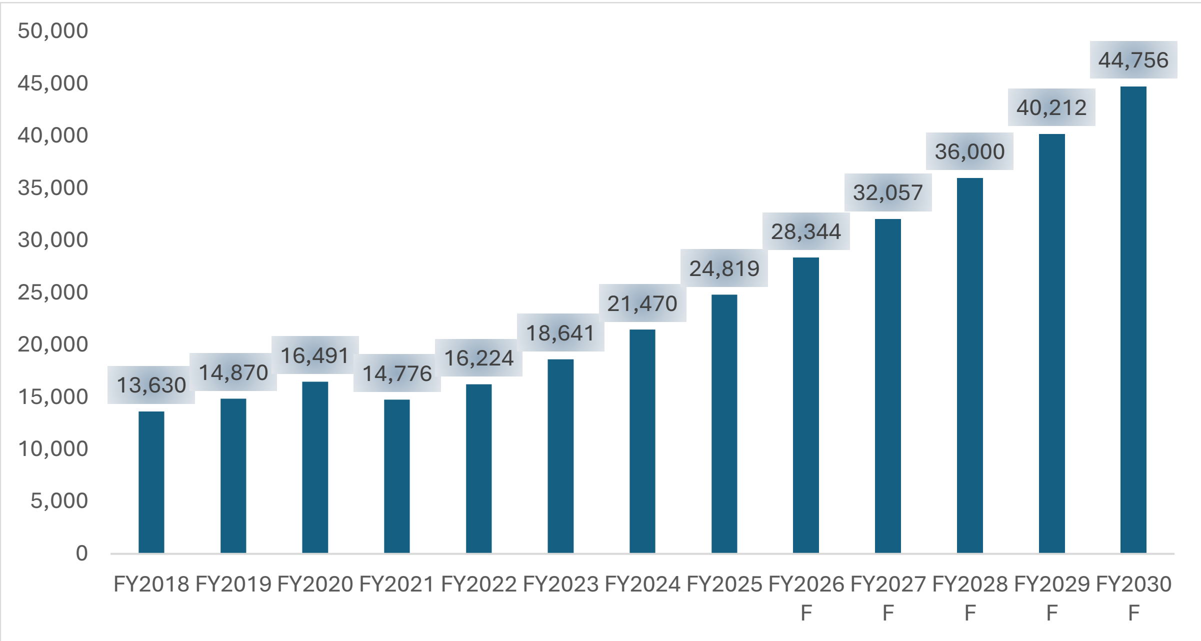
- Long operating life and durability: Solar water pumps typically have a lifespan of 10–20 years with minimal moving parts, leading to lower maintenance requirements and reliable long-term performance for farmers and households.

- Flexible and reliable water harnessing: Solar pump systems allow farmers to access water during daylight hours without relying on fixed grid supply schedules, enabling better irrigation planning and improved agricultural productivity.

- Reduced transmission and distribution losses: Decentralised rooftop solar and solar-powered irrigation reduce dependence on long-distance electricity transmission, helping cut transmission and distribution losses by up to 20% and improving overall power system efficiency in India.

9.3 India Pumps Market Scenario & Outlook (FY2019-FY2030F)

Chart: India: Pumps Market Trends and Forecast (in INR Crore), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

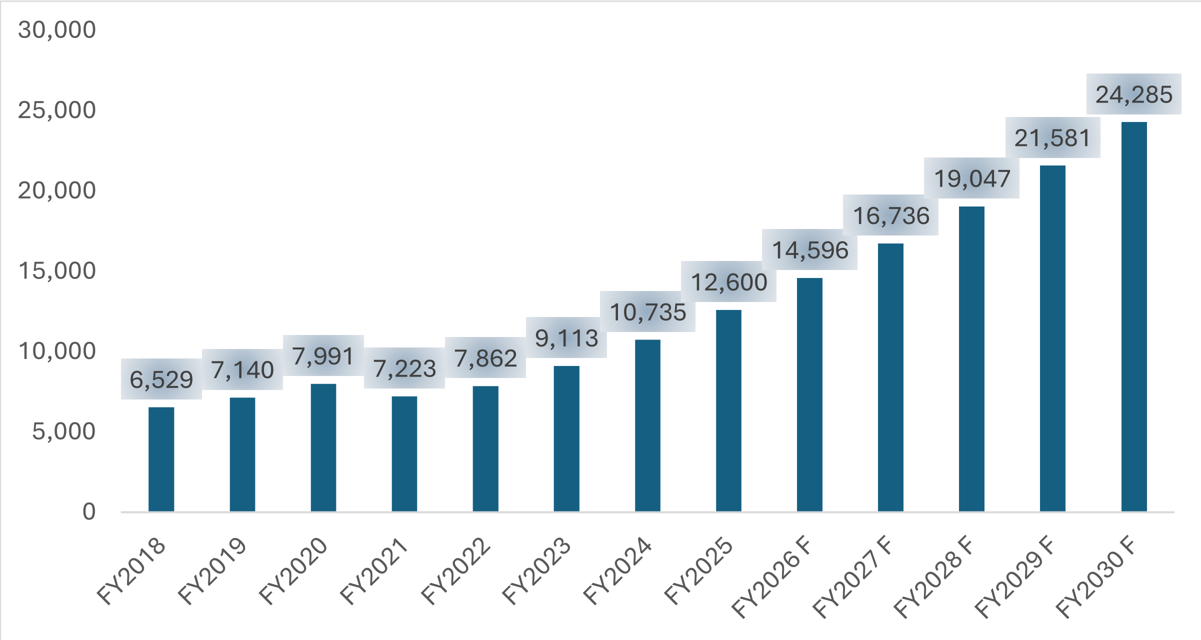
The India pumps market size was valued at INR 24,819 crore in FY2025 and is projected to reach INR 44,756 crore by FY2030, growing at a CAGR of 12.1% from FY2026 to FY2030.

The India pumps market is primarily driven by strong growth in the agriculture and water management sectors. With agriculture remaining a key contributor to rural livelihoods, rising demand for efficient irrigation systems is boosting the adoption of electric, diesel, and solar pumps across states facing water stress and erratic monsoon patterns. Government initiatives promoting micro-irrigation, solar-powered pumps, and rural electrification are further accelerating installations, particularly among small and marginal farmers. Additionally, increasing groundwater extraction for irrigation, coupled with the need for reliable water supply in off-grid areas, continues to support sustained demand for agricultural pumping solutions.

Another major driver is rapid urbanization and infrastructure development across industrial, commercial, and residential segments. Expansion of water supply and wastewater treatment projects, growth in construction activities, and rising investments in smart cities and industrial corridors are creating significant demand for pumps used in water distribution, sewage handling, HVAC systems, and industrial processes. Moreover, the growing focus on energy-efficient pumping systems, stricter regulatory norms for water conservation, and increasing adoption of automation and smart monitoring technologies are encouraging replacement of conventional pumps with advanced, high-efficiency solutions, thereby supporting long-term market growth in India.

9.3.1 Agriculture

Chart: India: Pumps (Agriculture) Market Trends and Forecast (in INR Crore), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

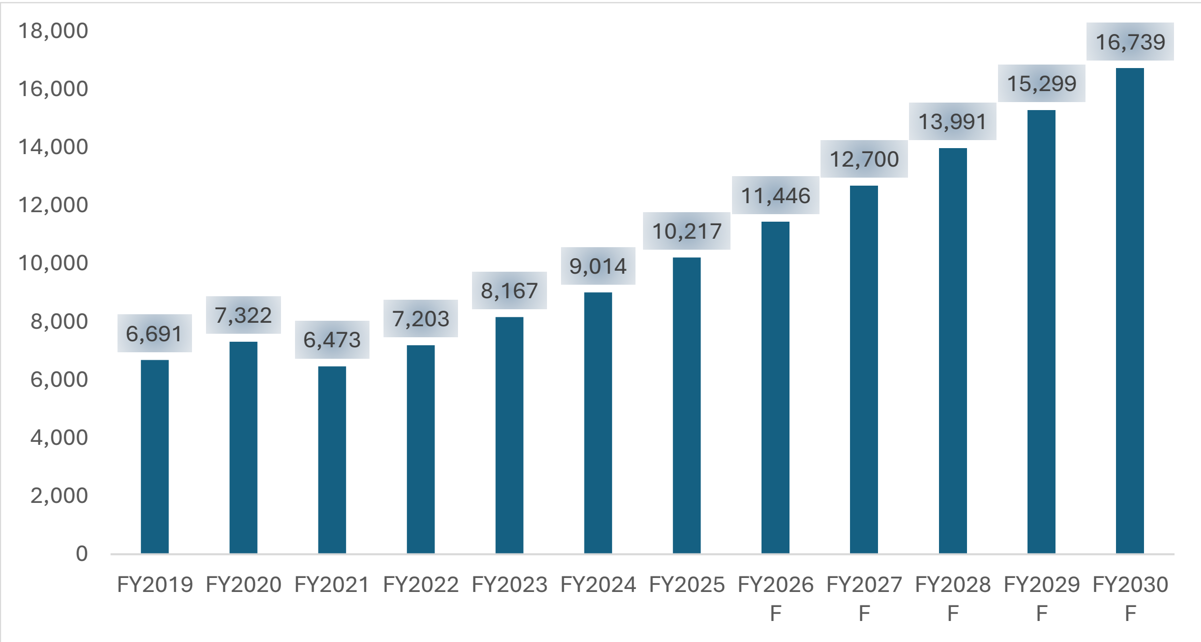
The agriculture pumps segment in India was valued at INR 12,600 crore in FY2025 and is projected to reach INR 24,285 crore by FY2030, registering a CAGR of 13.6% during FY2026–FY2030.

The solar water pumping systems utilize solar photovoltaic modules to generate electricity which powers water pumps used for irrigation purposes, thereby reducing dependence on conventional electricity supply or diesel-powered pumps. Solar water pumping projects are primarily implemented under government supported agricultural electrification programs that aim to promote renewable energy adoption in the agricultural sector.

Agriculture remains one of the largest demand generators for pumps in India, driven by the need for reliable irrigation amid erratic rainfall patterns and depleting groundwater levels. Government support through subsidy schemes for electric and solar irrigation pumps, expansion of micro-irrigation practices, and rural electrification initiatives are significantly increasing pump penetration among farmers. Rising focus on improving crop productivity and ensuring year-round irrigation access further sustains strong demand for both conventional and solar-powered pumping systems across rural regions.

9.3.2 Industrial

Chart: India: Pumps (Industrial) Market Trends and Forecast (in INR Crore), FY2019-FY2030F



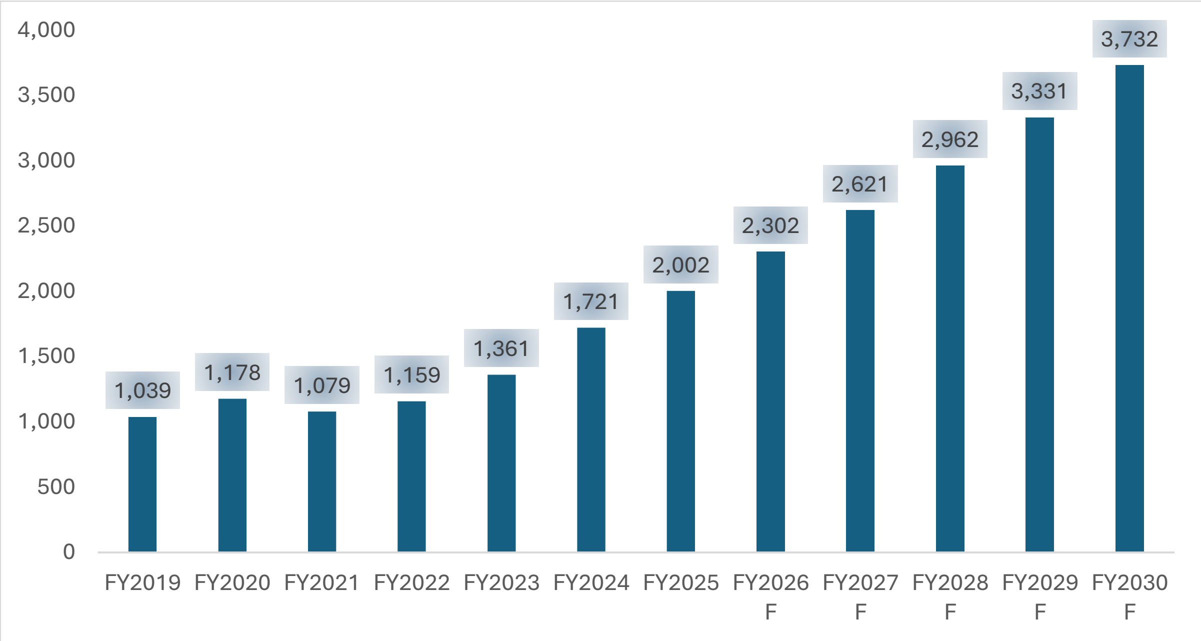
Source: Expert interactions, IMARC, ICRA Analytics

The industrial pumps segment in India was valued at INR 10,217 crore in FY2025 and is projected to reach INR 16,739 crore by FY2030, growing at a CAGR of 10.0% during FY2026–FY2030.

The industrial sector is a major driver of the India pumps market due to expanding manufacturing activities across chemicals, oil & gas, power generation, food processing, and pharmaceuticals. Increasing investments in industrial infrastructure, process automation, and fluid handling systems are boosting demand for high-efficiency centrifugal and positive displacement pumps. Additionally, the push for water recycling, effluent treatment, and compliance with environmental regulations is accelerating the adoption of advanced pumping solutions in industrial wastewater management and cooling applications.

9.3.3 Residential

Chart: India: Pumps (Residential) Market Trends and Forecast (in INR Crore), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

The residential pumps segment in India was valued at INR 2,002 crore in FY2025 and is expected to reach INR 3,732 crore by FY2030, expanding at a CAGR of 12.8% during FY2026–FY2030.

Growth in the residential segment is fueled by rapid urbanization, rising housing construction, and increasing need for efficient water supply and pressure management systems in multi-storey buildings and housing complexes. The expansion of municipal water supply networks, along with the adoption of booster pumps, submersible pumps, and sewage handling pumps in urban households, is supporting market growth. Moreover, increasing awareness about energy-efficient and low-maintenance domestic pumping solutions is encouraging replacement demand in both urban and semi-urban residential sectors.

9.4 Investments in the Pump Sector

- Amrut Energy raised INR 100 crore (~USD 11.5 million) in March 2025 from private equity investors to expand solar water pump manufacturing capacity, accelerate R&D in solar pumping technology, and scale operations across underserved agricultural regions, supporting the shift toward clean-energy irrigation solutions.

- Kirloskar Brothers Limited inaugurated a new factory building at its Kaniyur manufacturing facility in January 2026 to enhance production efficiency, strengthen indigenous manufacturing capabilities, and meet rising domestic and export demand for advanced pumping solutions across water, industrial, and energy sectors.

- CRI Pumps secured a INR 320 crore order in August 2025 from Maharashtra State Electricity Distribution Company for the supply and installation of 10,714 off-grid solar photovoltaic water pumping systems under the “Magel Tyala Saur Krushi Pump” scheme, integrating IoT-enabled remote monitoring to improve irrigation reliability and reduce dependence on conventional power sources.

- Shakti Pumps (India) Limited won a major contract worth INR 654.03 crore from Karnataka Renewable Energy Development Limited for the deployment of 16,780 solar photovoltaic water pumping systems, marking a strategic expansion into southern India and reinforcing investments in renewable-powered pumping infrastructure.

- Oswal Pumps secured a USD 5.06 crore order from Maharashtra State Electricity Distribution Company to supply 14,787 solar pumps, along with installation and commissioning across the state under the PM-KUSUM scheme, with the work scheduled for completion within 60 days.

9.5 Import-Export Scenario of Pumps from India

- India has emerged as a competitive global hub for pump manufacturing, supported by cost-efficient production, strong domestic supply chains, and policy support for domestic manufacturing. Indian pump manufacturers benefit from relatively lower production costs due to the availability of a large and cost-competitive workforce, while government initiatives encouraging local manufacturing further strengthen export competitiveness. Additionally, well-established domestic supply chains for components and raw materials help minimize import dependence and logistics costs, enabling Indian players to offer competitively priced pump solutions in global markets.

- The Indian pump industry has recorded strong export growth, with exports increasing at a CAGR of 9.9% from INR 7,760 crore in FY2020 to INR 11,310 crore in FY2024. The United States is the largest export destination, accounting for around 24% of total pump exports from India, followed by Germany (7%) and the UAE (5%), with the top 10 countries collectively contributing nearly 55% of total exports. On the import side, the market witnessed an 11.2% CAGR rise, with imports growing from INR 8,430 crore in FY20 to INR 12,880 crore in FY2024. China remains the largest exporter of pumps to India with an 18% share, followed by Germany (17%) and the United States (11%), while the top 10 source countries together account for about 76% of total pump imports. These trends indicate that India is a strong exporter of standard and mid-range pump solutions, while continuing to import high-end, specialized, and technologically advanced pumping equipment to meet diverse industrial requirements (Source: Directorate General of Commercial Intelligence and Statistics, DGCIS).

9.6 Different Types of Industrial Pumps & Classification

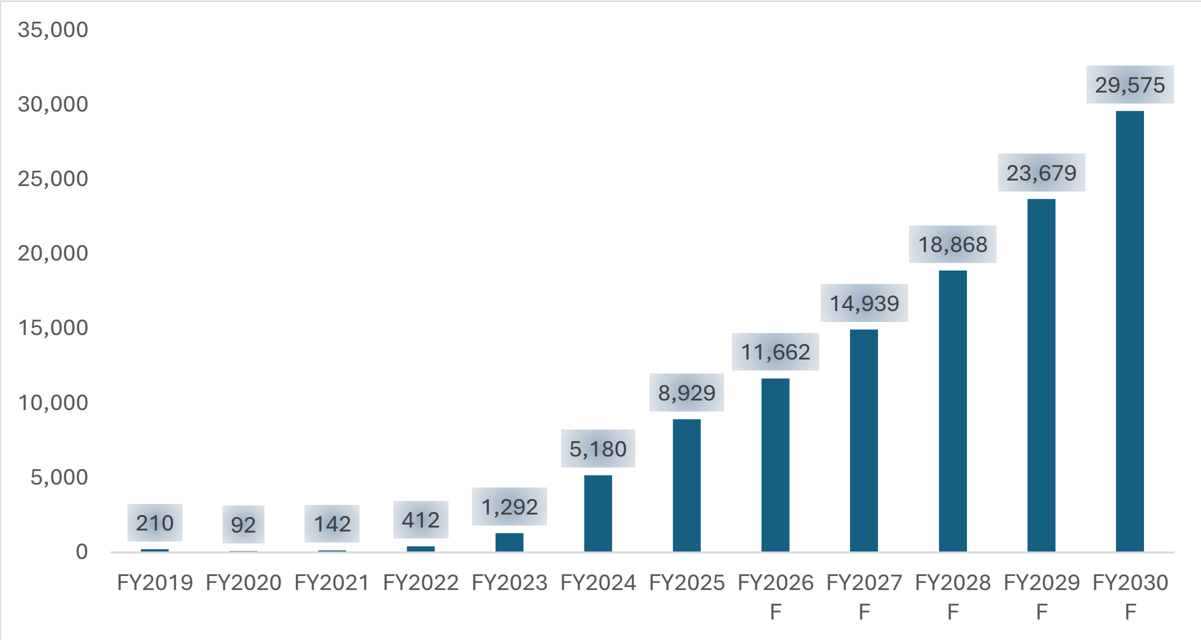
Industrial pumps are broadly classified into two major categories based on their operating mechanism: dynamic pumps and positive displacement pumps.

- **Dynamic Pumps:** Dynamic pumps operate by imparting velocity to the fluid through a rotating impeller. The kinetic energy generated by the impeller is converted into pressure energy, which enables the fluid to move through the system. These pumps typically have fewer moving parts and are suitable for continuous operation with relatively smooth flow characteristics.
    - Centrifugal Pumps: Centrifugal pumps are the most commonly used dynamic pumps across industries such as water treatment, chemicals, oil & gas, and power generation. They function by transferring rotational energy from the impeller to the fluid. Fluid enters along the axis of the impeller and is expelled radially by centrifugal force toward the outlet. These pumps can handle moderate-viscosity fluids and liquids containing small suspended solids.
    - Submersible Pumps: Submersible pumps are designed to operate fully submerged in the fluid being pumped. They are widely used in wastewater management, sewage treatment, drainage, and groundwater extraction. Their sealed construction allows them to function reliably in harsh environments and to move contaminated or particle-laden fluids efficiently.
    - Fire Hydrant / High-Pressure Pumps: Fire hydrant pumps are specialized dynamic pumps engineered to deliver water at very high pressure and flow rates. They are primarily used in firefighting systems, industrial safety networks, and municipal water distribution systems where rapid and forceful fluid delivery is critical.
- **Positive Displacement Pumps:** Positive displacement pumps move fluid by trapping a fixed volume and forcing it through the discharge pipe. Unlike dynamic pumps, they deliver a nearly constant flow regardless of system pressure and are highly suitable for handling viscous, shear-sensitive, and high-pressure fluids. The discharge is often pulsating because fluid is displaced in discrete volumes.
    - Lobe Pumps: Lobe pumps use rotating lobes that do not come into direct contact but rotate in synchronization to create cavities that trap and transport fluid. Their gentle pumping action makes them ideal for handling viscous fluids, slurries, and liquids containing soft solids, especially in food processing, pharmaceuticals, and chemicals.
    - Screw Pumps: Screw pumps employ one or more intermeshing screws rotating in opposite directions within a casing. The rotating screws generate axial pressure that moves fluid smoothly through the pump. They are widely used for transferring high-viscosity fluids such as crude oil, fuel, and lubricants.
    - Diaphragm Pumps: Diaphragm pumps, also called air-operated diaphragm (AOD) pumps, use a flexible diaphragm actuated by pneumatic or mechanical force to create suction and discharge pressure. They are suitable for handling corrosive chemicals, volatile solvents, and abrasive slurries, especially in applications where electrical power is limited or hazardous.
    - Gear Pumps: Gear pumps are rotary positive displacement pumps that use meshing gears to move fluid. As the gears rotate, they create suction at the inlet and force fluid toward the outlet. These pumps are ideal for pumping oils, greases, and other thick liquids that are free from solid contaminants.

- Piston Pumps: Piston pumps operate using a reciprocating piston that moves back and forth inside a cylinder to create suction and discharge pressure. The backward motion creates a vacuum drawing fluid into the chamber, while the forward motion pressurizes and expels it. They are widely used for high-pressure fluid transfer and precision dosing applications.

9.7 India Solar Pump Market Size (FY2019-FY2030)

Chart: India: Solar Pumps Market Trends and Forecast (in INR Crore), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

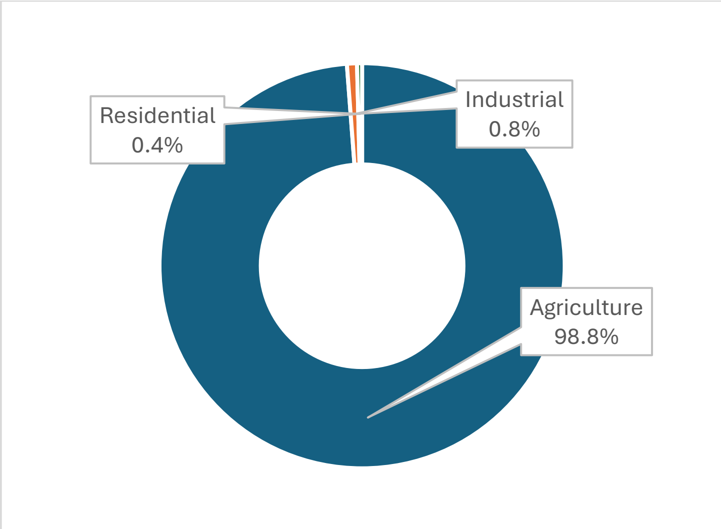
The India solar pumps market size was valued at INR 8,929 crore in FY2025 and is projected to reach INR 29,575 crore by FY2030, growing at a CAGR of 26.2% from FY2026 to FY2030.

The growth of the solar pumps market in India is strongly supported by increasing deployment under various government-led renewable energy and irrigation programmes. The rising number of installed off-grid solar photovoltaic (SPV) pumps highlights the accelerating adoption of solar-powered irrigation solutions across rural and off-grid regions. As per data released by the Ministry of New and Renewable Energy, the cumulative installation of off-grid SPV pumps increased significantly to 10,86,333 units as on 31.03.2025, compared to 630,189 units as on 31.03.2024, reflecting rapid year-on-year expansion driven by subsidy schemes and rural electrification initiatives. Additionally, 150,866 solar pumps were installed during FY2022–2023 alone under the off-grid SPV programme, underscoring sustained government push toward solar-based irrigation infrastructure.

This large-scale deployment is further propelled by the need to ensure reliable irrigation amid erratic monsoon patterns, rising diesel costs, and limited grid connectivity in remote agricultural areas. Solar pumps provide a cost-effective and sustainable alternative to conventional diesel and electric pumps, reducing operational expenses and carbon emissions while improving farm productivity. Continued policy support, coupled with increasing farmer awareness and financing access, is expected to sustain the strong installation momentum and remain a key driver for the solar pumps market growth in India.

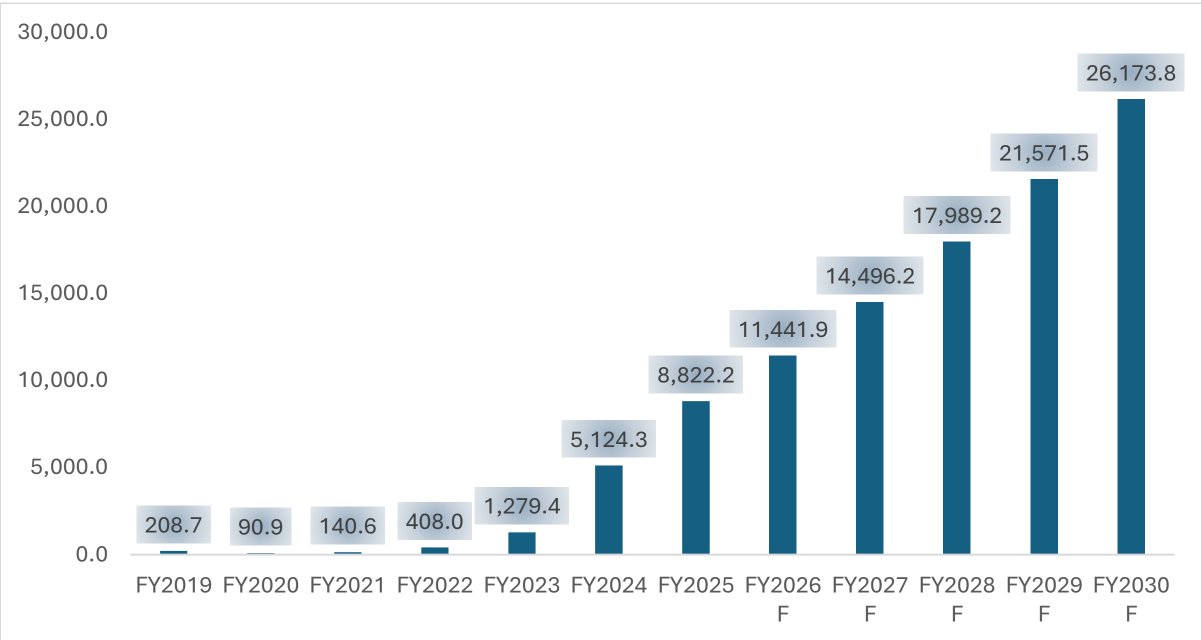
9.7.1 Market by Component

Chart: Component wise share of solar pumps market, FY2025



9.7.1.1 Agriculture

Chart: India: Solar Pumps (Agriculture) Market Trends and Forecast (in INR Crore), FY2019-FY2030F



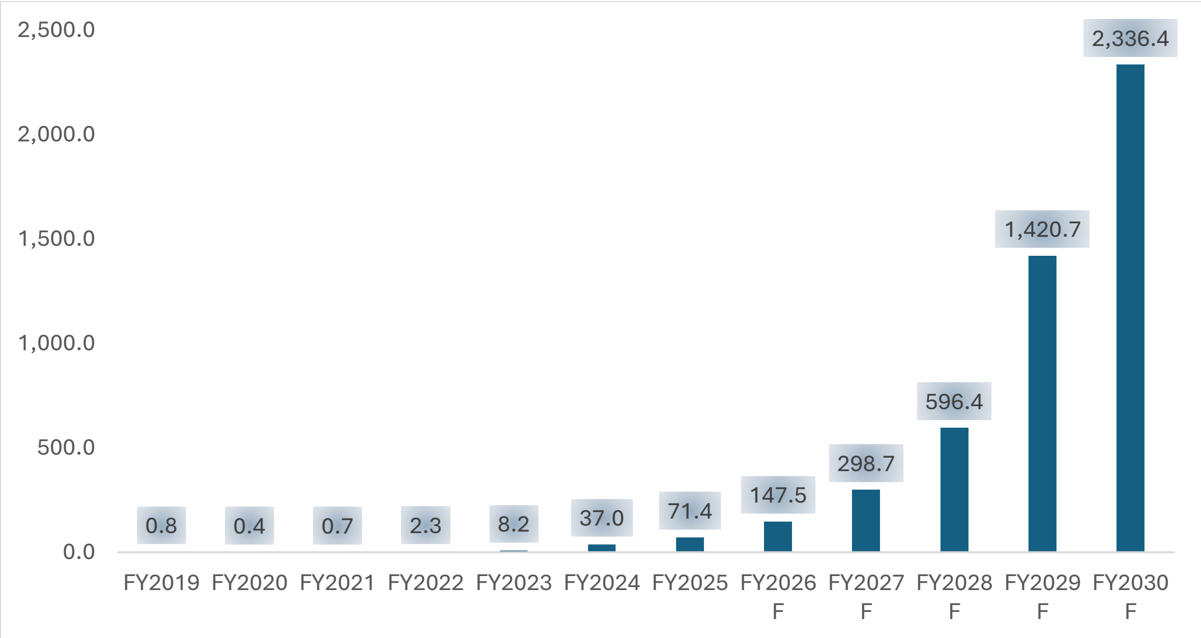
Source: Expert interactions, IMARC, ICRA Analytics

The agriculture solar pumps segment in India was valued at INR 8,822.2 crore in FY2025 and is projected to reach INR 26,173.8 crore by FY2030, registering a CAGR of 23.0% during FY2026–FY2030.

Agriculture remains the significant end-use segment for solar pumps in India, supported by strong government initiatives promoting solar irrigation to enhance farm productivity and reduce diesel usage. Rising groundwater extraction needs, erratic rainfall patterns, and limited access to reliable electricity in rural areas are key factors accelerating adoption among farmers. Large-scale deployment under various renewable energy programmes has significantly expanded the installed base, making solar pumps a viable and sustainable irrigation solution. The increasing focus on reducing input costs, ensuring daytime reliable irrigation, and promoting climate-resilient farming practices continues to drive strong demand for solar pumps in the agricultural sector.

9.7.1.2 Industrial

Chart: India: Solar Pumps (Industrial) Market Trends and Forecast (in INR Crore), FY2019-FY2030F



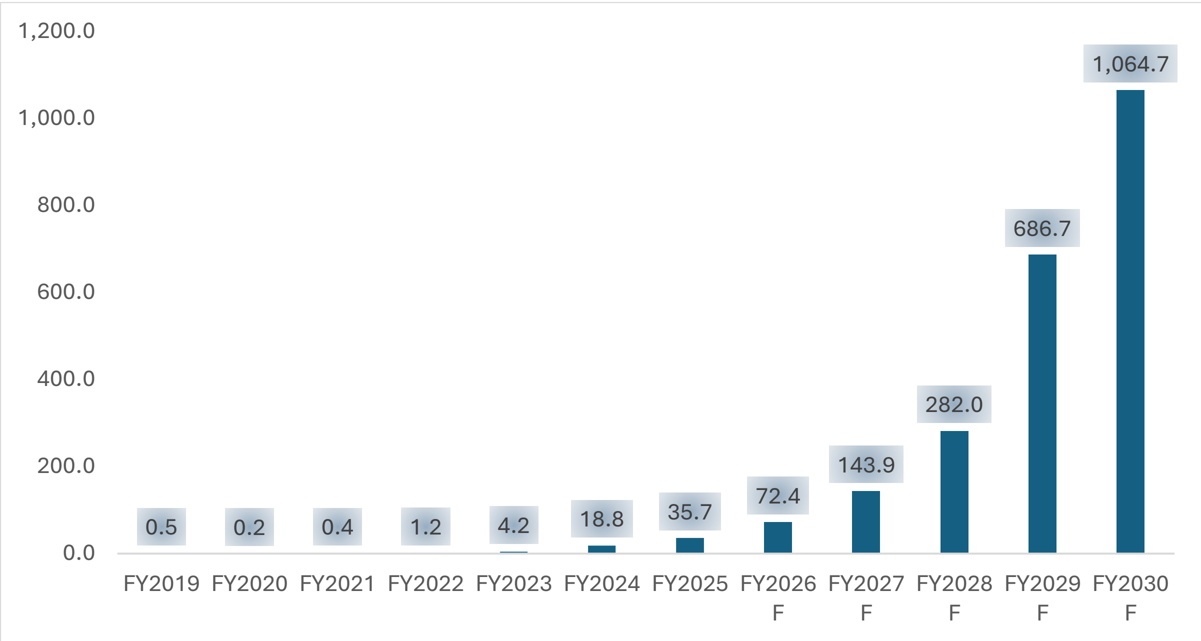
Source: Expert interactions, IMARC, ICRA Analytics

The industrial solar pumps segment in India was valued at INR 71.4 crore in FY2025 and is projected to reach INR 2,336.4 crore by FY2030, growing at a CAGR of 99.5% during FY2026–FY2030.

In the industrial segment, demand for solar pumps is rising due to increasing emphasis on energy cost optimization and sustainability across sectors such as manufacturing, mining, water treatment, and oil & gas. Industries are progressively adopting solar-powered pumping solutions for process water circulation, effluent treatment plants (ETPs), and cooling water applications to reduce dependence on grid electricity and diesel generators. Additionally, growing regulatory focus on reducing carbon emissions and improving energy efficiency is encouraging industries to integrate solar pumping systems into their operations, especially in remote industrial sites with unreliable grid connectivity.

9.7.1.3 Residential

Chart: India: Solar Pumps (Residential) Market Trends and Forecast (in INR Crore), FY2019-FY2030F



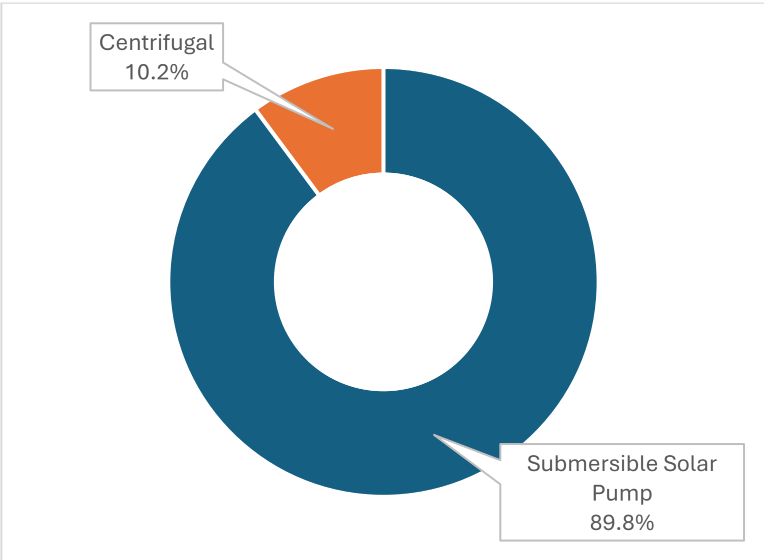
Source: Expert interactions, IMARC, ICRA Analytics

The residential solar pumps segment in India was valued at INR 35.7 crore in FY2025 and is expected to reach INR 1,064.7 crore by FY2030, expanding at a CAGR of 95.8% during FY2026–FY2030.

The residential segment is witnessing gradual adoption of solar pumps driven by rising demand for sustainable water supply solutions in independent houses, housing societies, and rural households. Solar pumps are increasingly used for domestic water lifting, overhead tank filling, and small-scale irrigation in peri-urban and rural areas where grid supply is inconsistent. Increasing awareness about renewable energy, coupled with falling solar PV costs and supportive subsidy programmes, is improving affordability and encouraging households to shift toward solar-powered water pumping systems for long-term savings and energy independence.

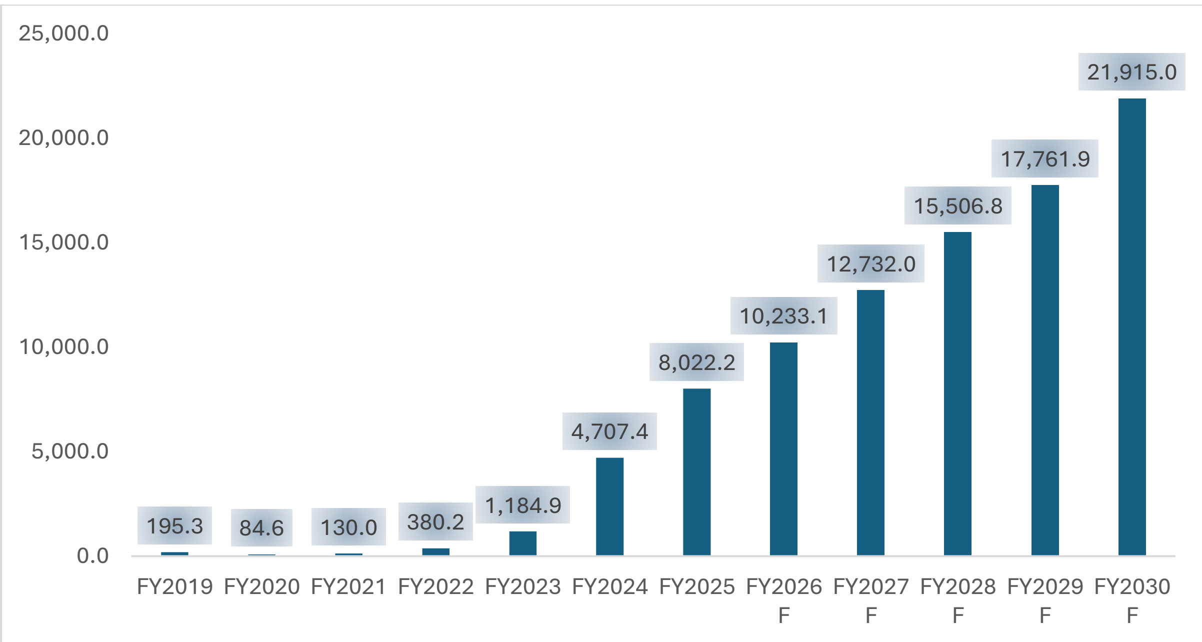
9.7.2 Market by Type

Chart: Type wise share of solar pumps market, FY2025



9.7.2.1 Submersible Solar Pump

Chart: India: Solar Pumps (Submersible Solar Pump) Market Trends and Forecast (in INR Crore), FY2019-FY2030F



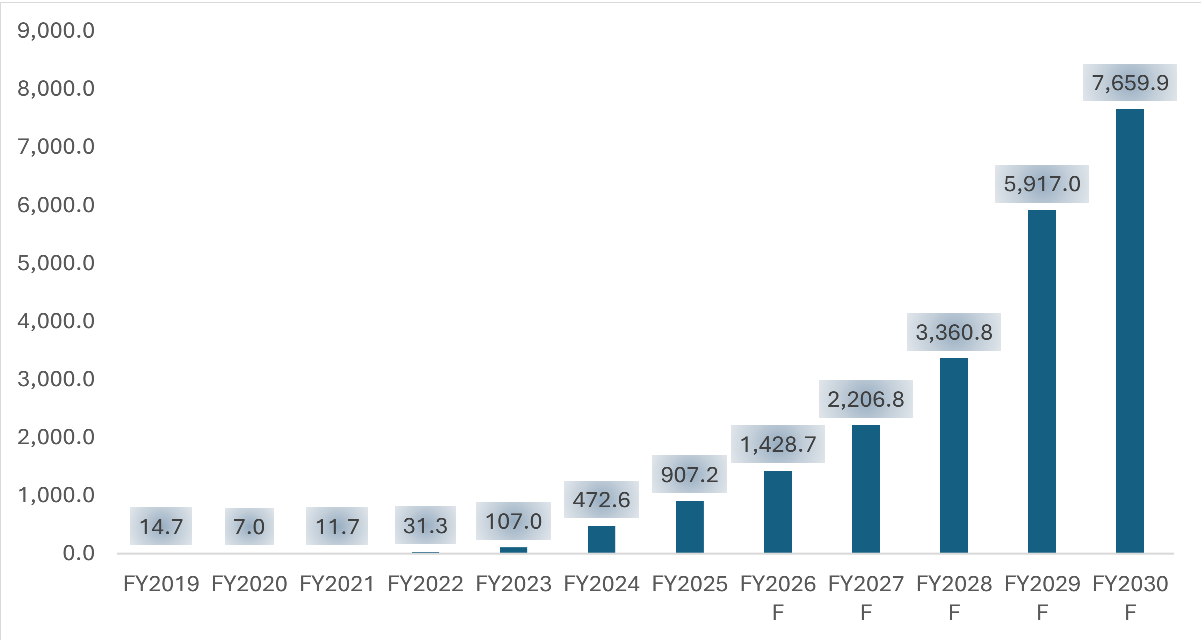
Source: Expert interactions, IMARC, ICRA Analytics

The submersible solar pumps segment in India was valued at INR 8,022.2 crore in FY2025 and is projected to reach INR 21,915.0 crore by FY2030, growing at a CAGR of 21.0% during FY2026–FY2030.

Submersible solar pumps account for a significant share of the India solar pumps market due to their suitability for deep borewells and regions facing declining groundwater levels. Increasing groundwater extraction for irrigation, coupled with unreliable grid power in rural areas, is driving strong adoption of submersible solar pumps among farmers. Government subsidy programmes and rural electrification initiatives further support installations, as these pumps provide reliable and efficient water lifting from deeper aquifers, ensuring consistent irrigation and improved crop productivity.

9.7.2.2 Centrifugal

Chart: India: Solar Pumps (Centrifugal) Market Trends and Forecast (in INR Crore), FY2019-FY2030F



Source: Expert interactions, IMARC, ICRA Analytics

The centrifugal solar pumps segment in India was valued at INR 907.2 crore in FY2025 and is expected to reach INR 7,659.9 crore by FY2030, expanding at a CAGR of 52.2% during FY2026–FY2030.

Centrifugal solar pumps are widely used for surface water sources such as canals, ponds, and shallow wells, making them suitable for small and medium farms. Their relatively lower cost, simple design, and ease of installation are key factors driving adoption in regions with adequate surface water availability. These pumps are also increasingly deployed for community water supply, livestock watering, and small-scale irrigation projects, particularly in off-grid rural areas where daytime solar-powered pumping offers a cost-effective alternative to diesel pumps.

9.8 Main Components of a Solar Pumping System

A typical solar-powered irrigation pumping system comprises multiple integrated components that work together to convert solar energy into hydraulic energy for water pumping. The key components are as follows:

- Solar Panels: Solar photovoltaic (PV) panels capture sunlight and convert it into direct current (DC) electricity, which serves as the primary power source for the solar pumping system.
- Solar Inverter (for AC pumps only): If the pump operates on an AC motor, a solar inverter is required to convert DC electricity generated by the solar panels into AC power suitable for the motor.
- Solar Pump (Hydraulic Unit): The solar pump is the main hydraulic component that lifts and transfers water from the source (borewell, canal, river, or tank) to the required destination for irrigation or storage. It can be of different types such as submersible or surface centrifugal pumps.
- Electric Motor (AC or DC): The motor utilizes the electricity generated by solar panels to drive the pump and draw water from sources such as borewells, rivers, canals, or storage tanks.
- Pump Controller / Drive: This component manages power flow, ensures smooth motor operation, and protects the pump from voltage fluctuations and dry-run conditions.
- Battery Storage (Optional Component): Battery storage systems, typically lithium-based, store excess solar energy generated during the day. This enables pump operation during nighttime or periods of low solar irradiation, though many agricultural systems operate without batteries to reduce cost.
- Piping and Wiring: These components interconnect the solar panels, controller, motor, and pump, and are responsible for transporting water from the source to the required irrigation or storage point.

9.9 Key Initiatives Driving Growth in Agricultural Pumps Segment

- **Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan (PM-KUSUM):** The PM-KUSUM scheme is the flagship national initiative driving the adoption of solar-powered agricultural pumps in India. Launched in March 2019 and extended until March 2026, the scheme aims to reduce diesel usage in irrigation, ensure reliable daytime electricity supply for farmers, and increase their income through decentralized solar power generation. It targets the addition of around 34,800 MW of solar capacity with a total central financial support of INR 34,422 crore. The scheme operates through three components:
    - Component-A: Installation of 10,000 MW decentralized grid-connected renewable power plants by farmers, cooperatives, and panchayats.
    - Component-B: Deployment of 14 lakh standalone off-grid solar agricultural pumps.
    - Component-C: Solarisation of 35 lakh existing grid-connected agricultural pumps, including feeder-level solarisation.

Under Components B and C, farmers receive 30% central subsidy on benchmark costs (up to 50% in special category states), with additional support from states and the remaining contribution from beneficiaries. Progress has been substantial, with over 10.9 lakh pumps already solarized and more than INR 7,100 crore in financial assistance released as of 30th November 2025, highlighting the scheme's strong role in scaling solar irrigation nationwide.

- **Pradhan Mantri Krishi Sinchai Yojana – Per Drop More Crop (PDMC):** The PDMC component of PMKSY promotes efficient irrigation practices and supports installation of water-lifting devices including solar pump sets, along with micro-irrigation technologies such as drip and sprinkler systems. By improving water-use efficiency and encouraging energy-efficient pumping solutions, the scheme indirectly drives demand for solar irrigation pumps. Between 2015-16 and 2025-26, around 96.83 lakh hectares have been covered under micro-irrigation with central assistance exceeding INR 23,000 crore, indicating strong government backing for efficient irrigation infrastructure that complements solar pump adoption.

- **State-Level Solar Pump Subsidy Programs:** Several state governments have launched dedicated subsidy schemes to accelerate solar pump deployment, particularly for small and marginal farmers. These programs typically provide subsidies on solar irrigation pumps to reduce upfront installation costs and promote sustainable irrigation practices. For instance, the horticulture department in Karnataka has introduced a dedicated subsidy scheme offering up to 50% financial assistance on solar-powered irrigation pumps for farmers in Mysuru and Chamarajanagar districts. Under the program, farmers can receive approximately INR 1 lakh support for a 3 HP solar pump and up to INR 3 lakh for a 5 HP pump. The initiative aims to reduce operational costs associated with diesel or grid-powered irrigation and promote environmentally sustainable farming practices.

- **Large-Scale Solar Pump Deployment Initiatives:** Rapid implementation programs under central and state schemes have significantly boosted adoption of solar irrigation pumps. For instance, Maharashtra has emerged as a leader in solar irrigation adoption through aggressive implementation of central and state-level programs. The state achieved a record milestone by installing 45,911 off-grid solar agricultural pumps within a span of 30 days under the combined implementation of the Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan Component B and the Magel Tyala Saur Krushi Pump Yojana.

9.10 End-Use Industries that the Pump Manufacturers Cater to

Table: End-Use Industries Catered to by Key Pump Manufacturers in India

End Use Industries	Agriculture	Chemicals	Pharmaceuticals	Real estate	Metals & mining	Sewage & water treatment	Hotels, malls & corporates	Others
Shakti Pumps (India) Ltd.	✓	✗	✗	✓	✗	✓	✓	✓
Oswal Pumps Limited	✓	✗	✗	✓	✗	✓	✗	✓
C.R.I. Pumps Private Limited	✓	✗	✗	✗	✓	✓	✗	✓

End Use Industries	Agriculture	Chemicals	Pharmaceuticals	Real estate	Metals & mining	Sewage & water treatment	Hotels, malls & corporates	Others
Unnati Pumps Pvt Ltd.	✓	✗	✗	✓	✗	✗	✗	✓
Kirloskar Brothers Limited (KBL)	✓	✗	✗	✓	✗	✗	✗	✓
Lubi Industries LLP	✓	✗	✗	✓	✗	✗	✓	✓
Tata Power Solar Systems Ltd.	✓	✗	✗	✗	✗	✗	✗	✓
Gen Creative Engineers Limited (Malhar Pumps)	✓	✗	✗	✗	✗	✗	✗	✓
Latteys Industries Pvt. Ltd	✓	✗	✗	✗	✗	✗	✗	✓
Novergy Energy Solutions Pvt. Ltd.	✓	✗	✗	✗	✗	✗	✗	✓
Royal Instrument India Private Limited	✓	✗	✗	✗	✗	✗	✗	✓
Crompton Greaves Consumer Electricals Limited	✓	✗	✗	✗	✗	✗	✗	✓

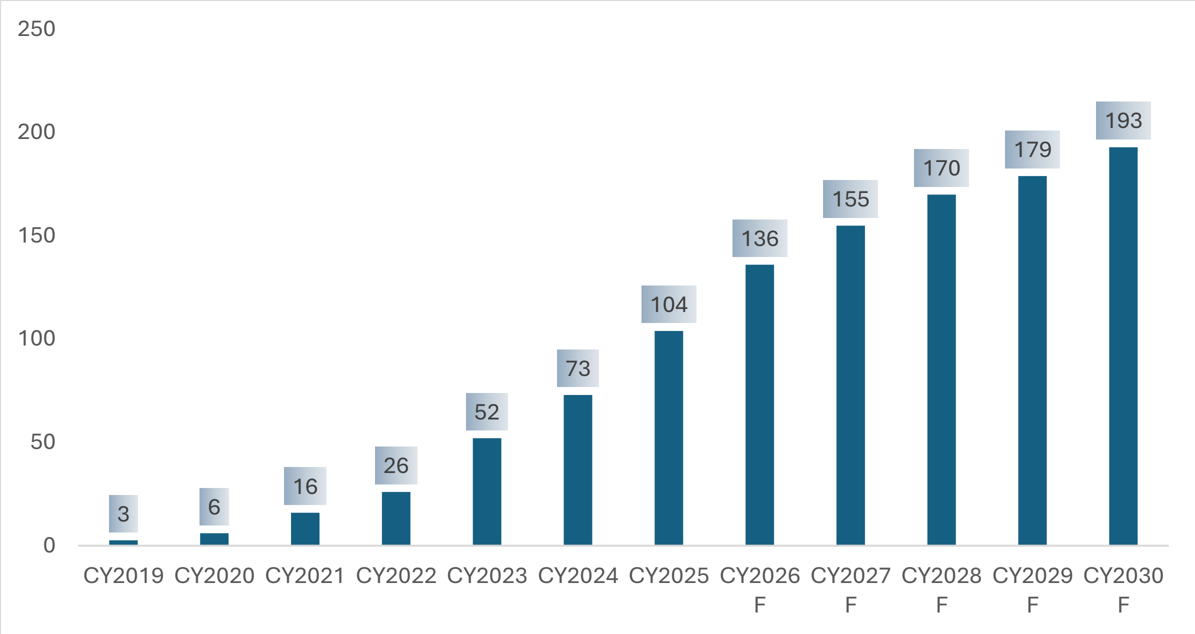
Source: IMARC, ICRA Analytics

10. Bess Market in India

10.1 Global Consumption Trend

Market Trends and Forecast

Chart: Global: BESS Market: Installation Trends (in GW), CY2019-CY2030 F



Source: Rystad Energy Storage Solution, Expert Interactions, IMARC, ICRA Analytics

Global battery energy storage system (BESS) installations have grown at an extraordinary pace, increasing from roughly 3 GW in CY2019 to about 104 GW in CY2025. This represents a very strong compound annual growth rate (CAGR) of approximately 84.9% during the period CY2019–CY2025. The rapid expansion has been largely driven by accelerated deployment of renewable energy, substantial reductions in lithium-ion battery costs, rising demand for grid flexibility, and growing investments in utility-scale storage infrastructure across the world. In addition, supportive policy initiatives, the development of ancillary service markets, and the increasing need to manage intermittency from solar and wind generation have further boosted the adoption of both grid-scale and behind-the-meter energy storage solutions across developed as well as emerging economies.

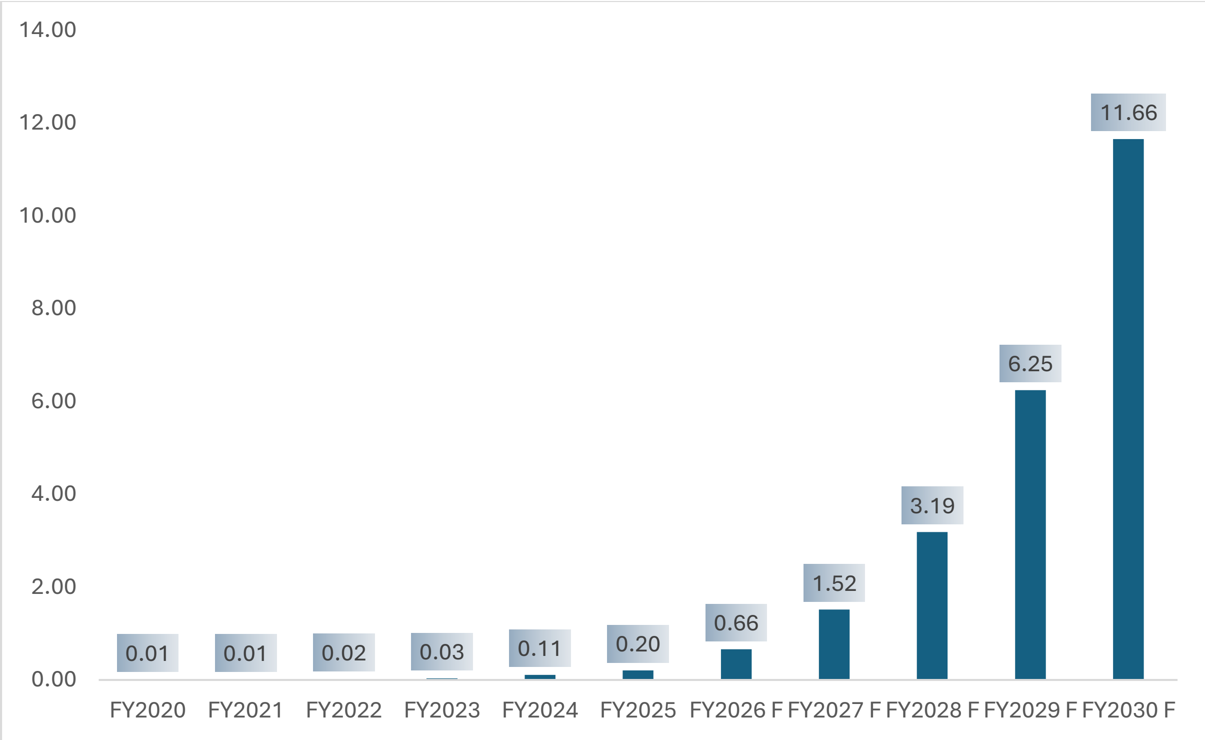
Hybrid power projects typically involve the integration of solar power with complementary energy sources and storage solutions to enable more stable and reliable power generation, while energy storage systems facilitate storage and dispatch of electricity based on demand requirements. The increasing penetration of renewable energy in India has led to a growing need for solutions that address intermittency and variability in solar power generation. Hybrid projects and energy storage systems are being adopted to enhance grid stability, improve power quality and enable efficient utilization of renewable energy.

Looking ahead, annual global BESS installations are expected to reach close to 193 GW by CY2030, reflecting a projected CAGR of around 9.1% during CY2026–CY2030. This future growth will be driven by stronger global decarbonization commitments, deeper integration of renewable energy into power systems, rising electrification of transportation and industrial sectors, and the growing deployment of hybrid renewable-plus-storage projects. Such projects are designed to deliver firm and dispatchable clean power while also improving grid stability, reliability, and resilience.

10.2 Market Trends and Forecast of BESS Market in India

Market Trends and Forecast

Chart: India: BESS Market: Installed Capacity Trends (in GW), FY2019-FY2030 F



Source: Central Electricity Authority (CEA), Expert Interactions, IMARC, ICRA Analytics

Battery Energy Storage System (BESS) capacity in India has expanded from a very small base of about 0.01 GW in FY2020 to nearly 0.20 GW by FY2025, reflecting an exceptionally high CAGR of around 100.0% during FY2020–FY2025. This rapid growth has been supported by increasing penetration of renewable energy, initial grid-scale storage pilot projects, and growing adoption within the commercial and industrial (C&I) segment for applications such as peak load management and replacement of diesel-based power. Policy initiatives including viability gap funding schemes, renewable tenders linked with storage requirements, and the rising demand for firm and dispatchable renewable power have also played an important role in accelerating early deployments across renewable-rich states such as Gujarat, Rajasthan, Maharashtra, and Andhra Pradesh.

Looking ahead, India's BESS installed capacity is expected to rise significantly to around 11.66 GW by FY2030, representing a projected CAGR of approximately 105.1% during FY2026–FY2030. This strong expansion is likely to be driven by the introduction of energy storage obligations for distribution utilities, increasing issuance of hybrid and round-the-clock renewable energy tenders, continuous reductions in battery costs, and the growing requirement for grid flexibility. These factors will support the integration of variable solar and wind power while enabling effective peak demand management and ensuring reliable, round-the-clock supply of clean electricity.

10.3 Potential Growth and Challenges

Growth Drivers:

- **Declining Lithium-Ion Battery Costs Strengthening Project Viability:** Rapid reductions in lithium-ion battery prices are significantly improving the economic feasibility of grid-scale storage projects in India. Bloomberg NEF reports that global battery pack prices declined by about 8% since 2024, reaching a record low of approximately USD 108/kWh in 2025. This trend has been driven by excess cell manufacturing capacity, heightened global competition, and the growing adoption of cost-effective lithium iron phosphate (LFP) battery chemistries. Lower battery prices directly reduce the capital cost of BESS installations, enabling more competitive tariffs in storage tenders and improving the financial viability of large-scale renewable-plus-storage projects across the country.

- **Strong Government Backing through VGF and PLI Incentives:** Government support is playing a crucial role in accelerating the early development of the energy storage market. The second tranche of the Viability Gap Funding (VGF) scheme, announced in 2025, provides support of INR 18 lakh/MWh for a new 30 GWh storage programme, backed by INR 5,400 crore from the Power System Development Fund. This initiative builds on the previously sanctioned 13.2 GWh pipeline already under implementation and is expected to mobilize investments of nearly INR 33,000 crore while speeding up storage deployment ahead of 2028. Additionally, the INR 18,100 crore Production Linked Incentive (PLI) scheme for Advanced Chemistry Cell (ACC) manufacturing seeks to establish a domestic battery manufacturing ecosystem, reduce reliance on imports, and enhance long-term cost competitiveness of energy storage systems.
- **Expanding Renewable Energy Capacity Driving Structural Demand for Storage:** India's ambition to achieve 500 GW of non-fossil fuel power capacity by 2030 is creating a strong structural requirement for large-scale energy storage solutions. As the share of solar and wind energy in the generation mix continues to increase, BESS is becoming critical for managing intermittency, addressing peak demand fluctuations, and reducing renewable energy curtailment. Energy storage systems help balance supply-demand mismatches, smooth variable renewable energy (VRE) output, and ensure reliable grid operations during evening peak demand periods and times of low renewable generation.
- **Energy Storage Obligation (ESO) Mandate for DISCOMs:** The introduction of Energy Storage Obligations for distribution companies is expected to create sustained long-term demand for storage capacity. The requirement begins at 1% of total electricity consumption in FY2024 and is scheduled to increase gradually to 4% by FY2030. Notably, around 85% of the stored electricity must be sourced from renewable energy, encouraging utilities to procure BESS capacity for applications such as renewable energy firming, peak load management, and grid stabilization. This regulatory mandate establishes a predictable procurement pipeline and improves revenue visibility for storage projects.
- **Growing Project Pipeline and Increasing Tender Activity:** India's BESS sector is experiencing strong growth, as reflected in rising tender volumes. According to the *India Energy Storage Market Report 2025*, total energy storage tendering reached approximately 102 GWh in 2025, about 1.4 times higher than in 2024. Standalone BESS tenders saw particularly sharp growth, increasing to around 60 GWh in 2025 compared with 24 GWh in 2024 and just 4 GWh in 2023. Since 2018, a cumulative 155 energy storage tenders amounting to roughly 224 GWh have been issued, indicating the sector's transition from pilot projects to large-scale commercial deployment. This expanding project pipeline provides strong visibility for future capacity additions and demonstrates continued policy and market support for large-scale energy storage in India.
- **Peak-Tariff Arbitrage Driving Adoption in C&I and Data Center Segments:** Peak-tariff arbitrage has become a key factor driving BESS adoption among commercial and industrial consumers as well as data centers. Energy storage systems enable these users to shift electricity consumption from high-cost peak hours to lower-cost off-peak periods. With the

widening gap between peak and off-peak tariffs under Time-of-Day (ToD) pricing structures, BESS helps high-energy users reduce operating expenses, minimize reliance on diesel-based backup generation, and improve their overall sustainability profile.

Challenges:

- **Regulatory Uncertainty in Asset Classification and Tariff Frameworks:** The regulatory status of BESS, whether it should be treated as a generation, transmission, or distribution asset continues to evolve, leading to uncertainties around revenue models and cost recovery mechanisms. Lack of clarity regarding tariff caps, permissible returns, and the ability to stack revenues from multiple sources such as energy arbitrage, ancillary services, and capacity payments can affect project bankability and investor confidence. Additionally, the absence of a uniform tariff framework across states results in varying procurement models and can contribute to delays in project finalization.

- **High Dependence on Imported Battery Supply Chains:** India's energy storage ecosystem currently relies heavily on imported lithium-ion cells and key components, largely sourced from East Asian manufacturing centres. This dependence exposes developers to risks associated with currency fluctuations, supply chain disruptions, and price volatility, while also limiting domestic value creation. Although initiatives to establish local battery manufacturing are underway, the existing reliance on overseas suppliers continues to present logistical, cost, and strategic challenges for large-scale BESS deployment.

- **Participation Gaps in Tenders and Delays in Project Execution:** Despite the rising number of storage tenders issued, some auctions have experienced limited participation or slower project implementation. This is often due to aggressive tariff expectations, evolving technical standards, and uncertainties surrounding long-term revenue structures. Developers may also encounter difficulties in securing project financing, negotiating supply agreements, and adapting to changing regulatory requirements, which can delay the transition from awarded tenders to operational projects.

- **Geopolitical Risks in Critical Mineral Supply Chains:** The global BESS supply chain is highly dependent on key minerals such as lithium, cobalt, and nickel, which are concentrated in a limited number of regions. Geopolitical tensions, export restrictions, and supply concentration risks can influence the availability and pricing of these raw materials, thereby impacting battery procurement costs and overall project economics. These challenges highlight the importance of diversifying sourcing strategies, strengthening battery recycling capabilities, and exploring alternative chemistries such as lithium iron phosphate (LFP) and sodium-ion to improve long-term supply security.

10.4 System Integrators already in India

- **Servotech Renewable Power System Ltd:** In September 2025, Servotech entered into an exclusive strategic alliance with Zhuhai Piwin New Energy Co., Ltd. (Pilot Group) to collaborate on technology support and domestic production of advanced BESS solutions in India. The partnership integrates Piwin's global expertise in energy storage with Servotech's local manufacturing and deployment strengths, supporting the objectives of the 'Make in India' initiative.

- **ACME Solar Holdings Ltd:** In July 2025, ACME Solar placed orders exceeding 3.1 GWh with Chinese storage solution providers Trina Storage and Narada Power for several FDRE and hybrid renewable-plus-storage projects across India. This procurement represents one of the largest BESS orders placed in the country to date.

- **Evervolt Green Energy Pvt. Ltd.:** In February 2026, Evervolt formed a strategic collaboration with Beijing HyperStrong Technology Co., Ltd. to distribute and promote advanced BESS solutions in India and Sri Lanka. Under the agreement, HyperStrong will offer technology support, product expertise, and training to strengthen deployment of storage solutions, particularly in the commercial and industrial (C&I) segment.

- **GP Eco Solutions India Ltd (through subsidiary Invergy India):** In late 2025, Invergy India signed a memorandum of understanding and supply agreement with Shenzhen Sinexcel Electric Co., Ltd. for 3 GW of power testers. The collaboration includes plans to develop India's largest BESS testing and manufacturing facility, aimed at enhancing domestic energy storage capabilities while utilizing advanced Chinese power electronics technology.

- **Tata AutoComp Systems Ltd:** In November 2023, Tata AutoComp, via its joint venture with Chinese battery manufacturer Gotion High-Tech supplied lithium-ion BESS units for a Tata Power energy storage park project in India. This project highlighted a localized assembly model supported by Chinese cell technology. Additionally, Chinese firm Sungrow was contracted by Tata Power Solar to provide BESS units for a 50 MWh energy storage project in Ladakh.

10.5 BESS Manufacturing in India

- **Expansion of Domestic Cell and Pack Manufacturing Capacity:** Several Indian battery manufacturers are making substantial investments in lithium-ion cell and pack production to serve both electric mobility and stationary energy storage markets. Amara Raja Energy & Mobility is establishing a gigafactory in Telangana with an initial capacity of 1 GWh for NMC cells by FY2027, with long-term plans to scale up to around 16 GWh to cater to both EV and energy storage applications. The company already operates battery pack assembly facilities for stationary storage at Tirupati and maintains technology partnerships for both NMC and LFP chemistries. Similarly, Exide Industries is developing a lithium-ion cell manufacturing facility that is expected to begin production by the end of FY2026. The plant will initially manufacture cylindrical NMC cells, followed by prismatic LFP cell lines targeted primarily at stationary BESS applications. These developments reflect a strategic shift toward building domestic cell manufacturing capabilities to reduce import dependence and strengthen supply chain resilience. Meanwhile, Ola Electric has already started operations at its gigafactory but has postponed its previously planned capacity expansion due to slower-than-expected growth in the electric vehicle market. The company now intends to maintain its cell manufacturing capacity at about 5 GWh until FY2029, compared to its earlier plan of achieving 20 GWh capacity by mid-2026.

- **Gigafactory Investments and Vertical Integration:** Large-scale integrated manufacturing facilities are becoming an important trend in India's energy storage ecosystem. In February 2026, Waaree Energies announced plans to establish a lithium-ion battery gigafactory of around 16 GWh capacity in Andhra Pradesh, involving an investment exceeding INR 8,000 crore. The proposed facility will cover the entire battery value chain including cell manufacturing, battery packs, and large-scale BESS solutions supporting renewable energy integration, enhancing grid stability, and strengthening India's domestic manufacturing capabilities.

- **New Entrants and Containerised BESS Manufacturing:** New engineering, procurement, and construction (EPC)-focused players are also entering the BESS manufacturing space. Pace Digitek has announced plans to manufacture containerised BESS solutions and develop a combined manufacturing capacity of about 10 GWh. The company is also exploring backward integration through container fabrication units to reduce system costs and increase domestic value addition. Recent EPC project wins for BESS installations with public sector agencies highlight the rising role of integrator-led manufacturing in India's storage market.

- **Technology Partnerships and Automated Assembly Ecosystems:** Strategic collaborations aimed at technology transfer and manufacturing automation are helping strengthen India's lithium battery production landscape. In late 2025, Cliantech Solutions partnered with Encore Systems to deploy turnkey automated assembly lines for lithium cells, modules, battery packs, and container-level BESS systems. These Industry 4.0-enabled manufacturing solutions improve traceability, quality assurance, and scalability, enabling gigawatt-scale production capacity to meet the country's growing storage demand.

- **Hybrid Localization by Global Manufacturers:** Global energy storage technology companies are also exploring localized manufacturing strategies to tap into India's rapidly expanding BESS market. Envision Group is evaluating the establishment of a battery assembly facility of approximately 5 GWh capacity in India. Under this model, battery cells would be imported from China, while rack assembly, integration, and software infrastructure would be localized. This hybrid manufacturing approach combines global supply chain advantages with domestic value addition, supporting India's clean-energy localization efforts.

- **Adani Group's Entry into the BESS Sector with a Mega Storage Project:** The Adani Group has announced its entry into the Battery Energy Storage Systems (BESS) segment through a major project of 1126 MW / 3530 MWh in Ahmedabad, expected to be commissioned by March 2026. The project will utilize more than 700 BESS containers to store around 3530 MWh of energy and deliver 1126 MW of power for approximately three hours. Once operational, it will represent the largest BESS installation in India and one of the largest single-location energy storage projects globally.

10.6 Government Policy Towards BESS in India

- **Mandatory Co-located Storage in Solar Tenders:** The Ministry of Power (MoP) issued an advisory requiring all solar tenders to include a co-located energy storage system with a minimum duration of two hours and sized at 10% of the solar project capacity. The Central Electricity Authority (CEA) later clarified that this requirement will apply only to future tenders and will not impact projects that have already been awarded or are currently under development, including residential rooftop programmes such as the PM Surya Ghar: Muft Bijli Yojana. The policy aims to ensure more stable renewable power output, reduce curtailment, and enhance grid flexibility while maintaining continuity in existing project pipelines.

- **Viability Gap Funding (VGF) – Second Phase:** The Government has approved INR 5,400 crore (around USD 631 million) under the second tranche of the VGF scheme to support the development of 30 GWh of battery energy storage capacity. The programme offers financial assistance of INR 0.18 crore per MWh, released in three stages based on the achievement of project milestones. This support mechanism is expected to improve project bankability, accelerate large-scale storage deployment, strengthen grid reliability, and attract both domestic and international investment into India's energy storage sector.

- **Revisions to Renewable Energy Bidding Guidelines:** The MoP has updated renewable energy bidding guidelines to formally incorporate provisions for energy storage integration, particularly for firm and dispatchable renewable power projects combined with energy storage systems. These revisions aim to simplify regulatory approvals, address delays caused by multiple oversight agencies, and modify performance guarantee requirements to better align with hybrid renewable-plus-storage project structures.

- **Tariff-Based Competitive Bidding Framework for Pumped Storage Projects:** On 6 February 2025, the MoP introduced tariff-based competitive bidding (TBCB) guidelines for procuring pumped storage projects (PSPs), recognizing pumped hydro as a complementary long-duration storage technology alongside battery storage. The framework outlines eligibility conditions, procurement structures, and contractual safeguards, while offering flexible tariff mechanisms such as separate storage charges or bundled tariffs, thereby supporting wider adoption of long-duration storage solutions.

- **Expansion of OTC Power Market Instruments by CERC:** The Central Electricity Regulatory Commission (CERC) proposed expanding over-the-counter (OTC) power market instruments to include BESS contracts, virtual power purchase agreements (VPPAs), capacity contracts, renewable energy certificates, and power banking arrangements. Importantly, this reform recognizes BESS contracts as tradable financial instruments, allowing storage assets to generate predictable revenue streams while supporting renewable energy integration and peak demand management.

- **Draft Amendment to Electricity Rules, 2005 – Commercialization of ESS:** The Ministry of Power has proposed amendments allowing energy storage systems to be sold, leased, or rented. This change enables utilities, consumers, and independent developers to own and operate storage infrastructure. It also introduces new business models such as shared storage and storage-as-a-service, thereby expanding access to storage solutions and recognizing energy storage as an independent market asset.

- **Draft Second Amendment to Tariff Regulations, 2024:** CERC has proposed a dedicated tariff framework for energy storage systems integrated with conventional generation sources such as coal, lignite, and gas as well as with interstate transmission systems. The framework outlines separate fixed capacity and energy charges, pass-through mechanisms for charging electricity costs, incentives for additional discharge, defined operating norms, and a standardized battery life of 12 years. It also specifies cost and revenue sharing mechanisms aimed at improving financial transparency for integrated storage projects.

- **Electricity (Amendment) Rules, 2025 – Expanding ESS Applications:** The Electricity (Amendment) Rules, 2025 broaden the role of energy storage systems across the entire electricity value chain. The rules allow generators, transmission and distribution licensees, system operators, and independent storage providers to own and operate ESS. They also classify standalone storage as a grid asset, expand scheduling access, and assign ESS the same legal status as its owner, thereby facilitating smoother integration into power system planning and operations.

- **Regulatory Relaxations and Incentives for Pumped Storage Projects:** The government has introduced regulatory relaxations to accelerate pumped storage development. Off-stream closed-loop PSP projects are now exempt from mandatory CEA concurrence regardless of project cost, although technical consultation with CEA remains necessary. For other hydroelectric projects exceeding INR 3,000 crore, CEA approval continues to be required. In addition, waivers on interstate transmission system (ISTS) charges have been extended for PSP projects with construction contracts awarded on or before 30 June 2028, and the approval timeline for detailed project reports by CEA has been reduced from 90 days to 50 days.

- **Connectivity Flexibility and Domestic Technology Requirements:** The Ministry of Power has permitted BESS projects to connect either to the intra-state transmission system (InSTS) or the interstate transmission system (ISTS), with project selection documents clearly specifying responsibilities related to land acquisition and grid connectivity. The updated guidelines also require that the energy management system (EMS) software used in BESS be developed domestically, mandate strict quality standards, and prohibit the use of refurbished battery cells to ensure reliability and promote indigenous technological capabilities.

11. Threats And Challenges of the Products and Services Offered

11.1 Off Grid Solar Pump Types

11.1.1 Surface Pumps

Limited Suitability for Deep Water Sources: Surface solar pumps are generally designed for use with shallow water sources such as open wells, ponds, and canals. However, the continuous decline in groundwater levels across several agricultural regions is gradually reducing their effectiveness. When water levels drop beyond the suction capacity of surface pumps, farmers often need to adopt deeper-lift submersible pump systems, which can limit the long-term relevance and market potential of surface pump technologies.

Component Exposure and Higher Maintenance Needs: Because surface pump systems are installed above ground, they remain exposed to environmental elements such as dust, sand, moisture, and harsh weather conditions. Continuous exposure can accelerate mechanical wear, corrosion, and electrical deterioration, resulting in more frequent maintenance and higher lifecycle servicing costs. These issues are particularly significant in arid and semi-arid areas where dust accumulation and large temperature variations can negatively impact system performance and durability.

Strong Dependence on Solar Irradiance: The operation of surface solar pumps relies directly on real-time solar energy generation, making them highly sensitive to fluctuations in solar irradiance. During cloudy weather, monsoon seasons, or winter months with shorter daylight durations, pump output can decrease considerably. Such variability may lead to inconsistent irrigation schedules, potentially affecting crop productivity and lowering farmer confidence in standalone solar pumping systems that lack energy storage or hybrid backup.

Constraints Due to Lack of Grid Backup or Storage: Most surface solar pump installations do not incorporate battery storage or hybrid grid connectivity, meaning they depend entirely on daytime solar power. As a result, irrigation activities cannot easily be carried out during early morning, evening, or periods of low sunlight. This limitation reduces operational flexibility and may restrict efficient water management, particularly in situations where timely irrigation is critical for maintaining crop yields.

11.1.2 Submersible Pumps

Declining Groundwater Levels: Rapid depletion of groundwater resources in several agricultural states is posing challenges to the long-term sustainability of submersible solar pump systems. As water tables continue to drop, farmers are required to drill deeper borewells and deploy pumps capable of lifting water from greater depths. This increases system sizing requirements, energy consumption, and overall project costs, which can affect affordability and scalability.

High Upfront Capital Investment: Submersible solar pump installations typically require significant initial expenditure for photovoltaic modules, high-capacity pumps, controllers, and system installation. Compared with conventional diesel or grid-connected pumps, the higher capital outlay can discourage adoption among small and marginal farmers, particularly when subsidy support, concessional financing, or flexible payment options are not readily available.

Complexity in Installation and System Design: Effective deployment of submersible solar pumps requires careful assessment of borewell conditions, appropriate pump selection based on head and discharge requirements, and proper system integration. In many rural areas, the limited availability of skilled technicians and inadequate site-specific system design can result in inefficient operation, reduced pumping performance, and increased operational issues over time.

Security Concerns in Remote Agricultural Areas: Submersible solar pump systems are often installed in remote farm locations, where exposed components such as solar panels, electrical wiring, and controllers may be vulnerable to theft or vandalism. To mitigate these risks, farmers may need to invest in additional protective measures such as fencing, secure mounting structures, or monitoring systems, thereby increasing the total lifecycle cost of ownership.

Risk of Groundwater Over-Extraction and Regulatory Constraints: In water-stressed regions, the availability of solar-powered pumping systems may inadvertently encourage excessive groundwater extraction. This raises concerns about resource sustainability and may lead to stricter regulations, usage limits, or permit requirements in the future, potentially influencing system utilization and long-term demand for such technologies.

11.2 On Grid Solar

Solar Rooftops and Ground Mounted

High Initial Capital Requirement: Both rooftop and ground-mounted solar systems involve considerable upfront costs for components such as solar modules, inverters, mounting structures, and installation services. For residential, commercial, and utility-scale users, access to affordable financing and the ability to achieve reasonable payback periods remain major challenges, particularly in price-sensitive markets.

Policy and Regulatory Uncertainty: Changes in net metering regulations, open-access frameworks, and state-level solar policies occur periodically, creating uncertainty around project economics. Such regulatory shifts can slow investment decisions and affect long-term revenue predictability for both distributed rooftop installations and large-scale ground-mounted solar projects.

Land and Space Constraints: Rooftop solar installations often face limitations due to restricted roof area, structural load-bearing capacity, and shading from surrounding structures, which can limit the optimal system size. In contrast, ground-mounted solar projects require large, contiguous land parcels, where challenges related to land acquisition, zoning regulations, and competing land-use priorities may delay project development.

Weather-Related Performance Variability: Solar power generation is heavily dependent on the availability of sunlight. Seasonal fluctuations, monsoon-related cloud cover, and air pollution can reduce solar irradiance levels, resulting in lower energy output. This variability may lead to intermittency in power supply and affect projected energy generation and financial returns.

Operational and Maintenance Issues: Over time, factors such as dust accumulation on panels, inverter malfunctions, cable deterioration, and insufficient maintenance can reduce system efficiency. Rooftop installations may face difficulties with regular cleaning and servicing access, while ground-mounted plants require continuous monitoring and more extensive operational logistics, increasing overall lifecycle maintenance costs.

Supply Chain and Component Price Fluctuations: The solar sector remains partly dependent on imported modules, cells, and inverters. This reliance exposes projects to risks from currency movements, international trade policy changes, and global supply chain disruptions. Variations in component prices can impact project budgeting, profit margins, and the timely completion of installations.

11.3 Operation & Maintenance (O&M) Services

Solar projects can lose up to 20% of their energy efficiency over a 25-year lifespan without proper operation and maintenance (O&M) practices. Research by the National Renewable Energy Laboratory highlights this significant decline in photovoltaic system performance, underscoring that maintenance is not optional but essential for ensuring the longevity and efficiency of solar assets.

Effective O&M practices can substantially improve project outcomes. Well-maintained solar power plants can achieve a 10–30% increase in return on investment (ROI), while solar arrays located in dusty or polluted environments can deliver up to 30% higher performance with regular cleaning and debris removal. Additionally, specialized O&M services help minimize downtime and can reduce repair costs by as much as 75%, ensuring optimal system performance and long-term asset reliability.

Threats and Challenges – Operation & Maintenance (O&M) Services

Performance Guarantee Liabilities: O&M contracts increasingly include strict performance guarantees and uptime commitments. Failure to meet predefined performance benchmarks due to factors such as weather variability, equipment degradation, or grid outages can expose service providers to financial penalties, increasing operational risk.

Skilled Workforce Shortage: Effective O&M requires technically skilled personnel for monitoring, diagnostics, and on-ground servicing. However, there is a shortage of adequately trained technicians, especially in remote and rural areas, which can lead to delayed maintenance, reduced system efficiency, and higher downtime.

Geographical Dispersion of Assets: Solar installations, particularly rooftop systems and agricultural pumps, are widely dispersed across regions. This increases logistical complexity, travel time, and servicing costs, making it challenging to maintain consistent service quality and quick response times.

Data Management and Digital Integration Challenges: While digital monitoring and predictive maintenance tools are gaining traction, integrating these technologies across legacy systems and diverse asset portfolios remains a challenge. Inconsistent data quality, lack of standardization, and cybersecurity risks can hinder effective decision-making.

Component Degradation and Replacement Risks: Over time, key components such as inverters, modules, and cables degrade or fail. Managing timely replacements while controlling costs is a major challenge, especially when warranty coverage is limited or component prices are volatile.

Dependence on Weather Conditions: Unpredictable weather events such as heavy rainfall, dust storms, or extreme temperatures can impact system performance and increase maintenance requirements. These external factors are beyond the control of O&M providers but directly affect service outcomes

12. Competitive Landscape

12.1 Company profiling and benchmarking

1. Sadbhav Futuretech Limited (SFL)

Sadbhav Futuretech Limited, incorporated on June 05, 2020 and converted into a public limited company in November 2024, is an active engineering, procurement and construction services Company operating across India. Headquartered in Gurugram with its registered office in Raipur, the company is led by directors Bhupender Singh, Nilesh Jain, and Saikat Roy. Company is an EPC player in India's solar energy sector which focuses on differentiated multi-segment presence across solar irrigation pumps, rooftop solar systems, and ground-mounted solar power plants.

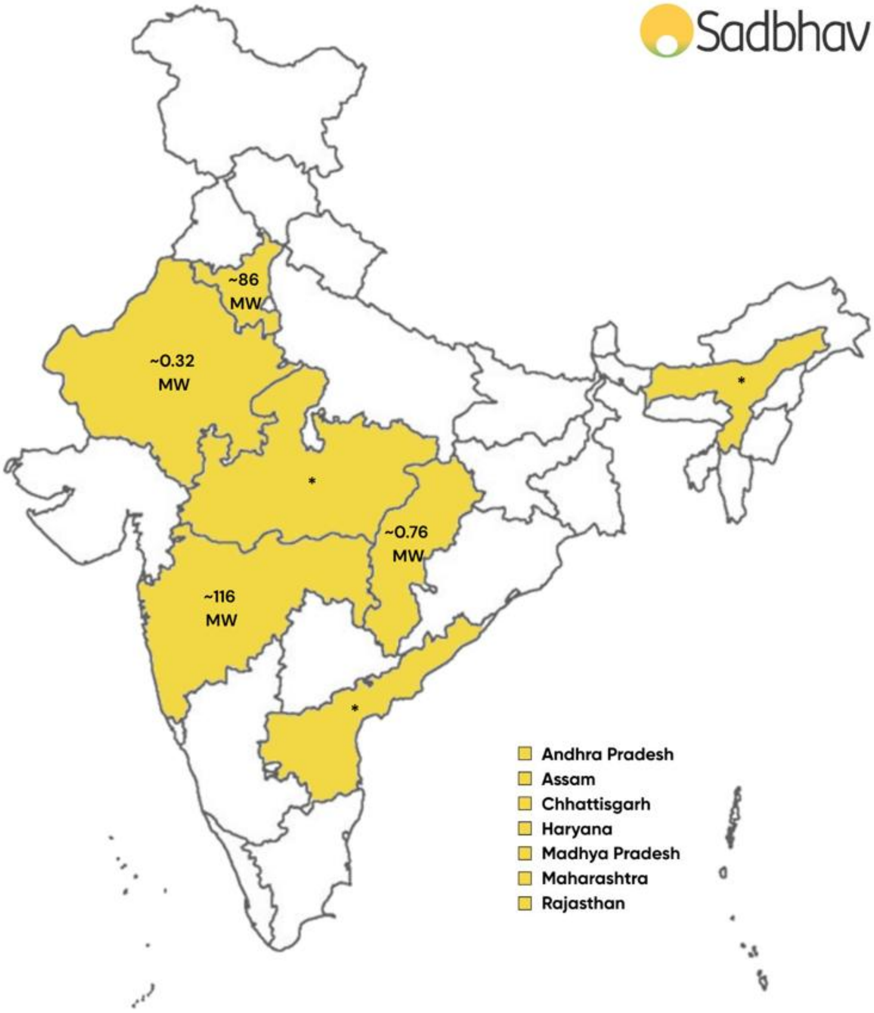
It is one such specialized provider of engineering, procurement, and construction (EPC) services, with a strong focus on installing submersible solar pumps for irrigation. The Company has successfully installed over 55,000 solar pumps since its incorporation and has developed a meaningful presence in the solar pump segment. In addition, the company offers comprehensive solar rooftop installation solutions, delivering reliable and sustainable clean-energy infrastructure.

The Company has been awarded approximately 13% of the total allocated capacity under the first tranche of the Utility-Led Aggregation (ULA) model in the State of Andhra Pradesh pursuant to the PM Surya Ghar: Muft Bijli Yojana. "ULA model" is aimed at facilitating aggregation and implementation of residential rooftop solar installations through designated agencies. In line with this allocation, the Company has secured contracts valued at around INR 850 crore for the installation of solar rooftop systems.

Company's business model is further strengthened by long-term supply arrangements and strategic sourcing frameworks, which help mitigate supply chain disruptions and price volatility risks particularly critical in a sector characterized by fluctuating module and component prices. Company is currently operating on an asset-light model with capital primarily deployed in working capital, the Company maintains financial flexibility while scaling operations efficiently.

The company has established track record for procuring solar cells for its roof top projects. It has procured solar-cells, aggregating approximately 18 MW and 110,000 kW of inverters to support future project execution.

Company shows one of the highest CAGR revenue growth rates for the FY2023-FY2025 period amongst the peer companies set considered.



Source: Company documents, Company auditor certificate
*Company has commenced project engagements in these states; however, it does not have any installed capacity in these states as of September 30, 2025.

2. GK Energy Limited (GKEL)

GK Energy Limited, incorporated in 2008 and headquartered in Pune, Maharashtra, is a public limited renewable-energy company in the design, manufacture, supply, installation, and commissioning of decentralized solar systems. The company provides a solar solution including solar agricultural pumps, photovoltaic modules, water pump controllers, and rooftop solar systems while also supplying third-party solar modules. GK Energy is an EPC player in India's solar sector, serving agricultural, rural electrification, and commercial markets.

3. Shakti Pumps (India) Limited (SPL)

Shakti Pumps (India) Limited, established in 1995 and headquartered in Pithampur, Madhya Pradesh, is an active public limited company specializing in the manufacturing of high-performance industrial pumps and fluid-handling systems. The company produces an extensive range of submersible pumps, solar pumps, motors, and advanced water-management solutions used across agriculture, irrigation, wastewater management, firefighting, and industrial applications.

4. Oswal Pumps Limited (OPL)

Oswal Pumps Limited, incorporated in 2003 and headquartered in Karnal, Haryana, is an active public limited company and manufacturers pump, offering a wide range of submersible pumps, monoblock pumps, sewage pumps, pressure pumps, electric motors, cables, and solar pumping solutions.

5. Rotomag Enertec Limited (REL)

Rotomag Enertec Limited, incorporated in 1993 and headquartered in Vithal Udyognagar, Anand, Gujarat, is an active public limited company. The company was originally founded as Rotomag Motors and Controls Private Limited and underwent name change in 2025. It is engaged in manufacturing specialty electric motors, solar pumps, and advanced power-equipment solutions. The company operates in the electrical-equipment and machinery sector, offering solar-powered DC surface and submersible pumps, brushless DC motor-based systems, AC motors, drives, and gearboxes under its brands Rotomag and Rotomotive.

12.2 Financial benchmarking of key peers in the sector

Table: Financial benchmarking of key peer companies for the H1FY2026 Comparison with industry pee

Particulars	Half Year ended September 30, 2025			
	Sadbhav Futuretech Limited	GK Energy Limited	Shakti Pumps (India) Limited	Oswal Pumps Limited
	Consolidated	**Consolidated**	**Consolidated**	**Consolidated**
GAAP Measures				
Revenue from operations (₹ in lakhs)	27,428.26	72,883.10	1,28,885.00	1,05,358.30
Profit before Tax (₹ in lakhs)	5,423.34	11,323.40	25,118.00	25,155.00
Profit After Tax (₹ in lakhs)	4,044.43	8,422.60	18,754.00	19,218.50
Net Worth (₹ in lakhs)	11,932.17	78,015.00	1,62,695.00	1,49,692.50
Non-GAAP Measures				
Growth in Revenue from Operations (%)	Not Comparable	Not Comparable	Not Comparable	Not Comparable
Profit After Tax Margin (%)	14.67%	11.50%	14.47%	18.10%
EBITDA (₹ in lakh)	6,719.85	13,021.00	27,952.00	26,875.90
EBITDA margins (%)	24.50%	17.87%	21.69%	25.51%
EBIT (₹ in lakh)	6,703.33	12,886.70	26,680.00	26,112.40
EBIT Margin (%)	24.44%	17.68%	20.70%	24.78%
RoE(%)*	40.81%	17.03%	13.45%	19.62%
RoCE (%)*	20.86%	15.80%	15.09%	21.75%
Debt Equity Ratio	2.65	0.54	0.38	0.08
Operating Cash Flows (₹ in lakh)	(16,772.69)	(24,573.80)	(47,839.00)	(9,248.50)
Operational Metrics				
Solar Pump installed (Nos)	11,575.00	24,502.00	39,861.00	NA
Solar Pump installed (MW)	38.73	NA	NA	NA
Solar Rooftop installed (Nos)	45.00	NA	NA	NA
Solar Rooftop installed (MW)	0.13	1.24	NA	NA
Nos of Installation Partner	100.00	NA	NA	NA
Nos of Employees	84	NA	NA	NA
Order Book	6,311.82	86,398.00	NA	NA

Source: Company filing, ICRA Analytics

**not annualised.*

Notes:

1. *All the financial information for listed industry peers mentioned above is on a standalone or consolidated basis as specified and is sourced from unaudited financial result for period ended September 30,2025 as available on the website of the company.*
2. *All metrics are calculated to the extent ascertainable using publicly disclosed information as on date of this Draft Red Herring Prospectus*

Table: Financial benchmarking of key peer companies for the Financial Year 2025 Comparison with industry peers

Particulars	Fiscal 2025			
	Sadbhav Futuretech Limited	GK Energy Limited	Shakti Pumps (India) Limited	Oswal Pumps Limited
	Consolidated	**Consolidated**	**Consolidated**	**Consolidated**
GAAP Measures				
Revenue from operations (₹ in lakhs)	30,209.58	1,09,482.70	2,51,624.00	1,43,030.70
Profit before Tax (₹ in lakhs)	4,174.34	18,027.00	55,580.00	36,774.50
Profit After Tax (₹ in lakhs)	3,080.35	13,320.90	40,837.00	28,061.30
Net Worth (₹ in lakhs)	7,888.01	20,909.30	1,16,117.00	46,235.20
Non-GAAP Measures				
Growth in Revenue from Operations (%)	125.99%	166.32%	83.57%	88.55%
Profit After Tax Margin (%)	10.17%	12.12%	16.12%	19.58%
EBITDA (₹ in lakh)	5,284.69	19,968.60	60,295.00	41,985.30
EBITDA margins (%)	17.49%	18.24%	23.96%	29.35%
EBIT (₹ in lakh)	5,276.72	19,826.60	58,296.00	40,706.20
EBIT Margin (%)	17.47%	18.11%	23.17%	28.46%
RoE(%)	67.61%	100.52%	42.61%	87.47%
RoCE (%)	37.19%	72.71%	54.30%	78.05%
Debt Equity Ratio	1.63	1.04	0.15	0.72
Operating Cash Flows (₹ in lakh)	(11,000.19)	(9,860.20)	2,049.00	(15,059.20)
Operational Metrics				
Solar Pump installed (Nos)	22,952	45,544.00	NA	71,167.00
Solar Pump installed (MW)	74.99	183.00	NA	NA
Solar Rooftop installed (Nos)	8.00	NA	NA	NA
Solar Rooftop installed (MW)	0.02	NA	NA	NA
Nos of Installation Partner	114.00	NA	NA	NA

Particulars	Fiscal 2025			
	Sadbhav Futuretech Limited	GK Energy Limited	Shakti Pumps (India) Limited	Oswal Pumps Limited
Nos of Employees	68	90.00	711.00	2,234.00
Order Book	14,642.53	NA	1,65,460.00	NA

Source: Company filing, ICRA Analytics

Note:

1. All the financial information for listed industry peers mentioned above is on a standalone or consolidated basis as specified and is sourced from the annual report, prospectus, or audited financial statements of the respective company for the year ended March 31, 2025 as available on the website of the company.

2. All metrics are calculated to the extent ascertainable using publicly disclosed information as on date of this Draft Red Herring Prospectus.

Table: Financial benchmarking of key peer companies for the Financial Year 2024 Comparison with industry peers

Particulars	Fiscal 2024			
	Sadbhav Futuretech Limited	GK Energy Limited	Shakti Pumps (India) Limited	Oswal Pumps Limited
	Consolidated	**Standalone**	**Consolidated**	**Consolidated**
GAAP Measures				
Revenue from operations (₹ in lakhs)	13,367.86	41,108.90	1,37,073.85	75,857.10
Profit before Tax (₹ in lakhs)	1,157.55	4,827.70	18,988.57	12,987.70
Profit After Tax (₹ in lakhs)	769.01	3,609.00	14,170.90	9,766.50
Net Worth (₹ in lakhs)	1,224.41	5,595.80	75,569.42	17,927.10
Non-GAAP Measures				
Growth in Revenue from Operations (%)	83.01%	44.23%	41.65%	97.01%
Profit After Tax Margin (%)	5.75%	8.75%	10.31%	12.83%
EBITDA (₹ in lakh)	1,680.00	5,382.50	22,483.19	15,012.40
EBITDA margins (%)	12.57%	13.09%	16.40%	19.79%
EBIT (₹ in lakh)	1,674.20	5,315.50	20,580.16	14,152.70
EBIT Margin (%)	12.52%	12.93%	15.01%	18.66%
RoE(%)	91.53%	95.19%	24.15%	75.61%
RoCE (%)	30.57%	58.34%	30.94%	71.40%
Debt Equity Ratio	5.27	1.12	0.11	0.44
Operating Cash Flows (₹ in lakh)	(1,772.56)	(486.30)	5,437.77	1,692.00

Particulars	Fiscal 2024			
	Sadbhav Futuretech Limited	GK Energy Limited	Shakti Pumps (India) Limited	Oswal Pumps Limited
Operational Metrics				
Solar Pump installed (Nos)	9,179.00	16,293.00	NA	48,263.00
Solar Pump installed (MW)	38.14	NA	NA	NA
Solar Rooftop installed (Nos)	-	NA	NA	NA
Solar Rooftop installed (MW)	-	NA	NA	NA
Nos of Installation Partner	75.00	NA	NA	NA
Nos of Employees	51	NA	507.00	1,851.00
Order Book	22,380.77	NA	~ 2,40,000	NA

Source: Company filing, ICRA Analytics

Note:

1. All the financial information for listed industry peers mentioned above is on a standalone or consolidated basis as specified and is sourced from the annual report, prospectus, or audited financial statements of the respective company for the year ended March 31, 2025 as available on the website of the company.

2. All metrics are calculated to the extent ascertainable using publicly disclosed information as on date of this Draft Red Herring Prospectus.

Table: Financial benchmarking of key peer companies for the Financial Year 2023 Comparison with industry peers

Particulars	Fiscal 2023			
	Sadbhav Futuretech Limited	GK Energy Limited	Shakti Pumps (India) Limited	Oswal Pumps Limited
	Consolidated	**Standalone**	**Consolidated**	**Consolidated**
GAAP Measures				
Revenue from operations (₹ in lakhs)	7,304.63	28,502.60	96,768.33	38,503.60
Profit before Tax (₹ in lakhs)	119.54	1,347.20	3,224.73	4,660.10
Profit After Tax (₹ in lakhs)	84.84	1,008.00	2,413.18	3,419.90
Net Worth (₹ in lakhs)	455.94	1,986.80	41,805.48	7,907.00
Non-GAAP Measures				
Growth in Revenue from Operations (%)	NA	304.63%	(17.89%)	6.84%
Profit After Tax Margin (%)	1.16%	3.53%	2.49%	8.83%
EBITDA (₹ in lakh)	386.66	1,717.90	6,656.04	5,781.90
EBITDA margins (%)	5.29%	6.03%	6.88%	15.02%
EBIT (₹ in lakh)	381.82	1,669.60	4,815.83	5,006.60
EBIT Margin (%)	5.23%	5.86%	4.98%	13.00%

Particulars	Fiscal 2023			
	Sadbhav Futuretech Limited	GK Energy Limited	Shakti Pumps (India) Limited	Oswal Pumps Limited
RoE(%)	20.54%	69.55%	5.95%	55.73%
RoCE (%)	12.93%	34.36%	9.66%	36.42%
Debt Equity Ratio	6.20	2.14	0.18	0.79
Operating Cash Flows (₹ in lakh)	629.00	(1,494.10)	3,868.63	4,992.30
Operational Metrics				
Solar Pump installed (Nos)	4,254.00	10,787.00	NA	51,047.00
Solar Pump installed (MW)	19.67	NA	NA	NA
Solar Rooftop installed (Nos)	-	NA	NA	NA
Solar Rooftop installed (MW)	-	NA	NA	NA
Nos of Installation Partner	43.00	NA	NA	NA
Nos of Employees	42	NA	640.00	1,673.00
Order Book	7,039.24	NA	NA	NA

Source: Company filing, ICRA Analytics

Note:

1. All the financial information for listed industry peers mentioned above is on a standalone or consolidated basis as specified and is sourced from the annual report, prospectus, or audited financial statements of the respective company for the year ended March 31, 2025 as available on the website of the company.

2. All metrics are calculated to the extent ascertainable using publicly disclosed information as on date of this Draft Red Herring Prospectus.

Table: List of Formulas used for the key peer comparison

Formula	Defination
Revenue from operations	Revenue from Operations is used by the management to track the revenue profile of the business and in turn helps assess the overall financial performance of the Company and size of the business.
Profit before Tax	The amount that remains after a company has paid off all of its operating and non-operating expenses. It provides information regarding the profitability before tax of our Company.
Profit/ (Loss) after tax	The amount that remains after a company has paid off all of its operating and non-operating expenses and taxes. It provides information regarding the profitability of our Company.
Net Worth	Net Worth means the aggregate value of the paid-up share capital and all reserves created out of the profits and securities premium account and debit or credit balance of profit and loss account, after deducting the aggregate value of the accumulated losses, deferred expenditure and miscellaneous expenditure not written off, as per the audited balance sheet, but does not include reserves created out of revaluation of assets, write-back of depreciation and amalgamation. This is helpful in evaluating current financial standing of the Company
Growth in revenue from operations (%)	Growth in Revenue from Operations provides information regarding the growth of the business for the respective period.
Profit/ (Loss) after tax margin (%)	Percentage of the amount that remains after a company has paid off all of its operating and non-operating expenses, other liabilities and taxes. It provides information regarding the profitability of our Company.
EBITDA	Earnings before interest, tax, depreciation and amortization is calculated as the restated profit before tax for the period, finance cost, depreciation and amortization expenses less other

Formula	Defination
	income. EBITDA provides information regarding operational profitability and efficiency of our Company.
EBITDA Margin (%)	EBITDA Margin (%) is computed as EBITDA divided by revenue from operations. This metric helps in benchmarking the operating profitability against the historical performance of our Company.
EBIT	Earnings before interest and tax is calculated as the restated profit before tax for the period or year plus finance cost less other income.
EBIT Margin (%)	EBIT Margin (%) helps in keeping track of the operational efficiency of our company after the depreciation and amortization expenses calculated as EBIT as a percentage of revenue from operations.
RoE (%)	Return on Equity is calculated on the basis of net profit after tax divided by average shareholder's equity and is calculated by profit after tax divided by our average net worth (share capital and other equity). It indicates our Company's ability to turn equity investments into profits.
RoCE (%)	Return on Capital Employed provides us information on efficiency of our capital deployment and utilization.
Debt To Equity Ratio	Debt-to-equity (D/E) ratio is used to evaluate a company's financial leverage.
Operating Cash Flows	Operating cash flows provides how efficiently our company generates cash through its core business activities.
Solar Pump installed (Nos)	It helps the company assess the market penetration of solar pumps and track the growth in product adoption by farmers. It's a direct indicator of demand and expansion in the renewable energy space.
Solar Pump installed (MW)	This measures the overall energy impact and capacity provided by the installed solar pumps, helping the business gauge the scale of its operations.
Solar Rooftop installed (Nos)	Helps track the growth and impact of solar rooftop solutions, allowing the business to understand its share in the renewable energy market. It is also useful for expanding brand reach and customer base in residential and commercial solar installations.
Solar Rooftop installed (MW)	This metric helps in evaluating the scalability of solar rooftop installations and provides insights into the energy potential the business is harnessing from rooftops.
Nos of Active installation partner	This KPI shows the extent of the company's network and collaboration with third-party partners, which is critical for expanding operations, improving installation efficiency, and managing demand fluctuations across different regions.
Nos of Employees	Helps assess the workforce strength and the company's ability to scale operations. Tracking this KPI ensures that the company has adequate resources to meet growing demand while maintaining operational efficiency.
Order Book	Provides a clear picture of the company's future revenue streams and work commitments. A strong order book is an indicator of healthy business demand and future growth. It also helps in forecasting and operational planning.

13. Definitions and Abbreviations

Table: Definitions and Abbreviations

Abbreviation	Full Form	Definition
AC	Alternating Current	A type of electric current in which the direction of flow periodically reverses, commonly used for power transmission and distribution due to its efficiency over long distances
AIDC	Agriculture Infrastructure and Development Cess	A tax levied on imports to support agricultural infrastructure funding
AI	Artificial Intelligence	Advanced computing technology used in data centers and grid optimization
ALMM	Approved List of Models and Manufacturers	Government-approved list of solar PV manufacturers eligible for projects
AT&C Loss	Aggregate Technical & Commercial Loss	Total power losses including transmission losses and billing inefficiencies in the distribution system
BCD	Basic Customs Duty	Import duty imposed on goods such as solar cells and modules
BESS	Battery Energy Storage System	Technology used to store electricity for later use, supporting grid stability
BoS	Balance of System	Components of a solar power system excluding modules (inverters, cables, structures, etc.)
C&I	Commercial and Industrial	Segment of electricity consumers including businesses and industries
CAGR	Compound Annual Growth Rate	Mean annual growth rate over a specified period
CEA	Central Electricity Authority	Statutory body responsible for power sector planning and policy advisory
CPSU	Central Public Sector Undertaking	Government-owned corporations involved in power generation and infrastructure
CY	Calendar Year	The period begins on 1 January and concludes on 31 December.
DC	Direct Current	Type of electric current with constant direction, commonly used in batteries and solar panels
DCR	Domestic Content Requirement	Policy mandating use of locally manufactured components in solar projects
DDUGJY	Deen Dayal Upadhyaya Gram Jyoti Yojana	Scheme for rural electrification and feeder separation
DISCOM	Distribution Company	Entity responsible for electricity distribution to end consumers
EPC	Engineering, Procurement, and Construction	Project delivery model in infrastructure and power projects

Abbreviation	Full Form	Definition
EV	Electric Vehicle	Vehicle powered by electricity instead of fossil fuels
FDI	Foreign Direct Investment	Investment made by a foreign entity in domestic industries
FY	Financial Year	Accounting year used for financial reporting (April–March in India)
GDP	Gross Domestic Product	Total value of goods and services produced in an economy
GW	Gigawatt	Unit of power capacity (1 GW = 1,000 MW)
GWp	Gigawatt Peak	Maximum power output of solar PV systems under standard conditions
GWh	Gigawatt-hour	Unit of energy consumption or generation
HJT	Heterojunction Technology	Advanced solar cell technology offering high efficiency
IEA	International Energy Agency	Global organization providing energy data and policy recommendations
INR	Indian Rupee	Official currency of India
ISTS	Inter-State Transmission System	Network for electricity transmission across states
kWh	Kilowatt-hour	Unit of electricity consumption
LCOE	Levelized Cost of Energy	Average cost of electricity generation over a project's lifetime
MNRE	Ministry of New and Renewable Energy	Government body responsible for renewable energy development
CU	Crore Units	Unit of electricity
MW	Megawatt	Unit of power capacity
NDC	Nationally Determined Contribution	Climate action commitments under the Paris Agreement
NEP	National Electricity Plan	Long-term planning document for the power sector
NISE	National Institute of Solar Energy	Organization supporting solar research and policy implementation
NPP	National Power Portal	Platform for power sector data in India
NSM	National Solar Mission	Flagship program to promote solar energy deployment
PLF	Plant Load Factor	Measure of actual output versus maximum possible output of a power plant
PLI	Production Linked Incentive	Government scheme to boost domestic manufacturing
PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan	Scheme for solarizing agriculture pumps
PPA	Power Purchase Agreement	Contract between electricity generator and buyer
PV	Photovoltaic	Technology converting sunlight into electricity

Abbreviation	Full Form	Definition
RDSS	Revamped Distribution Sector Scheme	Initiative to improve DISCOM efficiency and financial health
RE	Renewable Energy	Energy from naturally replenishable sources such as solar and wind
T&D	Transmission and Distribution	Infrastructure for delivering electricity from generation to consumers
TOPCon	Tunnel Oxide Passivated Contact	High-efficiency solar cell technology
TWh	Terawatt-hour	Large-scale unit of electricity
UJALA	Unnat Jyoti by Affordable LEDs for All	Scheme promoting energy-efficient LED usage
VGF	Viability Gap Funding	Government financial support to make projects viable
YoY	Year-on-Year	Growth comparison metric between consecutive years

Disclaimer:

All information contained in the Report has been obtained by ICRA Analytics Limited from sources believed by ICRA Analytics Limited to be true, accurate and reliable and after exercise of due care and diligence by us. Although reasonable care has been taken to ensure that the information therein is true, such information is provided 'as is' without any warranty of any kind, and in particular, makes no representation or warranty, express or implied, as to the accuracy, timeliness or completeness of any such information. All information contained therein must be construed solely as statements of opinion and not any recommendation for investment. ICRA Analytics Limited shall not be liable for any losses incurred by users from any use of the Report or its contents.