Industry Report
on
Solar EPC and PPA Industry

For Ricans Solar Energy Limited

March 27, 2026

Disclaimer

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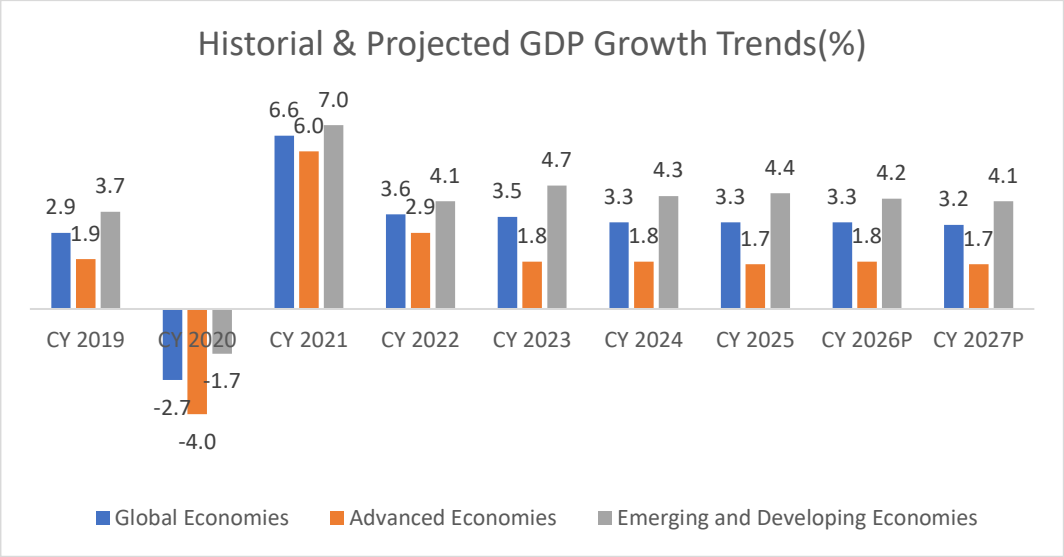
Global Macroeconomic Scenario

Global Economic Overview

Global growth is projected to remain resilient at 3.3 percent in 2026 and at 3.2 percent in 2027, rates similar to the estimated 3.3 percent outturn in 2025. The forecast marks a small upward revision for 2026 and no change for 2027 compared with that in the October 2025 World Economic Outlook (WEO). This steady performance on the surface results from the balancing of divergent forces. Headwinds from shifting trade policies are offset by tailwinds from surging investment related to technology, including artificial intelligence (AI), more so in North America and Asia than in other regions, as well as fiscal and monetary support, broadly accommodative financial conditions, and adaptability of the private sector.

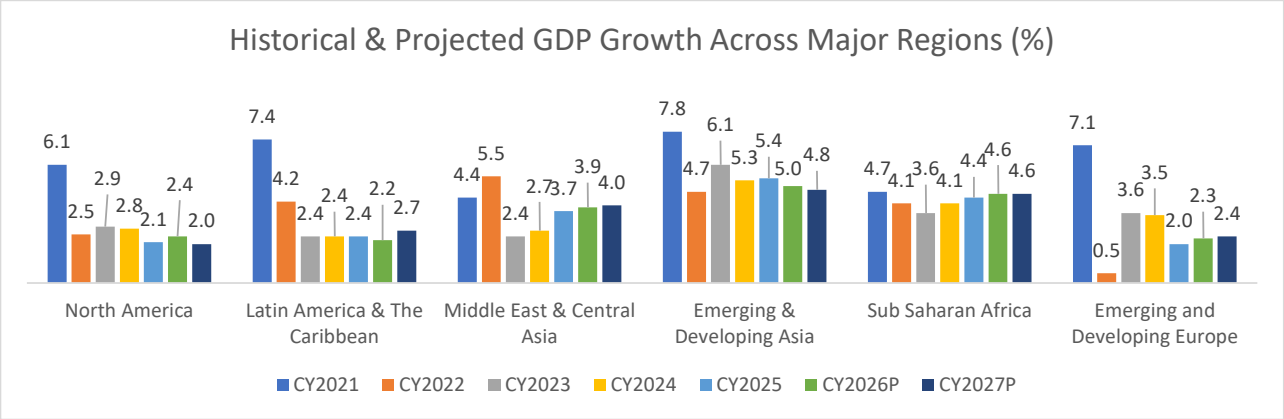


Source – IMF Global GDP Forecast Release January 2026

Note: Advanced Economies and Emerging & Developing Economies are as per the classification of the World Economic Outlook (WEO). This classification is not based on strict criteria, economic or otherwise, and it has evolved over time. It comprises of 40 countries under the Advanced Economies including the G7 (the United States, Japan, Germany, France, Italy, the United Kingdom, and Canada) and selected countries from the Euro Zone (Germany, Italy, France etc.). The group of emerging market and developing economies (156) includes all those that are not classified as Advanced Economies (India, China, Brazil, Malaysia etc.)

Historical and Projected GDP Growth

GDP growth across major regions exhibited a mixed trend during 2024–25. While growth in several regions—including Emerging and Developing Asia as well as Latin America and the Caribbean—is expected to slow further in 2026, performance remains uneven across geographies. In Emerging and Developing Asia (comprising economies such as India, China, Indonesia, and Malaysia), GDP growth is projected to moderate to 5.4% in 2026, compared with 5.3% in the previous year. Similarly, in Latin America and the Caribbean, growth is expected to ease to 2.2% in 2026, before rebounding to 2.7% in 2027 as countries in the region approach potential output from differing cyclical positions.



Source-IMF World Economic Outlook January 2026 update.

By contrast, growth in the Middle East and Central Asia is projected to accelerate, rising from 3.7% in 2025 to 3.9% in 2026 and further to 4.0% in 2027. This acceleration is supported by higher oil output, resilient domestic demand, and ongoing structural reforms. Likewise, growth in sub-Saharan Africa is expected to strengthen, increasing from 4.4% in 2025 to 4.6% in both 2026 and 2027, driven by macroeconomic stabilization and reform efforts in key economies. Meanwhile, in emerging and developing Europe, a sharp slowdown to 2.0% in 2025 is expected to reverse, with the region's economies expanding at an average rate of 2.3% in 2026 and 2.4% in 2027. Across most regions, this recovery also reflects the diminishing effects of recent shifts in global trade policies.

Global Economic Outlook

Since the October 2025 World Economic Outlook (WEO), trade tensions have continued to abate, although they remain subject to occasional flare-ups. A dispute between China and the United States involving controls on exports of semiconductors and rare earth minerals was followed by a truce that reduced bilateral tariffs until November 2026 and introduced a pause on export controls.

In addition, US authorities removed tariffs on some agricultural products for all countries, offsetting the higher tariffs on certain sectors that were previously announced and are now in effect. As a result, the overall US effective tariff rate remains broadly unchanged from the level assumed in the October 2025 WEO although changes for specific countries are significant. The US Supreme Court is widely expected to deliver a decision in early 2026 regarding the president's use of the International Emergency Economic Powers Act. At the same time, newly signed bilateral trade and other agreements, often including substantial investment and purchase commitments with limited public disclosure, have added further complexity. Although policy uncertainty has declined since October, it remains considerably higher than in January 2025.

Global growth in the third quarter of 2025 decelerated to 2.4 percent on an annualized basis, exceeding expectations; however, upside surprises in some countries were offset by downside surprises in others. In France, a boost from aerospace exports lifted growth to 2.2 percent, whereas in Germany, falling exports

continued to weigh on activity, thereby leaving real GDP unchanged between the second and third quarters. Meanwhile, Japan's economy contracted by 2.3 percent, as private and government consumption partially offset the contraction driven by declines in private residential investment and exports. At the same time, China's growth decelerated to 2.4 percent (according to staff estimates), with weak domestic demand—particularly in the housing sector—only partly offset by resilient exports.

In contrast, growth in the United States accelerated to 4.3 percent, supported by a pickup in technology investment and expenditure, which is estimated to have added approximately 0.3 percentage point to average annualized GDP growth during the first three quarters of 2025, thereby offsetting the drag from the federal government shutdown in the final quarter of the year. In addition, there are indications that technology-related investment also contributed to economic activity in Spain and the United Kingdom, although the scale of this contribution was smaller than that observed in the United States.

Global Growth Projection

At broader level, the global growth is expected to remain steady, as momentum in high-tech sectors is projected to slow but continue to partly offset the drag elsewhere. While tariffs and elevated uncertainty are expected to weigh on the level of activity, their impact on growth is projected to fade during 2026 and 2027. At 3.3 percent in 2026 and 3.2 percent in 2027, global growth is therefore expected to decelerate slightly from the estimated 3.3 percent recorded in 2025. Compared with the October 2025 World Economic Outlook (WEO), the forecast for 2026 has been revised upward by 0.2 percentage point, whereas the forecast for 2027 remains unchanged. Nevertheless, there are significant revisions for some countries, with changes occurring in different directions.

Growth in advanced economies is projected at 1.8 percent in 2026 and 1.7 percent in 2027. In the United States, economic activity is expected to expand by 2.4 percent in 2026, supported by fiscal policy and a lower policy rate, while the impact of higher trade barriers gradually wanes. This 0.3 percentage point upward revision relative to October reflects a stronger thane xpected GDP outturn in the third quarter of 2025, a rebound in activity in the first quarter of 2026 compared with the fourth quarter of 2025 following the end of the federal government shutdown, and the associated carryover effects. Looking ahead, growth in the United States is projected to remain solid at 2.0 percent in 2027, supported by a near term fiscal boost from tax incentives for corporate investment under the One Big Beautiful Bill Act of 2025. Although technology driven momentum is expected to moderate, it is still projected to provide a partial offset to lower immigration and moderating consumption.

In the euro area, growth is expected to remain steady at 1.3 percent in 2026 and to increase modestly to 1.4 percent in 2027. The slightly faster growth in 2027 reflects projected increases in public spending, particularly in Germany, alongside continued strong performance in Ireland and Spain. Overall, the forecast remains

broadly unchanged from October, with the subdued growth outlook reflecting unresolved structural headwinds. The impact of the planned increase in defense spending is expected to materialize only in subsequent years, as commitments to reach target levels are phased in gradually through 2035. Compared with other regions, the euro area benefits less from the recent technology-driven investment boost. In addition, the lingering effects of persistently higher energy prices following Russia's invasion of Ukraine are expected to continue weighing on manufacturing, with additional pressure stemming from the real appreciation of the euro relative to the currencies of countries exporting similar products. In Japan, growth is projected to moderate from 1.1 percent in 2025 to 0.7 percent in 2026 and to 0.6 percent in 2027. This marks a small upward revision relative to the October figure, reflecting in part the fiscal stimulus package announced by the new government.

In emerging market and developing economies, growth is projected to remain just above 4.0 percent in both 2026 and 2027. Relative to the October forecast, China's growth in 2025 has been revised upward by 0.2 percentage point to 5.0 percent, reflecting the implementation of stimulus measures and additional policy bank lending for investment. Growth in China for 2026 has also been revised upward by 0.3 percentage point to 4.5 percent, as a result of lower effective US tariff rates on Chinese goods following the yearlong trade truce agreed in November, alongside stimulus measures assumed to be implemented over a two-year period. However, the economy's growth rate is expected to decelerate to 4.0 percent in 2027, as structural headwinds increasingly weigh on activity.

India Macroeconomic Analysis

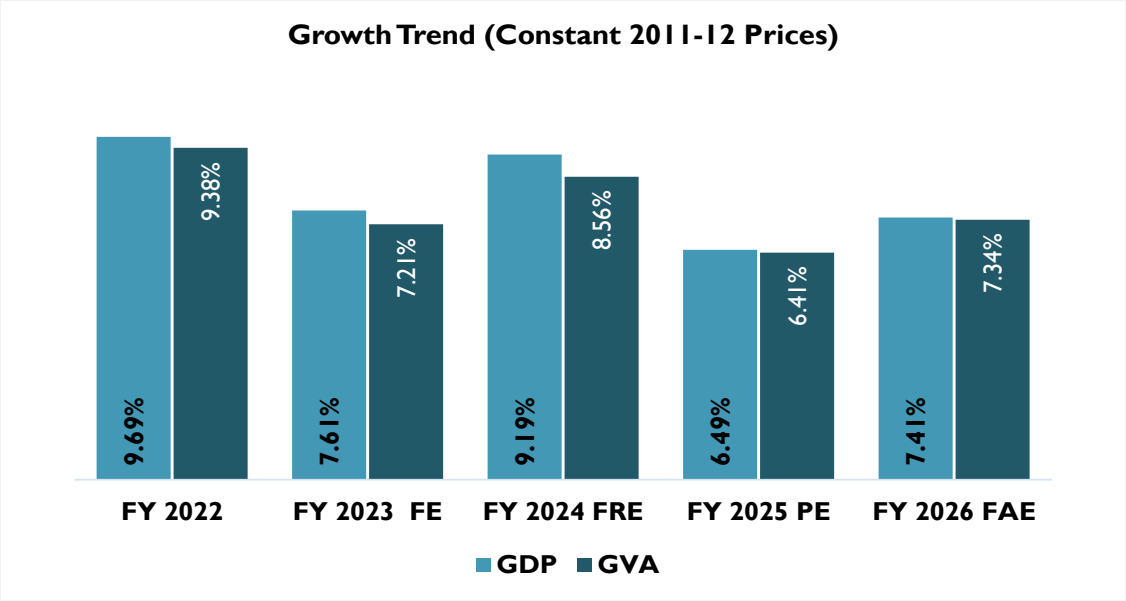
The International Monetary Fund (IMF) has revised upward India's economic growth for CY 2025 by 0.7 percentage point to 7.3%. In its World Economic Outlook update, the IMF stated that the upward revision reflects strong growth momentum in the fourth quarter of the current fiscal year. At the same time, the IMF projects India's growth at 6.4 percent in the CY 2026, noting that despite the expected moderation, India is expected to remain a key driver of growth among emerging market and developing economies. In addition, the IMF expects inflation in India to return to near-target levels following a marked decline in 2025, driven by subdued food prices, which is expected to provide further support to domestic demand. However, the IMF cautioned that AI-driven productivity gains could lead to a pullback in investment and tighter global financial conditions, with spillover effects for emerging economies.

Country	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025	CY 2026 P	CY 2027 P
India	–5.8%	9.7%	7.6%	9.2%	6.5%	7.3%	6.4%	6.4%
China	2.3%	8.6%	3.1%	5.4%	5.0%	5.0%	4.5%	4.0%
United States	-2.2%	6.1%	2.5%	2.9%	2.8%	2.1%	2.4%	2.0%
Japan	-4.2%	2.7%	0.9%	1.4%	-0.2%	1.1%	0.7%	0.6%
United Kingdom	-10.3%	8.6%	4.8%	0.4%	1.1%	1.4%	1.3%	1.5%
Russia	-2.7%	5.9%	-1.4%	4.1%	4.3%	0.6%	0.8%	1.0%

Source: World Economic Outlook, January 2026

Historical GDP and GVA Growth trend

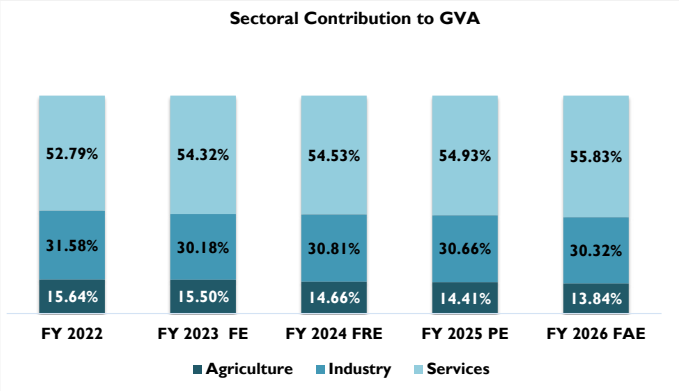
As per the latest estimates, India's GDP at constant prices is estimated to grow to INR 2,018.9919 trillion in FY 2026 (First Revised Estimates) with the real GDP growth rates estimated to be 7.41% for FY 2026. Similarly, real Gross Value Added (GVA) growth stood is estimated to 7.34% in FY 2026. Even amidst global economic uncertainties, India's economy exhibited resilience supported by robust consumption and government spending.

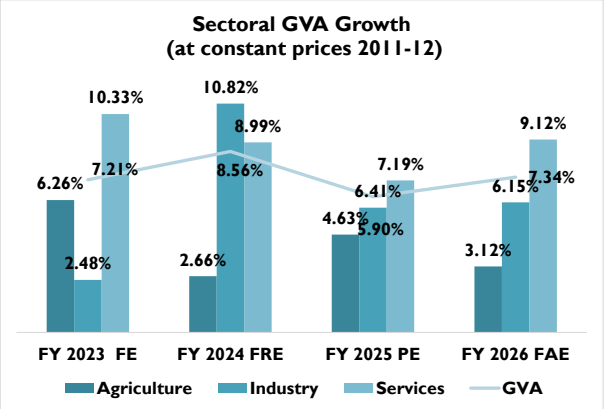


Source: Ministry of Statistics & Programme Implementation (MOSPI), National Account Statistics: FY2025.

FE is Final Estimates, FRE is First Revised Estimate, PE is Provisional Estimates and FAE: First Advance Estimates

Sectoral Contribution to GVA and annual growth trend





Source: Ministry of Statistics & Programme Implementation (MOSPI)

FE is Final Estimates, FRE is First Revised Estimate, PE is Provisional Estimates and FAE: First Advance Estimates

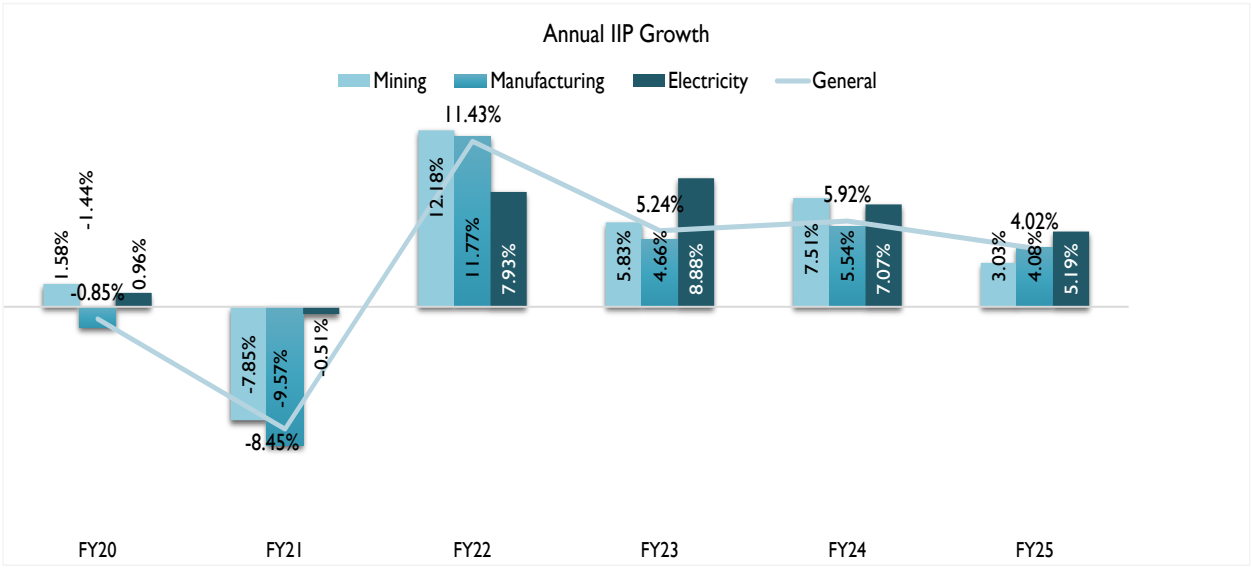
Sectoral analysis of GVA reveals that the industrial sector experienced steady growth momentum in FY 2026, recording a 6.15% y-o-y growth against 5.90% year-on-year growth in FY 2025. Within the industrial sector, growth moderated across sub sector with mining, and construction activities growing by -0.69%, and 7.03% respectively in FY 2026, compared to 2.69%, and 9.35% in FY 2025. Growth in the utilities sector too moderated to 2.07% in FY 2026 from 5.88% in the previous year. The industrial sector's contribution to GVA moderated marginally from 30.66% in FY 2025 to 30.32% in FY 2026.

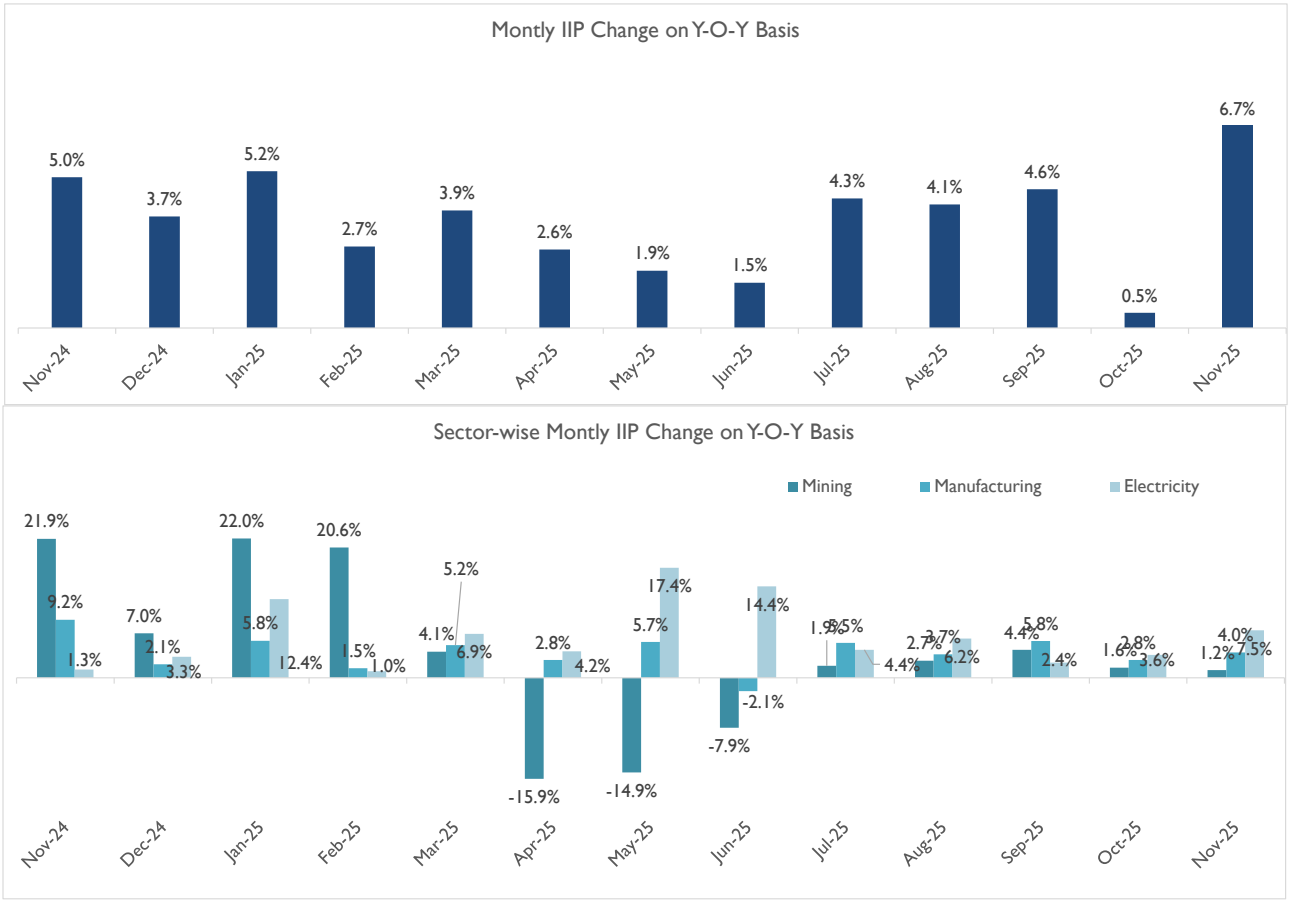
The services sector continued to be the main driver of economic growth. It expanded by 9.12% in FY 2026 from 7.19% in FY 2025. The services sector retained its position as the largest contributor to GVA, rising from 54.53% in FY 2024 to 54.93% in FY 2025, with a further increase to 55.83% in FY 2026.

The agriculture sector saw an acceleration, with growth increasing from 2.66% in FY 2024 to 4.63% in FY 2025. However, its contribution to GVA declined marginally from 14.41% in FY 2025 to 13.84% in FY 2026. Overall, Gross Value Added (GVA) growth rise to 7.34% in FY 2026 from 6.41% in FY 2025

Annual & Monthly IIP Growth

Industrial sector performance as measured by IIP index exhibited moderation in FY 2025, recording a 4.02% y-o-y growth against 5.92% increase in the previous year. The manufacturing index showed moderation and grew by 4.08% in FY 2025 against 5.54% in FY 2024. Mining sector index too moderated and exhibited a growth of 3.03% in FY 2025 against 7.51% in the previous years while the Electricity sector Index, also witnessed moderation of 5.19% in FY 2025 against 7.07% in the previous year.



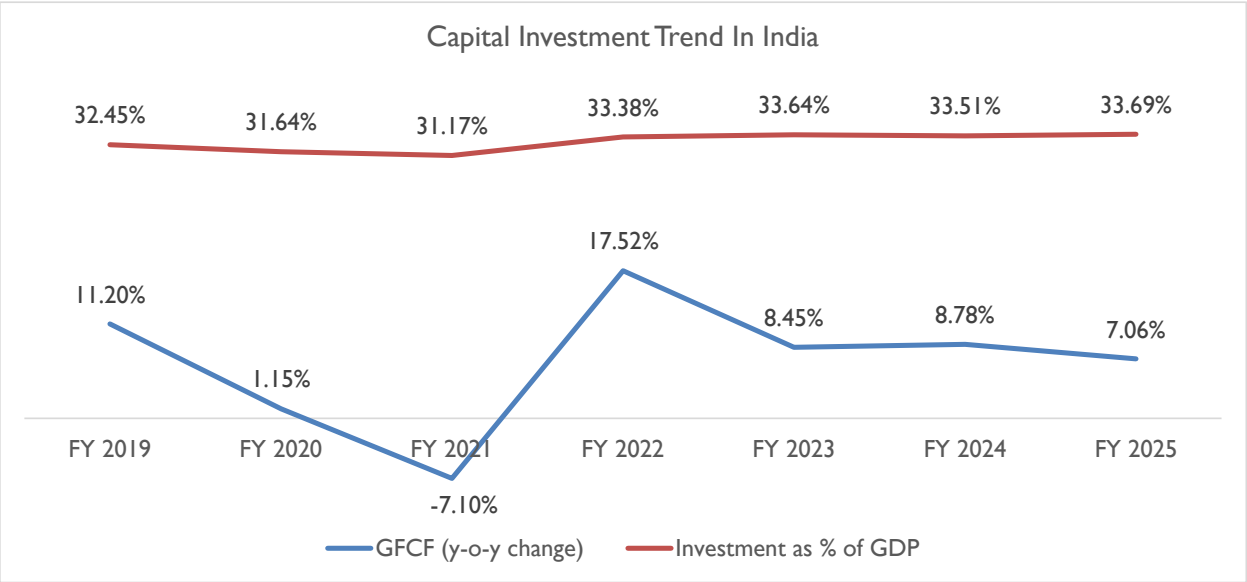


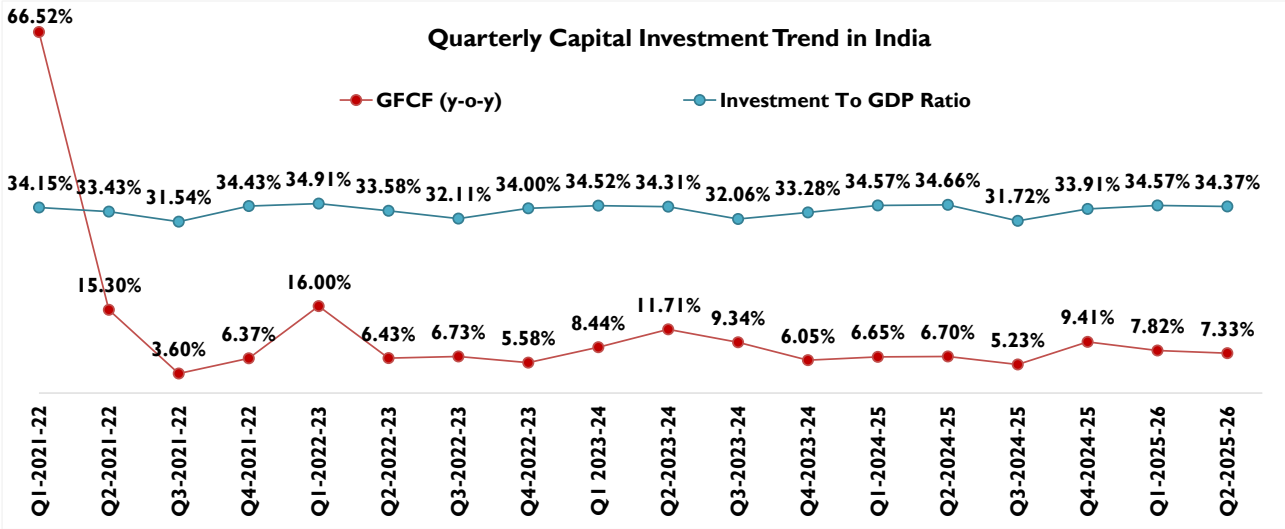
Source: Ministry of Statistics & Programme Implementation (MOSPI)

The IIP growth rate for the month of November 2025 is 6.7% which was 0.5% in the month of October 2025. The growth rates of the three sectors, Mining, Manufacturing and Electricity for the month of November 2025 were 5.4%, 8.0% and -1.5% respectively.

Annual and Quarterly: Investment & Consumption Scenario

Other major indicators such as Gross fixed capital formation (GFCF), a measure of investments, has shown fluctuation during FY 2025 as it registered 7.06% year-on-year growth against 8.78% yearly growth in FY 2024, taking the GFCF to GDP ratio measured to 33.69%.

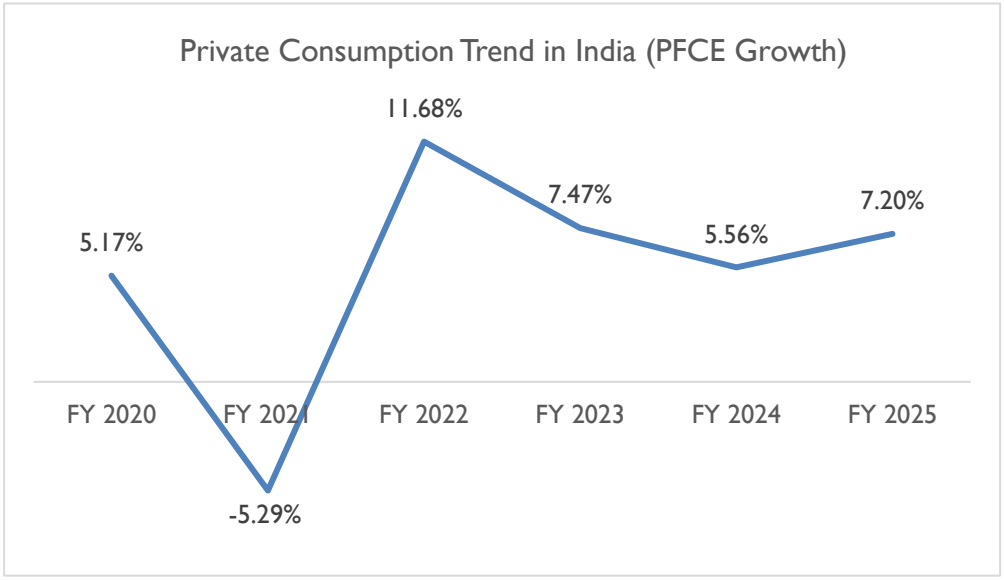


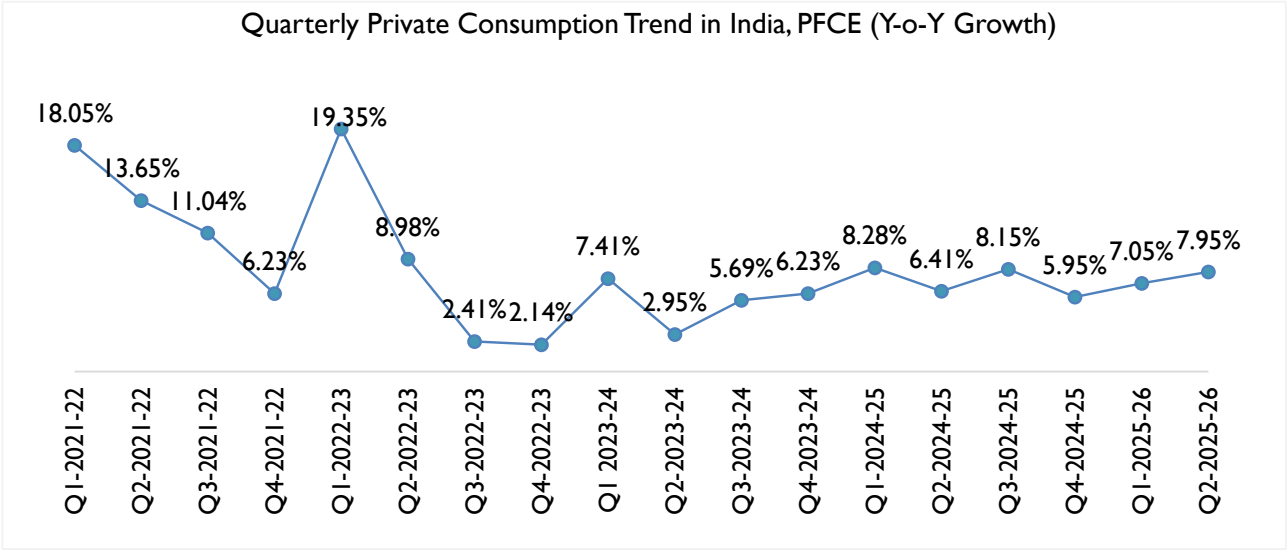


Source: Ministry of Statistics & Programme Implementation (MOSPI)

On a quarterly basis, GFCF showed a fluctuating trend in year-on-year growth. After a sharp spike of 66.52% in Q1 FY 2021-22, growth moderated significantly and remained volatile across subsequent quarters. In FY 2024, the growth rate eased to 6.05% in Q3 (Dec quarter) compared to 9.34% in Q2, as government capital spending slowed ahead of the 2024 general election. It improved slightly to 6.65% in Q1 FY 2024-25 but moderated again to 6.70% in Q2 and 5.23% in Q3, before rebounding to 9.41% in Q4. In Q2 FY 2025-26, growth stood at 7.33%, lower than the previous quarter. The GFCF to GDP ratio measured 34.37% in Q2 FY 2025-2026.

Private Consumption Scenario





Sources: MOSPI

Private Final Expenditure (PFCE) a realistic proxy to gauge household spending, observed growth in FY 2025 as compared to FY 2024. Quarterly Private Final Consumption Expenditure (PFCE) has reported 7.95% growth rate during Q2 of FY 2025-26 as compared to the 6.41% growth rate in the corresponding period of previous financial year.

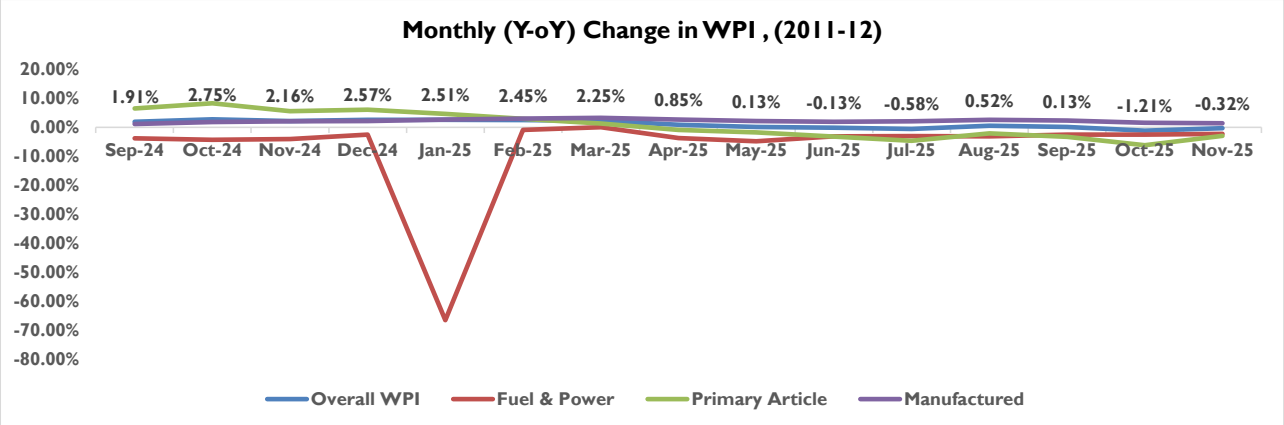
Inflation Scenario

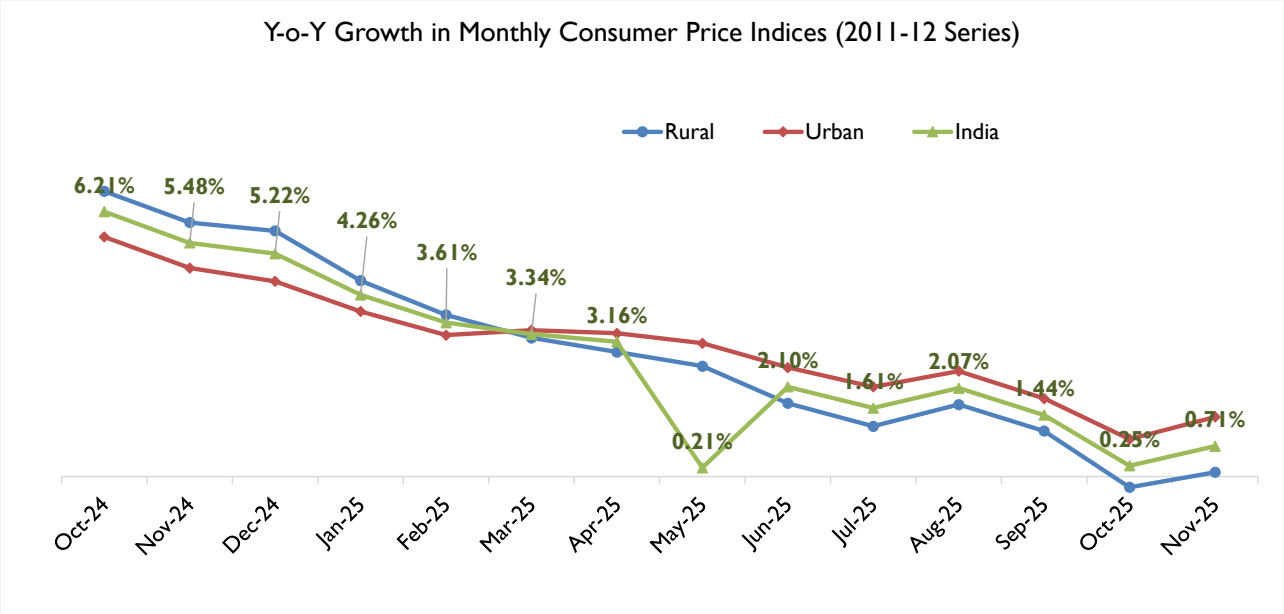
The annual rate of inflation based on All India Wholesale Price Index (WPI) number is (-) 0.32% (provisional) for the month of November 2025 (over November 2024). Negative rate of inflation in November 2025 is primarily due to decrease in prices of food articles, mineral oils, crude petroleum & natural gas, manufacture of basic metals and electricity etc.

Primary Articles (Weight 22.62%): The index for this major group increased by 2.07% from 188.2 (provisional) for the month of October 2025 to 192.1 (provisional) in November 2025. Moreover, the price of minerals (4.50%), food articles (2.50%) and non-food articles (1.28%) increased in November 2025 as compared to October 2025. However, the price of Crude Petroleum & Natural Gas (-1.62%) decreased in November 2025 as compared to October 2025.

Fuel & Power (Weight 13.15%): The index for this major group increased by 1.03% from 145.0 (provisional) for the month of October 2025 to 146.5 (provisional) in November 2025. Furthermore, the price of electricity (6.70%) increased in November 2025 as compared to October 2025. In contrast, the price of mineral oils (0.67%) decreased in November 2025 as compared to October 2025. The price of coal remained same as in the previous month.

Manufactured Products (Weight 64.23%): The index for this major group decreased by (-) 0.07% from 145.1 (provisional) for the month of October 2025 to 145.0 (provisional) in November 2025. In addition, out of the 22 NIC two-digit groups for manufactured products, 14 groups witnessed a decrease in prices, 7 groups witnessed an increase in prices and 1 group witnessed no change in prices. Some of the important groups that showed month-over-month decrease in prices were manufacture of fabricated metal products, except machinery and equipment; food products; other non-metallic mineral products; computer, electronic and optical products and chemicals and chemical products etc. Conversely, some of the groups that witnessed an increase in prices were other manufacturing; machinery and equipment; textiles; electrical equipment and wearing apparel etc. in November 2025 as compared to October 2025.

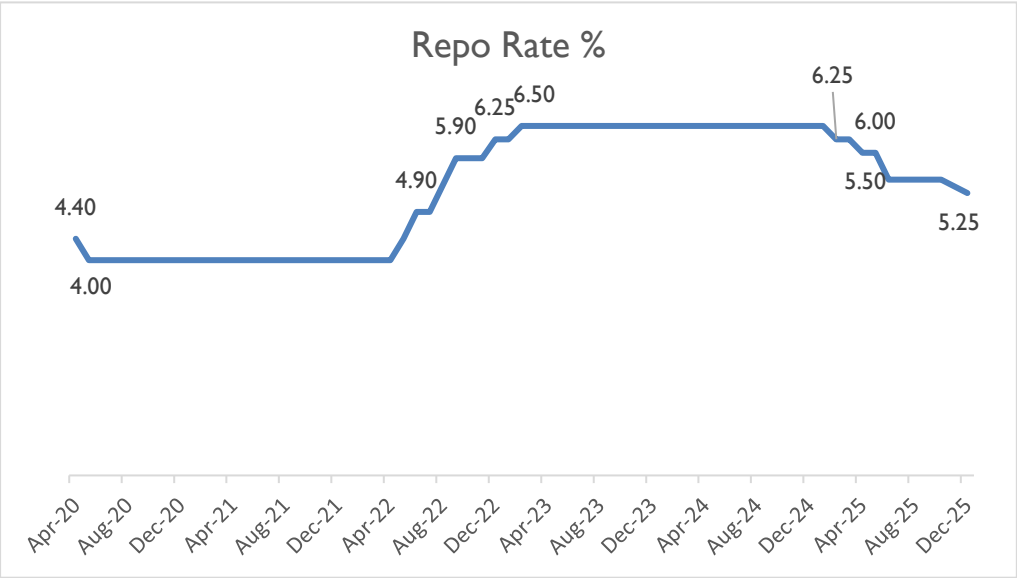




Source: MOSPI, Office of Economic Advisor

Retail inflation rate (as measured by the Consumer Price Index) in India showed notable fluctuations between November 2024 and November2025. Year-on-year inflation rate based on All India Consumer Price Index (CPI) for the month of November 2025 over November 2024 is 0.71% (Provisional). Moreover, there is an increase of 46 basis points in headline inflation of November 2025 in comparison to October 2025.

Rural Inflation: An increase in headline and food inflation in the rural sector is observed in November 2025. The headline inflation is 0.10% (Provisional) in November 2025 while it was -0.25% in October 2025. Furthermore, in urban inflation, an increase from 0.88% in October 2025 to 1.40% (Provisional) in November 2025 is observed in headline inflation of the urban sector. In addition, an increase is also observed in food inflation from -5.18% in October 2025 to -3.60% (Provisional) in November 2025. As part of its anti-inflationary stance, the Reserve Bank of India (RBI) hiked the repo rate by 250 basis points between May 2022 and 8 February 2023, holding it steady at 6.50% until January 2025. On 5 December2025, the RBI reduced the repo rate by 25 basis points, bringing it to 5.25%.



Sources: CMIE Economic Outlook

Growth Outlook

The Union Budget 2025-26 has laid the foundation for sustained growth by balancing demand stimulation, investment promotion and inclusive development. Inflation level is reaching within the central bank's target; the RBI may pursue further monetary easing that will support growth. The medium-term outlook is bright, fueled by the emphasis on physical and digital infrastructure spending. With a focus on stimulating demand, driving investment and ensuring inclusive development, the budget introduces measures such as tax relief, increased infrastructure spending and incentives for manufacturing and clean energy. These initiatives aim to accelerate growth while maintaining fiscal discipline, reinforcing India's long-term economic resilience. The expansion of tax relief i.e zero tax liability for individuals earning up to INR 12 lacs annually under the new tax regime is expected to strengthen household finances and, consequently, boost consumption.

The external sector remains resilient, and key external vulnerability indicators continue to improve. However, tariff-related uncertainty is likely to weigh on exports and investment, prompting us to cut our CY26 GDP growth forecast to 6.4%.

Renewable Energy Landscape in India

India has emerged as a global leader in renewable energy, ranking 4th globally for total renewable power capacity additions and 4th in wind power, while being among the top 5 for solar, according to the REN21 Global Status Report. At COP26, the country pledged to build 500 GW of non-fossil fuel capacity by 2030, one of the most ambitious clean energy expansions in the world.

As of early 2026, India has made significant progress toward this goal: non-fossil installed capacity has reached 262.74 GW (as of November, including solar, wind, hydro, bio, and nuclear). In FY 2025-26 (till November 2025), India added 44.5 GW of renewable energy, nearly doubling annual additions of total non-fossil capacity even further.

Solar power remains the engine of growth installed solar capacity reached 132.85 GW by November 2025, up from just 2.5 GW in 2014. The country's solar potential is also massive, estimated at 748 GWp, according to NISE. Wind energy is similarly scaling up, with 53.99 GW installed as of 2025 (November), and projections to reach nearly 99.9 GW by 2029–30.

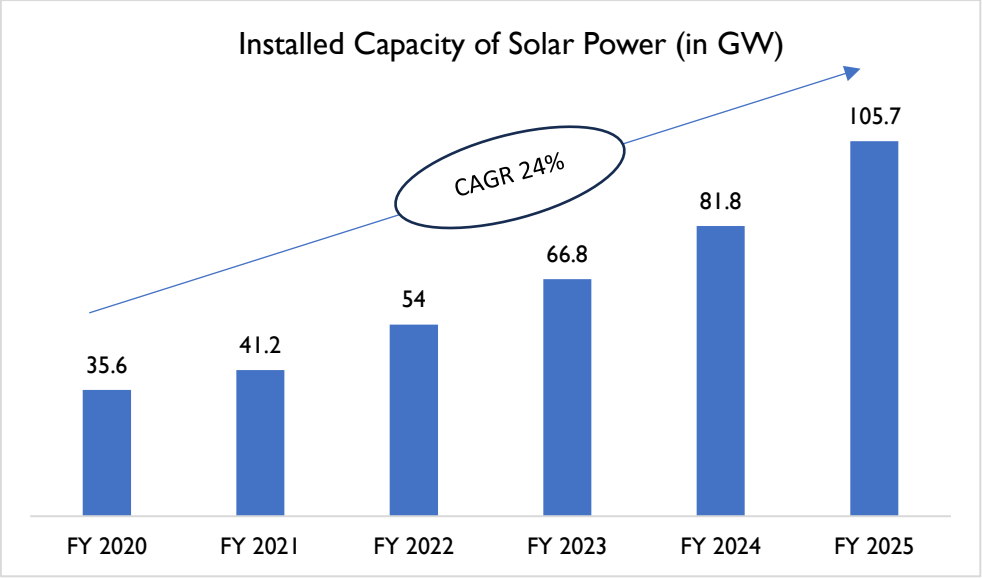
The Indian government's policy framework strongly supports this growth: 100% FDI is permitted under the automatic route for renewable energy generation and distribution. The PLI scheme for high-efficiency solar PV modules is driving domestic manufacturing, with solar module capacity goals aligned to further reduce import dependency.

India has also approved 55 solar parks with a combined sanctioned capacity of 40GW approved across 13 Indian states, accelerating utility-scale deployment. Meanwhile, investment in emerging segments like green hydrogen and energy storage is gaining momentum, underlining India's commitment to a clean and resilient energy future.

Solar Power Generation Scenario in India

India has rapidly ascended as a global leader in solar power generation, ranking 5th globally in solar power capacity and 4th in renewable energy installations, including large hydro. As of November 2025, India has achieved a cumulative installed solar power capacity of 132.85 GW. This includes 98.72 GW from ground-mounted solar plants, 22.42 GW from grid-connected solar rooftop systems, 3.33 GW from the solar component of hybrid projects, and 5.45 GW from off-grid solar installations. These figures reflect India's accelerated growth in solar deployment across both utility-scale and distributed segments, highlighting its continued progress toward national renewable energy targets.

India has witnessed remarkable technological advancements in the solar power sector, with the installed solar capacity growing over 37 times in the last decade, rising from 2.8 GW in 2014 to 105.7 GW as of March 2025. The National Institute of Solar Energy (NISE) estimates India's solar potential at 748 GWp, supported by nearly 300 sunny days annually across most regions. The country's solar deployment includes diverse technologies such as rooftop solar systems, large-scale ground-mounted solar parks (including Bhadla and Pavagada), and innovative floating solar installations on reservoirs and water bodies.



Source: Ministry of New and Renewable Energy

India's solar power sector has demonstrated robust growth, marked by a significant increase in installed capacity over the past five fiscal years. Beginning at 35.6 GW in FY 2020, the country's solar power capacity surged to 105.7 GW by FY 2025, reflecting a notable compound annual growth rate (CAGR) of nearly 24%. This rapid expansion underscores India's strategic push towards renewable energy, with substantial investments and policy initiatives driving the adoption of solar technologies across the nation. The upward trajectory in solar installations highlights India's commitment to achieving energy security, reducing carbon emissions, and leveraging its abundant solar resources for sustainable development.

India's solar power sector has seen significant growth and development, reflecting the country's commitment to renewable energy. As of 2025, India aims to achieve a solar power capacity of 280 GW by 2030, with current installations reaching over 105.7 GW in March 2025. Rajasthan leads with over 25 GW, driven by projects like the Bhadla Solar Park, the world's largest fully operational solar park. Gujarat follows with over 12 GW, emphasizing installations such as the Charanka Solar Park and the under-development Khavda Renewable Energy Park, one of the world's largest hybrid projects. Karnataka ranks third with 9.5 GW, anchored by the Pavagada Solar Park. Tamil Nadu and Maharashtra round out the top five states with 8.4 GW and 5 GW, respectively. Each state showcases ambitious targets and substantial investments in solar energy infrastructure, underscoring India's rapid advancement in green power generation.

In the realm of solar power plants, India stands out prominently with significant achievements. Bhadla Solar Park in Rajasthan exemplifies this distinction, boasting a colossal capacity of 6,263 MW spread across 126.74 km^2, making it the world's largest solar park. Securing long-term power purchase agreements ensures the sale and stability of generated electricity, underscoring India's commitment to renewable energy transition. Moreover, India's initiatives extend to innovative projects like the Kutch Renewable Energy Park, aimed at supplying electricity to remote regions through advanced technologies such as solar ponds, floating solar systems, and integrated solar desalination units. These efforts highlight India's strategic focus on sustainable development, reducing reliance on fossil fuels, and strengthening its position as a global leader in the solar energy sector.

Solar Power: Technologies Deployed

Solar power harnesses energy from the sun using various technologies, each suited for different applications and environments. The primary technologies deployed in solar power generation in India include:

Solar Photovoltaic (PV) Technology

- Solar Photovoltaic (PV) technology converts sunlight directly into electricity using semiconductor materials, primarily silicon, and is the most widely deployed technology in India, significantly contributing to the country's installed capacity.
- PV systems include monocrystalline solar panels, known for high efficiency and space optimization but typically more expensive; polycrystalline solar panels, which are more affordable but less efficient; and thin-film solar panels, which are lightweight and flexible but generally have lower efficiency.
- Tata Power Solar produces both monocrystalline and polycrystalline panels and is involved in large-scale solar PV projects across India, while Adani Solar, a subsidiary of Adani Group, manufactures both types of panels and operates a significant 2,000 MW solar farm in Khavda, Gujarat, part of the world's largest solar park.
- Rooftop solar systems have gained popularity for residential and commercial buildings due to government incentives and net metering policies that allow self-generated electricity, while large-scale ground-mounted solar farms, known as solar parks, include notable examples like Bhadla Solar Park (2,245 MW) in Rajasthan and Pavagada Solar Park (2,050 MW) in Karnataka.
- The combination of these technologies and manufacturers demonstrates India's commitment to expanding its solar energy capacity and transitioning to renewable energy sources.

Concentrated Solar Power (CSP)

- CSP technology utilizes mirrors or lenses to concentrate sunlight onto a small area, generating heat that is then used to produce electricity through steam turbines. This process enables efficient conversion of solar energy into electricity, making CSP a viable option for large-scale energy production.
- CSP systems are most effective in large-scale utility projects, where they can harness significant amounts of solar energy. One of the key advantages of CSP is its ability to incorporate thermal energy storage systems. This capability allows CSP plants to store heat generated during sunny periods and use it to produce electricity even when sunlight is not available, providing a more stable and reliable energy supply.
- The 100 MW solar thermal power plant located in Dhursar village, Rajasthan, exemplifies CSP technology in India. This plant utilizes parabolic trough technology, which consists of curved mirrors that focus sunlight onto a receiver tube filled with heat transfer fluid. The heated fluid then produces steam that drives a turbine to generate electricity, showcasing the practical application of CSP in the country.
- While Bhadla Solar Park is primarily known for its photovoltaic (PV) installations, it has also begun experimenting with hybrid systems that integrate CSP technologies. This innovative approach aims to

enhance energy output by combining the strengths of both PV and CSP, potentially improving efficiency and reliability in solar energy generation.

- Although CSP technology is less common than photovoltaic (PV) technology in India, it is increasingly being explored for its potential to provide effective energy storage solutions. As India seeks to diversify its renewable energy portfolio and enhance energy security, CSP's ability to store thermal energy could play a significant role in the future of the country's solar energy landscape.

Solar Thermal Systems

- Solar thermal systems collect sunlight to produce heat, which can be utilized for various applications, including residential water heating and space heating. These systems play a vital role in promoting the use of renewable energy for domestic and industrial purposes.
- Solar Water Heaters: These systems utilize solar collectors to heat water for domestic use, offering an efficient and sustainable alternative to traditional water heating methods, thereby reducing energy costs and reliance on fossil fuels.
- Solar Air Heaters: Designed to heat air for space heating, solar air heaters are commonly employed in buildings and industrial processes. They contribute to reducing energy consumption and enhance overall energy efficiency in various applications.
- Solar Thermal Projects:
  - Rajasthan Solar Water Heating Project: This comprehensive initiative has been implemented across residential, commercial, and industrial sectors in Rajasthan. The project promotes the adoption of solar water heating systems, significantly reducing reliance on fossil fuels and lowering energy costs for users.
  - Sundarbans Solar Thermal Project: This initiative focuses on providing solar thermal systems for cooking and water heating in rural areas of the Sundarbans. By enhancing energy access and promoting sustainability, the project aims to improve the quality of life for residents in these regions through the utilization of renewable energy resources.

Building-Integrated Photovoltaics (BIPV)

- Building-Integrated Photovoltaics (BIPV) systems incorporate solar cells into building materials, such as windows, roofs, and facades, enabling buildings to generate energy while maintaining aesthetic appeal. This innovative technology serves the dual purpose of energy generation and structural support.
- The Indian Institute of Technology (IIT) Madras has successfully integrated solar panels into its building structures. This initiative demonstrates the feasibility of BIPV in urban environments and promotes energy efficiency on campus, showcasing a commitment to sustainable building practices.

- The Solar House Project, located in Delhi, the Solar House project exemplifies BIPV technology, where solar panels are seamlessly integrated into the building's facades and roofs. This project highlights the potential for energy generation while preserving the aesthetic integrity of architectural designs.
- By integrating solar technology into building materials, BIPV systems can reduce reliance on traditional energy sources, lower energy costs, and contribute to the overall sustainability of urban infrastructure.
- As cities continue to grow, BIPV offers a promising solution for incorporating renewable energy into the built environment, potentially transforming urban landscapes into energy-producing structures while enhancing their visual appeal.

Floating Solar Farms

- Floating solar farms consist of solar panels mounted on floating structures on bodies of water. This innovative approach helps reduce land use, minimizes evaporation, and can enhance the efficiency of solar panels due to the cooling effects provided by the water.
- Kolar Floating Solar Project: Located in Karnataka, the Kolar Floating Solar Project has a capacity of 54 MW. This project effectively utilizes water surfaces for deploying solar panels, thereby minimizing land use and enhancing overall efficiency.
- NTPC Floating Solar Project: The National Thermal Power Corporation (NTPC) has commissioned a floating solar project in Andhra Pradesh with a capacity of 100 MW. This initiative showcases the potential of floating solar technology in utilizing water bodies for renewable energy generation.
- Mudasarlova Reservoir Floating Solar Project: Another significant project is the Mudasarlova Reservoir Floating Solar Project in Andhra Pradesh, which has a capacity of 2 MW. This installation exemplifies the application of floating solar technology in enhancing energy production while conserving land resources.
- Expansion of Floating Solar Technology: NTPC has also developed floating solar plants in Telangana and other states, indicating a growing interest and investment in floating solar technology across India, aimed at maximizing renewable energy output while minimizing ecological impact.

Hybrid Solar Systems

- Hybrid solar systems combine different solar technologies or integrate solar power with other renewable energy sources to optimize energy generation and enhance reliability. This approach allows for a consistent power supply by addressing fluctuations in solar energy availability.
- Integration with Other Sources: For instance, solar photovoltaic (PV) systems can be paired with wind energy or energy storage systems, creating a more stable and reliable energy solution for various applications.
- Tata Power Hybrid Solar Projects: Tata Power has successfully developed hybrid solar projects that integrate solar PV with wind energy. These projects are strategically implemented in various locations, significantly enhancing energy reliability and consistency in power supply.

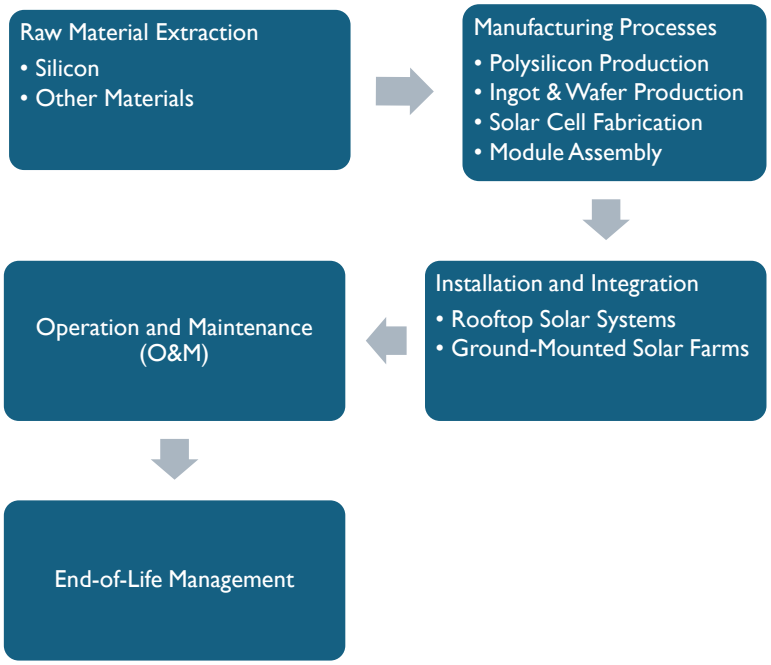
- Renew Power Initiatives: Renew Power has made substantial investments in hybrid projects that combine solar PV with energy storage systems. This innovative approach not only improves grid stability but also helps meet peak demand, making renewable energy more accessible and dependable.
- By leveraging multiple energy sources, hybrid solar systems enhance overall energy security, reduce dependency on a single source, and contribute to a more resilient and efficient power grid.

Agrivoltaics

- Agrivoltaics is an emerging technology that involves co-locating solar panels with agricultural activities. This innovative approach allows for simultaneous solar energy generation and crop production, maximizing land use and providing dual benefits for energy and food production.
- An agrivoltaics pilot project in Gujarat exemplifies this technology by installing solar panels on agricultural land. This setup enables farmers to cultivate crops beneath the solar panels while generating renewable energy.
- The agrivoltaics approach optimizes land use, allowing farmers to increase their income by leveraging both crop production and renewable energy generation.
- By integrating solar energy with agriculture, agrivoltaics contributes to sustainable land management practices and supports the transition to cleaner energy sources.
- This technology holds significant potential for expansion across various regions in India, promoting food security while contributing to the country's renewable energy goals.

Value Chain of Solar Parts

The solar power value chain encompasses various stages, from raw material extraction to the final installation of solar systems. Understanding this value chain is crucial for analysing the solar industry's dynamics and identifying opportunities for efficiency and innovation.



- Raw Material Extraction: The primary material used in solar panel production is silicon, extracted and purified to create polysilicon. Other essential materials include silver, used for conductive layers, glass for panel coverings, and aluminium for framing.
- Manufacturing Processes: Polysilicon undergoes purification to produce chunks, which serve as the feedstock for solar cells. In the subsequent stages, polysilicon is melted and formed into cylindrical ingots. These ingots are sliced into thin wafers, the foundation for solar cell fabrication. The wafers are then processed to create solar cells, which convert sunlight into electricity. Finally, these cells are assembled into solar modules or panels and encapsulated for environmental protection.
- Installation and Integration: Solar installations are implemented either as rooftop systems, typically deployed on residential and commercial buildings, or as ground-mounted solar farms, large-scale installations connected to the electrical grid or operating off-grid.
- Operation and Maintenance (O&M): Post-installation, solar systems require regular maintenance to ensure efficient performance. This includes cleaning solar panels, inspecting electrical connections, and monitoring overall system functionality.
- End-of-Life Management: As the solar industry evolves, recycling processes for decommissioned solar panels are gaining importance, with efforts focused on recovering valuable materials for reuse.

Solar Cell & Module Scenario

India's solar manufacturing sector continues to scale rapidly, driven by strong policy support such as the PLI (Production-Linked Incentive) scheme and mandatory ALMM (Approved List of Models & Manufacturers) certification. In the H1 of 2025, India added 44.2 GW of solar module manufacturing capacity and 7.5 GW of cell capacity, reflecting strong demand from a 186 GW solar pipeline and aggressive domestic deployment targets

As of mid-2025, 91.5 GW of module capacity is ALMM-certified, and 13.1 GW of cell capacity is under ALMM List-II. The major technology driving module expansion is TOPCon (about 39.9 GW added), followed by monocrystalline (~3 GW) and, for the first time, 1.2 GW of HJT capacity.

On the cell side, the capacity mix by June 2025 stood at 54.5% monocrystalline, 41.5% TOPCon, and 4% polycrystalline. Meanwhile, manufacturing pipelines are very strong: around 182 GW of module capacity and 86 GW of cell capacity are under construction, with commissioning expected by 2027.

Looking further ahead, India has announced 97 GW of additional module capacity and 84.7 GW of cell capacity slated to come online by 2030. On the geographic front, Gujarat leads module manufacturing (~41.6% of capacity), followed by Rajasthan and Uttar Pradesh. For cell production, Gujarat also dominates with 47.3% of capacity, followed by Tamil Nadu (4.3 GW) and Karnataka (3.6 GW).

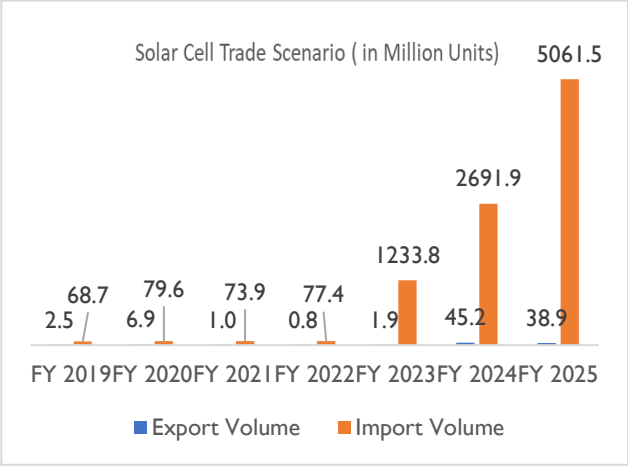
Import-export trends continue to reflect strong trade dependence: in H1 2025, India imported 44.6 GW equivalent of solar modules and cells, with cells making up 66% of that. At the same time, domestic manufacturers exported nearly 3 GW of modules and 83 MW of cells, primarily to the U.S.

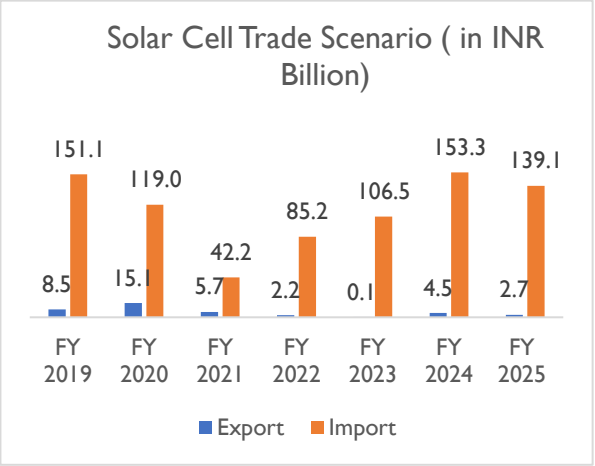
Foreign Trade: Export & Import Scenario

Solar Cell

India's solar cell trade has witnessed fluctuating patterns over the past few years, with notable changes in both exports and imports. In FY 2019, India exported solar cells worth INR 8.5 billion, while imports stood significantly higher at INR 151.1 billion. Over the years, imports have consistently outweighed exports, with the disparity peaking in FY 2024, when imports surged to INR 153.3 billion, while exports were recorded at just INR 4.5 billion. This trend underscores India's continued reliance on imported solar cells despite growing domestic manufacturing capabilities.

In FY 2025, exports stood at INR 2.69 billion, while imports were significantly higher at INR 139.05 billion, further reinforcing the structural gap between domestic production and demand.





Source: Ministry of Trade and Commerce

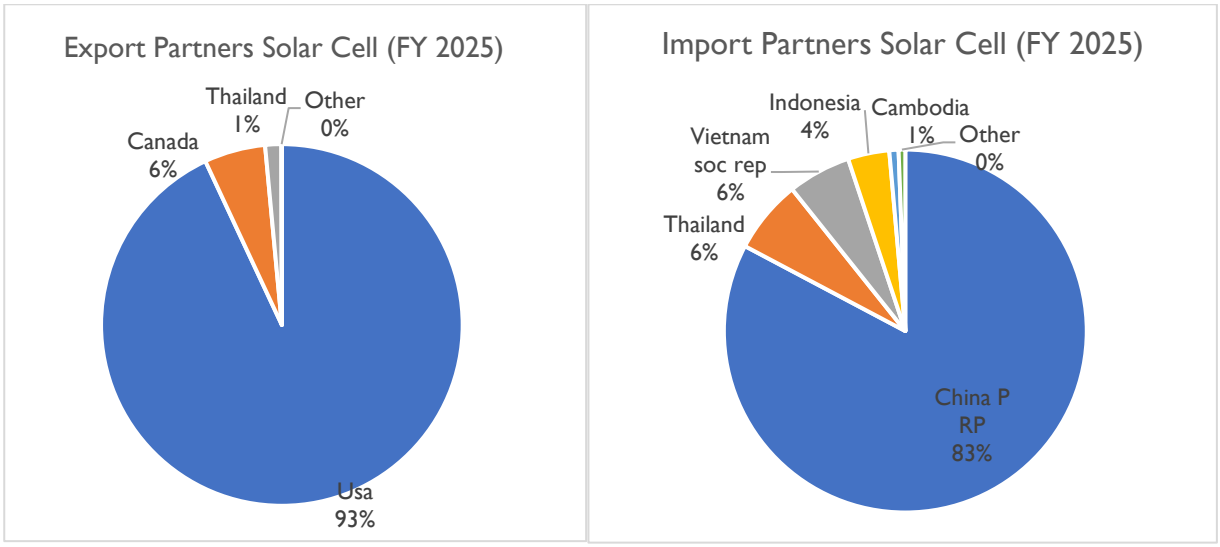
In terms of volume, the import of solar cells has sharply increased from 681.7 million units in FY 2019 to a substantial 2,691.9 million units in FY 2024. On the export front, volumes showed significant variability, peaking at 45.2 million units in FY 2024, up from just 0.1 million units in FY 2023. This sharp rise in exports suggests a recent push to tap into the global solar market, although India remains a net importer by a large margin.

In FY 2025, India exported 38.89 million units, while imports reached 5,061.54 million units, indicating continued growth in domestic demand for solar cells that local manufacturers are still working to fulfil. These figures collectively emphasize the need for further capacity expansion, technological advancements, and supply chain strengthening to reduce import dependence and bolster India's position in the global solar ecosystem.

Trading Partner

India’s export of solar cells in FY 2025 was concentrated mainly in the United States, which accounted for 93% of total exports. Other destinations such as Canada (6%), Thailand (1with the remaining share (0.04%)

classified under other minor markets. The overwhelming reliance on the U.S. market highlights strong demand for Indian solar components, while exports to Asian countries indicate gradual diversification in India's trade reach.



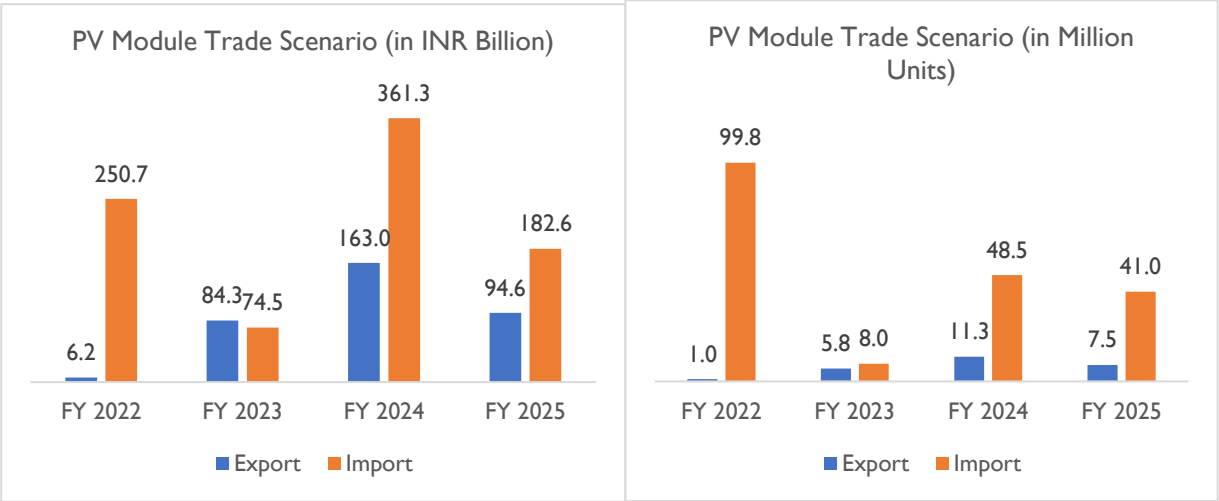
Source: Ministry of Trade and Commerce

On the import side, FY 2025 continued to show a strong dependence on major Asian suppliers. China accounted for 83% of total solar cell imports, followed by Thailand (6%), Vietnam (6%), Indonesia (4%), and Cambodia (1%). The remaining 0.6% came from other countries. This continued reliance on low-cost Asian suppliers underscores the gap between domestic manufacturing capacity and rapidly rising solar energy demand, reinforcing the need for further technological upgrades and capacity expansion within India's solar cell ecosystem.

Solar PV module

India's photovoltaic (PV) module trade scenario has experienced significant shifts between FY 2022 and FY 2025, reflecting the country's evolving position in the global solar market. In FY 2022, exports of PV modules were valued at INR 6.2 billion, while imports were significantly higher at INR 250.7 billion. This gap highlights

India's heavy reliance on imported PV modules to meet domestic demand despite initial export efforts.



Source: Ministry of Trade and Commerce

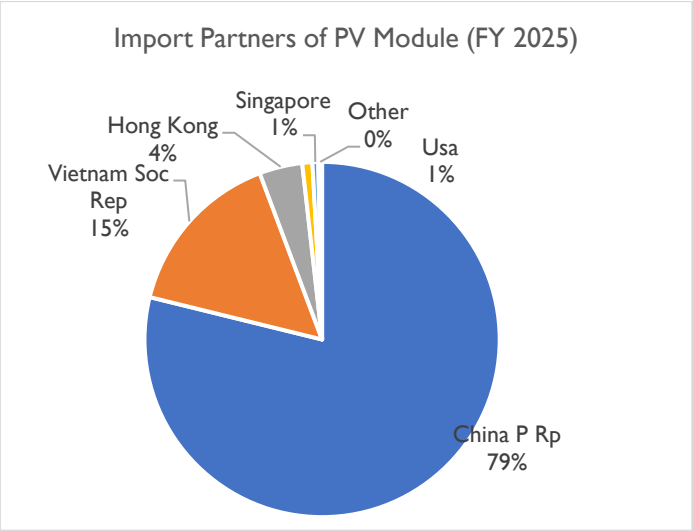
However, FY 2023 marked a turning point, with exports surging to INR 84.3 billion and imports declining to INR 74.5 billion. This shift suggests that India's efforts to enhance domestic PV module production started yielding results, with manufacturers exporting more modules and reducing import dependency.

The upward trend continued in FY 2024, with exports soaring to INR 163.0 billion, although imports also spiked to INR 361.3 billion, driven by rising domestic demand for solar infrastructure.

In FY 2025, exports stood at INR 94.63 billion, while imports reached INR 182.63 billion. Although imports remained higher, the strong export performance indicates that India is increasingly positioning itself as a key player in the global PV module market. This trend suggests that domestic manufacturing capacities are expanding, but the continued reliance on imports signals a need for further investment in local production to balance growing demand with domestic supply capabilities.

Trading Partner

In FY 2025, China dominated India's imports of photovoltaic (PV) modules, accounting for 79% of total imports. This heavy reliance on Chinese modules underscores China's significant cost advantage and well-established manufacturing infrastructure, which continues to cater to India's growing solar energy needs. Vietnam, contributing 15%, emerged as another key supplier, benefiting from competitive pricing and favourable trade conditions. Hong Kong, the U.S., and Singapore accounted for smaller shares, with 4%, 1%, and 1%, respectively, indicating a concentration of imports from major Asian manufacturing hubs.



Source: Ministry of Trade and Commerce

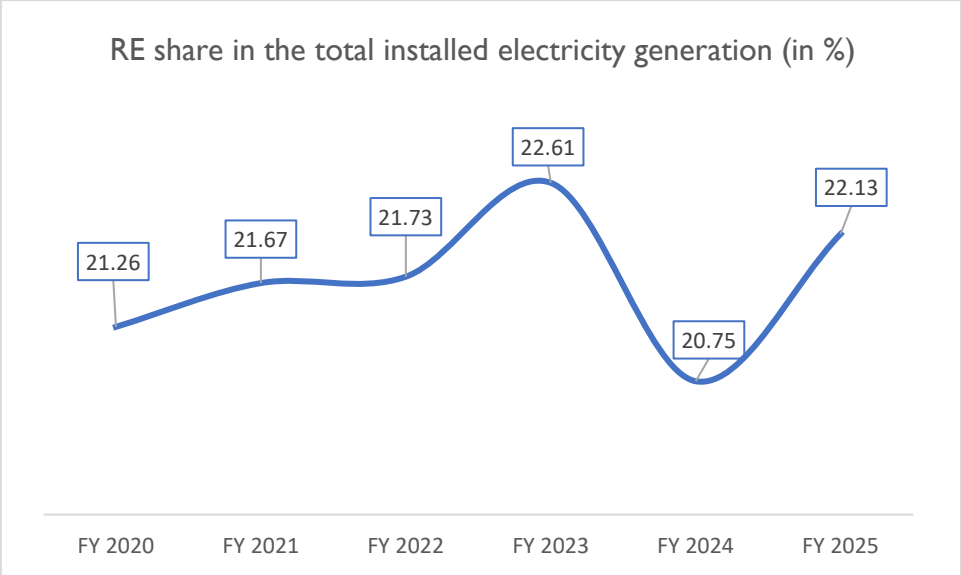
On the export side, India's PV module exports were almost exclusively directed to the United States, with a staggering 97.76% share in FY 2025. This reflects strong demand from the U.S., likely driven by policies promoting renewable energy adoption and efforts to diversify its supply chain away from China. The minimal export to other markets including Bangladesh (1.76%), Sri Lanka (0.31%), Vietnam (0.10%), and China (0.07%) suggests that while India is making strides in PV module manufacturing, its focus on the U.S. market could present risks if it does not broaden its export base. Diversification into additional markets may be necessary to sustain long-term growth and reduce dependency on a single trade partner.

Key Demand Drivers: Analysis of factors driving the growth in India.

India's solar energy sector is rapidly expanding, driven by several key factors that are shaping the future of this industry. As the country strives to meet its energy needs sustainably and reduce its carbon footprint, solar energy has emerged as a vital solution. Here are ten key factors that are propelling the future of solar energy in India

- **Rising Energy Demand**

The rapid population growth and industrialization in India have driven a significant surge in electricity demand. As urbanization accelerates and the middle class expands, the prevalence of energy-intensive devices has risen, underscoring the urgent need to transition to sustainable energy sources such as solar power to ensure reliable and affordable electricity for all. Between FY 2019-20 and FY 2024-25, the share of renewable energy (in %) towards total installed electricity generation has stayed between 20.75% and 22.61%. With peak in FY 2023, reaching 365.66 BU (22.61%), the generation capacity saw a dip in the successive year to 20.75% share. However, FY2025 electricity generation % with renewable energy is now showing a positive trend (22.13%).



Source: MNRE Statistics FY2025

The Indian government launched the Solar Mission with an ambitious goal of deploying 100 gigawatts (GW) of solar power by 2022. As per the latest data released by the Ministry of New and Renewable Energy (MNRE), India has now reached a cumulative installed solar capacity of 132.85 GW as of November 2025, demonstrating strong progress toward long-term renewable energy goals.

Additionally, the Mission had set a target of 40 GW of rooftop solar capacity for mid-2022; however, as highlighted by the Comptroller and Auditor General (CAG) 2025 audit, only 22.42 GW of grid connected rooftop solar had been installed by December 2025, indicating a substantial gap from the original target. To

address this shortfall, the government launched the PM Surya Ghar: Muft Bijli Yojana in February 2024, introducing a revamped subsidy framework and aiming to significantly accelerate rooftop adoption by installing 1 crore rooftop systems by 2027.

As energy demand continues to surge particularly in rural and semi-urban regions with limited access to conventional electricity solar energy presents a highly viable solution. Its rapid scalability, declining costs, and suitability for decentralized deployment position it as a key driver in bridging the energy access gap and ensuring reliable, affordable, and sustainable electricity for households across both urban and rural India.

- **Utilization of Wasteland for Solar PV Installation**

India is confronted with substantial waste generation due to its vast population. However, the National Institute of Solar Energy (NISE) highlights the potential of this wasteland for solar power generation. NISE estimates that if merely 3% of India's wasteland were outfitted with solar photovoltaic (PV) modules, the country could harness approximately 748 gigawatts (GW) of solar energy. This is further supported by India's abundant sunlight, receiving an estimated 5,000 trillion kilowatt-hours (kWh) of energy annually, with most regions enjoying between 4 and 7 kWh per square meter each day.

- **Battery Energy Storage Systems (BESS) as an Enabler**

Battery Energy Storage Systems (BESS) continue to play a pivotal role in enabling India's energy transition by providing grid stability, firming renewable power, and enhancing system reliability. As per the latest government-aligned data, India's operational BESS capacity has grown to 505.6 MWh as of early 2025, with nine utility-scale BESS projects (204.5 MW / 505.6 MWh) commissioned across the country. Solar-integrated BESS continues to dominate India's storage mix, accounting for the vast majority of deployed capacity, as highlighted in recent MNRE and CEA updates.

A major milestone was India's first standalone utility-scale BESS project by BSES Rajdhani Power Ltd, featuring a 20 MW / 40 MWh installation. This project received full regulatory approval under the Electricity Act, 2003 and was supported by the Global Energy Alliance for People and Planet (GEAPP), setting a strong precedent for future grid-scale storage deployments. GEAPP continues to expand its support and aims to mobilize 1 GW of BESS commitments by 2026, complementing India's long-term target of achieving 47 GW of energy storage capacity by 2032, as outlined in the Central Electricity Authority (CEA) National Electricity Plan.

- **Declining Cost of Solar Panels**

The declining cost of solar panels has been a major catalyst for the growth of solar power adoption, especially in India. Several factors have contributed to this trend, including advancements in photovoltaic (PV) technology, which have significantly improved the efficiency of solar panels, allowing for more electricity

generation from the same surface area. Additionally, innovations in manufacturing processes and economies of scale have lowered production costs, making solar energy more affordable. Government support through subsidies, tax incentives, and various solar schemes has further stimulated demand, while increased competition among manufacturers has driven innovation and price reductions. Global supply chain dynamics, particularly the role of China in solar module production, have also contributed to the sharp decline in prices. In the fourth quarter of 2023, the average cost of large-scale solar projects in India saw a remarkable 26.6% year-over-year decrease, marking the lowest project cost on record. Module prices also followed this downward trend, with Chinese mono PERC module prices declining by 50.9% year-over-year and Indian mono PERC modules decreasing by 37.3% year-over-year.

These declining costs have made solar power more accessible to both households and businesses, particularly in India, where the government has been actively promoting renewable energy. The affordability of solar installations has led to widespread adoption, creating new opportunities for job creation and economic growth. The overall cost reductions extended beyond solar panels, as module mounting structure costs also fell by 13% quarter-over-quarter. Historical trends show that benchmark costs for solar panels in India declined by 77% for "up to 10 kW capacity" systems and 73.8% for "10-100 kW capacity" systems from 2017 to 2020. As costs continue to fall, solar energy is becoming a viable alternative to traditional fossil fuels, with solar electricity bids dropping to record lows, making solar power an increasingly competitive energy source. Emerging technologies, such as thin-film solar cells and bifacial panels, promise further advancements in efficiency and cost reduction, solidifying solar energy's role in the future of sustainable power generation.

- **Rural Electrification Programs**

India’s rural electrification efforts have been a significant factor driving the growth of solar energy. Solar-powered mini-grids and rooftop solar installations have become practical solutions for providing electricity to remote and rural areas, where traditional grid infrastructure is either absent or unreliable. A recent study on the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) revealed that larger villages significantly benefited from electrification, while smaller villages saw limited economic gains. Conducted by economists Fiona Burlig and Louis Preonas, the study examined the impact on over 400,000 villages, showing that larger communities with 2,000 or more residents experienced a 9% increase in per capita expenditure and a 10% rise in business activity, whereas smaller villages of around 300 people saw minimal improvements despite increased access to electricity.

These findings underscore the need to tailor rural electrification efforts to village size and economic structure rather than applying a one-size-fits-all approach. Solar power plays a crucial role in these efforts, providing reliable and sustainable energy solutions for remote areas. As solar energy addresses infrastructure gaps, it continues to drive demand, enabling economic development in larger communities where the benefits of electrification are more pronounced.

- **Corporate and Industrial Adoption**

Corporate and industrial adoption of solar energy is becoming a key driver for solar power generation in India. Businesses are increasingly turning to solar power plants and rooftop installations to reduce energy costs and meet sustainability goals. With companies looking to cut electricity expenses and decrease their carbon footprint, solar energy is playing a critical role in the corporate sector's shift toward renewable energy. Large-scale solar projects have already gained traction, with businesses leveraging solar power to meet their environmental, social, and governance (ESG) requirements.

India's Industry 4.0 adoption is expected to further fuel the demand for solar energy. By 2025, more than two-thirds of Indian manufacturers are projected to embrace digital transformation, which will drive a need for sustainable and reliable power sources. This adoption is part of India's goal to raise its manufacturing GDP to 25%, and solar power is anticipated to play a crucial role in supporting the energy demands of automated and energy-intensive manufacturing processes. Additionally, insights from a study involving 55 large and mid-sized manufacturers and 25 technology providers have underscored the significance of Industry 4.0 in enhancing manufacturing productivity while pushing for clean energy use. Solar energy is, thus, poised to become an indispensable asset in India's industrial growth and sustainability efforts.

- **Solar Financing and Investment Opportunities**

Access to affordable financing is a key driver for the growth of solar power generation in India. Private financial institutions are offering various loan schemes and incentives, making solar projects more feasible for both residential and commercial sectors. Solar loans from banks and non-banking financial companies (NBFCs) are helping homeowners install rooftop solar systems. For instance, the Union Bank of India's Rooftop Solar Scheme (URTS) provides loans of up to INR 1.5 million for systems above 3 kW, while the State Bank of India's solar rooftop finance covers up to 80% of installation costs. Punjab National Bank also offers loans of up to INR 600,000 for similar installations.

Beyond residential financing, solar manufacturing and energy storage solutions are gaining attention from investors. Investments in battery storage technology, particularly lithium-ion, are seen as a key solution to address the variability of solar power generation. The expanding market for solar energy, combined with accessible financing options, is significantly boosting demand for solar projects in both the corporate and residential sectors across India.

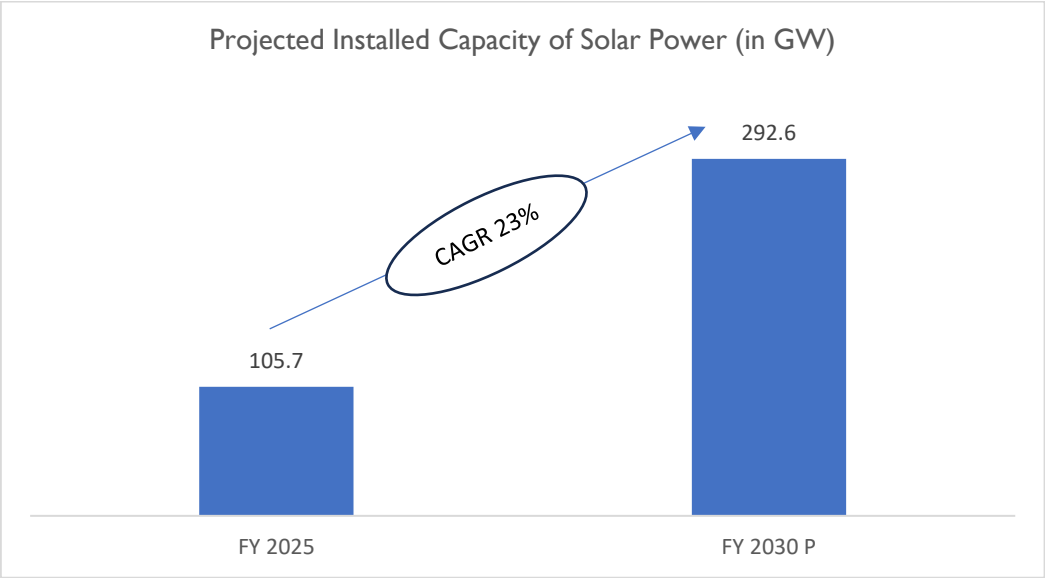
- **Environmental Concerns and Climate Goals**

India has pledged to reduce its carbon emissions and increase its reliance on renewable energy as part of its climate change commitments. Under the Paris Agreement, the country has set ambitious targets, aiming to meet 40% of its total energy requirements from renewable sources by 2030. Solar energy is expected to play

a pivotal role in achieving these objectives, serving as a key component in India's strategy to fulfill its environmental goals and transition towards a more sustainable energy future.

Growth Forecast: Installed Capacity in Solar Power Generation Segment

India's solar power generation segment is on a remarkable growth trajectory, driven by ambitious government initiatives and substantial investments in renewable energy. By the end of 2029-30, the total installed capacity in the country is projected to reach 777,144 MW, with a diverse breakdown that includes 292,566 MW from solar power. This projection positions India to meet its Nationally Determined Contribution (NDC) commitment, which mandates that 50% of the total installed capacity be derived from non-fossil fuel sources by 2030. As of 31 October 2025, India's installed solar capacity has surged to approximately 129.92 GW, a dramatic rise from just 2.6 GW in 2014 marking nearly a 50-fold increase over the past decade.



Source: CEA, Report on Optimal Generation Capacity Mix For 2029-30 Version 2.0

India's solar power generation capacity has experienced remarkable growth, reflecting the country's commitment to renewable energy. The installed solar capacity reached 35.6 GW in FY 2020 and expanded to 41.2 GW in FY 2021. This upward trend continued with installations increasing to 54.0 GW in FY 2022, followed by 66.8 GW in FY 2023. By FY 2024, installed capacity had reached 81.8 GW, and further surged to 105.7 GW in FY 2025, according to MNRE's latest reported data. The rapid increase in solar capacity has been supported by favourable policies, falling technology costs, and expanding project pipelines across states.

Looking ahead, projections suggest that India is on track to achieve 292.6 GW of solar power capacity by FY 2030, aligning with its long-term renewable energy targets. The consistent expansion over the years highlights strong policy momentum, large-scale private investments, and technological advancements, firmly establishing solar energy as a central pillar in India's clean energy transition.

The growth of India's solar sector is bolstered by proactive policies such as the Production-Linked Incentive (PLI) scheme, which has a total allocation of INR 24,000 crore and now supports 48.33 GW of domestic solar PV module manufacturing capacity across its tranches. This initiative is aimed at strengthening India's

integrated solar manufacturing ecosystem and reducing dependence on imports. Additionally, the government has approved the establishment of 50+ Solar Parks, with a cumulative sanctioned capacity of 37.74 GW, providing large-scale infrastructure for accelerated solar deployment. The overall renewable energy capacity, including large hydro, has increased by over 150% since 2014, reaching 250.64 GW as of October 2025, as reported by MNRE. Solar power continues to be a major driver of this expansion, supported by policy stability, declining costs, and rising investment in both utility-scale and distributed solar segments.

Looking forward, the Indian solar sector is anticipated to continue its rapid ascent, with forecasts suggesting it could surpass 300 GW of installed capacity by 2026. This growth will be fuelled by advancements in innovative technologies, an increasing focus on decentralized energy solutions, and heightened energy security concerns. The National Institute of Solar Energy (NISE) estimates that India's solar potential stands at around 748 GWp, signifying considerable opportunities for further capacity additions. As India strives to achieve net-zero carbon emissions by 2070, the solar power sector is set to play a pivotal role in shaping the nation’s sustainable energy landscape, aligning with global climate objectives while positioning India as a leader in renewable energy.

Statutory and Regulatory Compliances in Renewable Energy in India

Regulatory compliance plays a critical role in ensuring the sustainable growth of the renewable energy sector. Adherence to regulations guarantees that renewable energy projects are executed in an environmentally and socially responsible manner, protecting the rights of stakeholders, including landowners and affected communities. Compliance also enhances access to funding and investments, fostering a positive market reputation for renewable energy companies. The Ministry of New and Renewable Energy (MNRE) serves as the nodal agency responsible for the development and regulation of renewable energy in India. Other key regulatory bodies include the Central Electricity Authority (CEA), State Electricity Regulatory Commissions (SERCs), and State Nodal Agencies (SNAs).

- **Environmental Clearances**

Obtaining environmental clearance is a critical regulatory requirement for renewable energy projects in India. The clearance process involves evaluating the potential environmental impacts of a project and identifying strategies to mitigate any adverse effects. This process is governed by the Environment Impact Assessment (EIA) Notification of 2006, which outlines the procedures and criteria for obtaining the necessary clearances. Different renewable energy projects necessitate varying types of environmental clearances. For instance, small-scale projects with a capacity of less than 1 MW may undergo a simplified clearance process, while larger projects must adhere to a more rigorous evaluation. Specific projects, such as wind and solar installations, also require additional assessments, including wildlife and bird impact evaluations. However, companies often face challenges in navigating the clearance process, which can be time-consuming due to bureaucratic hurdles, delays, and conflicting regulations. Ensuring compliance with the imposed conditions is crucial for companies to avoid penalties and legal complications.

- **Land Acquisition and Compensation**

Land acquisition is a vital element of renewable energy projects, as it secures the physical space necessary for construction. In India, the land acquisition process is governed by multiple laws and regulations designed to guarantee fair compensation for landowners and affected parties. Typically, land acquisition involves negotiations between project developers and landowners, with compensation determined by factors such as location, size, and potential project impacts. Compliance requirements related to land acquisition are significant, necessitating the acquisition of necessary clearances and approvals from governmental bodies, such as the Ministry of Environment and Forests. Moreover, ensuring that compensation aligns with government guidelines is essential; non-compliance can lead to project development delays or legal disputes.

- **Power Purchase Agreements (PPAs)**

Power Purchase Agreements (PPAs) play a critical role in the renewable energy sector, serving as legal contracts between renewable energy companies and power purchasers, such as utilities or corporate buyers.

These agreements detail the terms and conditions for the sale and purchase of electricity and are generally structured as long-term contracts lasting between 15 to 25 years. The stability provided by PPAs benefits both buyers and sellers by ensuring financial predictability. There are two primary types of PPAs: on-site and off-site. On-site PPAs involve renewable energy systems installed directly on a buyer's property, such as rooftop solar installations, while off-site PPAs pertain to electricity generated from projects located away from the buyer's premises, like wind farms or solar power plants. Key features of PPAs typically include pricing terms, agreement duration, project location, and the responsibilities of each party concerning maintenance and operation. In India, the MNRE has established guidelines for renewable energy procurement through PPAs, and compliance with these guidelines is mandatory for entering into agreements with power purchasers. Additionally, state electricity regulatory commissions oversee these agreements to ensure that their terms are equitable and reasonable for both parties.

- **Renewable Purchase Obligation (RPO)**

The Renewable Purchase Obligation (RPO) regulation mandates that electricity distribution companies (DISCOMs) and captive power consumers acquire a specific percentage of their power from renewable energy sources. The National Tariff Policy in India has established a target of 17% for total power generation from renewable sources by 2022. The RPO mechanism is designed to guarantee a stable market for renewable energy developers. State electricity regulatory commissions determine the RPO targets, which are revised annually based on the state's renewable energy potential, installed capacity, and consumption patterns. Non-compliance with RPO targets results in penalties for DISCOMs and captive power consumers, typically calculated based on the shortfall in targets and the current market price of non-solar and solar renewable energy certificates (RECs). To fulfill their RPO requirements, DISCOMs and captive power consumers generally enter into long-term PPAs with renewable energy developers, which typically span 15 to 25 years and include clauses regarding energy delivery, payment terms, and penalties for defaults.

- **Grid Connectivity**

Grid connectivity is crucial for renewable energy projects in India, as it involves linking the generated power to the national grid. The process is regulated by the Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERCs) and entails several compliance requirements, including the submission of feasibility reports, grid impact assessments, and power evacuation studies. Companies seeking grid connectivity must obtain necessary approvals and permits from relevant authorities, including the respective state transmission utility, regional load dispatch center, and the National Load Dispatch Center. Compliance with various technical and safety standards, such as voltage levels, frequency, and protection systems, is also essential. Despite its importance, companies face numerous challenges in securing grid connectivity, particularly in remote and rural areas where many renewable projects are situated. This often leads to delays and increased costs due to inadequate grid infrastructure. Furthermore, a lack of coordination among different governmental agencies involved in the grid connectivity process compounds these challenges.

- **Billing Mechanism**

Net metering is a mechanism that enables renewable energy companies to sell excess power generated by their projects back to the grid, allowing them to earn credits. This system is designed to alleviate energy costs for companies and incentivize the adoption of renewable energy. In India, net metering regulations are managed by the respective State Electricity Regulatory Commissions. The benefits of net metering for renewable energy companies are significant, as it permits them to offset their electricity bills with credits received from selling excess power to the grid, thereby reducing financial burdens and enhancing the cost-effectiveness of renewable energy. Additionally, net metering encourages the proliferation of rooftop solar installations among households and commercial entities. To comply with net metering requirements, companies must install bi-directional meters, enter into net metering agreements with distribution companies, and adhere to technical standards concerning voltage and frequency.

- **Financial Obligations**

Renewable energy companies in India are subject to a variety of financial compliance requirements designed to ensure transparency and accountability in financial transactions and investments. Companies must disclose their funding sources, detail the utilization of funds, and submit financial statements. Additionally, compliance with taxation and accounting regulations, including the payment of taxes and filing of tax returns, is essential. Adherence to financial regulations not only enhances the credibility and reputation of renewable energy companies but also attracts investment and funding from both domestic and international sources.

- **Workforce and Employment Regulations**

In India, renewable energy companies must comply with numerous labour laws aimed at safeguarding employees' rights and welfare. These regulations cover aspects such as employment contracts, wages, working hours, and social security benefits. Furthermore, companies are required to adhere to health and safety regulations concerning workplace safety, occupational hazards, and accident prevention. Non-compliance with labour laws can result in penalties and legal liabilities. However, companies often face challenges in fulfilling these obligations, including a shortage of skilled labour within the renewable energy sector, which leads to increased labour costs and project delays. Additionally, a lack of awareness and training among employees regarding their rights and safety regulations poses further difficulties.

- **Intellectual Property Rights (IPR)**

Intellectual property rights (IPR) are essential for renewable energy companies in India, as they help protect innovation and creativity, providing a competitive edge in the market. Companies can secure various forms of IPR protection, including patents, trademarks, copyrights, and trade secrets. To maintain IPR protection, companies must comply with specific requirements, such as filing patent applications, registering trademarks, and upholding confidentiality agreements.

- **Corporate Social Responsibility (CSR)**

Renewable energy companies in India are also required to comply with corporate social responsibility (CSR) regulations, which mandate engagement in activities that promote social welfare and environmental sustainability. These activities may involve charitable donations, sponsorship of community development projects, and efforts to reduce carbon footprints. Compliance with CSR regulations necessitate identifying areas for positive impact, developing a CSR strategy, and reporting on CSR activities to stakeholders. For renewable energy companies, fulfilling CSR obligations can enhance public perception, foster customer loyalty, and improve brand reputation.

Compliance with statutory and regulatory requirements significantly influences the daily operations of renewable energy companies. Ensuring adherence to all relevant regulations can be a time-consuming and costly endeavour, often impacting project timelines and budgets. However, while compliance may initially present challenges, it ultimately fosters a more sustainable and responsible business environment, enabling companies to build trust with stakeholders and secure long-term success. Renewable energy companies that prioritize compliance can enhance their reputations, attract investment, and contribute to the overall growth of the renewable energy sector in India.

- **Waiver of ISTS Charges for Co-Located BESS (2025)**

In 2025, the Ministry of Power introduced a significant regulatory update by granting a 100% waiver of Inter-State Transmission System (ISTS) charges for renewable energy projects equipped with co-located Battery Energy Storage Systems (BESS), applicable to all eligible projects commissioned up to 30 June 2028. This policy is aimed at reducing transmission costs and improving the commercial viability of large-scale renewable-plus-storage projects, particularly those that supply power across state boundaries. By incentivizing developers to combine solar or wind with battery storage at the same site, the waiver strengthens India's renewable energy integration efforts, enhances grid reliability, and accelerates the adoption of dispatchable clean power. Overall, this regulation is expected to boost investment in hybrid projects and position BESS as a central component of India's energy transition strategy.

- **Viability Gap Funding (VGF) Scheme – Tranche II for BESS (2025)**

In 2025, the Government of India launched Tranche II of the Viability Gap Funding (VGF) Scheme, approving a substantial allocation of ₹54,000 crore to support the development of 30 GWh of grid-scale Battery Energy Storage Systems (BESS). The scheme aims to make storage infrastructure financially competitive by providing capital subsidies, thereby lowering the Levelized Cost of Storage (LCOS) and enabling broader adoption of storage-backed renewable energy. Under this initiative, BESS developers are required to meet defined technical performance standards while contributing services such as peak load management, frequency regulation, and renewable firming. By reducing cost barriers and fostering both public and private investment,

VGF Tranche II is expected to accelerate India's transition toward round-the-clock renewable energy and strengthen the domestic storage manufacturing ecosystem under Make in India.

- **Updated Energy Storage Obligation (ESO) Trajectory (2024–2030)**

The Government of India has revised the Energy Storage Obligation (ESO) trajectory for the period 2024–2030, mandating a progressive increase in the share of energy storage adoption by distribution companies, open access consumers, and captive power plants. Beginning with a requirement of 1% in FY 2024 and rising to 4% by FY 2030, the updated framework allows renewable energy stored in BESS to count toward Renewable Purchase Obligation (RPO) compliance, thereby offering utilities greater operational flexibility. This regulation is designed to support the integration of higher shares of variable renewable energy, improve grid stability, and encourage the adoption of storage solutions that enable time-shifting of renewable generation. By creating a dedicated demand trajectory for energy storage, the updated ESO strengthens market certainty for developers and contributes to India's broader goal of achieving 500 GW of non-fossil fuel capacity by 2030.

Solar EPC and PPA Business Model

Solar EPC Business Model

The Engineering, Procurement, and Construction (EPC) business model is widely adopted in the solar industry due to its comprehensive, turnkey nature. In this model, a solar EPC company takes full responsibility for designing, procuring materials, and constructing a solar power project. The process starts with the engineering phase, where technical teams develop detailed project designs, including electrical schematics, structural layouts, and energy output forecasts. These designs are aligned with both the client's specifications and regulatory requirements. The goal is to create an efficient, high-performing solar system tailored to the project's site and conditions.

Next is the procurement phase, where the EPC company sources all, the essential components needed for the solar installation. This includes solar panels, inverters, wiring, mounting structures, and other equipment. Leveraging strong supplier relationships, the company can secure high-quality materials at competitive prices, which is critical for ensuring both cost efficiency and system longevity. The final stage of the EPC model is construction, where the project is physically built, installed, and connected to the grid. During this phase, the company oversees the on-site installation, project management, and commissioning of the solar system to ensure it meets performance guarantees and is completed on time and within budget. This end-to-end service model makes EPC highly appealing to developers and investors seeking turnkey solutions for solar power projects.

Solar PPA Business Model

The Power Purchase Agreement (PPA) model, in contrast, focuses on long-term energy purchasing rather than project ownership and construction. In this model, a solar developer or a third-party financier installs and owns the solar power system on a customer's property, which can be residential, commercial, or industrial. The customer enters a contract to purchase the electricity generated by the solar system over a long period, typically between 15 and 25 years. One of the major advantages of the PPA model is that it provides zero upfront cost to the customer. The solar developer bears the financial burden of installation, maintenance, and system ownership. This makes solar energy accessible to businesses and homeowners without requiring any capital investment.

Through a long-term agreement, the customer benefits from purchasing solar electricity at a fixed or predictable rate, often lower than the standard utility prices. This arrangement ensures that the customer enjoys stable and often reduced energy costs over the agreement's term, which can be especially advantageous in regions with volatile electricity prices. Under the PPA model, the developer retains ownership of the solar system, which also means the responsibility for maintenance, repairs, and performance monitoring rests with the developer, not the customer. The customer benefits from energy savings without any of the risks or operational burdens associated with owning the system. By opting for a PPA, businesses

and individuals can significantly lower their carbon footprints and reduce reliance on traditional energy sources, all while experiencing the financial benefits of renewable energy.

Both the EPC and PPA models play crucial roles in promoting solar energy adoption by addressing different market needs. The EPC model is best suited for entities looking to own their solar assets, while the PPA model is ideal for those looking to enjoy the benefits of solar power without the associated ownership and operational responsibilities. Together, these business models are driving the growth of solar energy across various sectors.

Types of Technology

The solar energy industry relies on various types of technologies and applications to meet the growing demand for renewable energy across diverse sectors. The three main types of solar technology are **rooftop**, **utility-scale**, and **hybrid** systems. Each type serves specific purposes and is used depending on factors like space availability, energy requirements, and regulatory policies. The following sections provide an in-depth look at these technologies and how they apply to residential, commercial, and industrial sectors.

Rooftop Solar Technology

Rooftop solar systems involve the installation of solar photovoltaic (PV) panels on the rooftops of residential, commercial, and industrial buildings. These systems are especially suitable for decentralized energy generation, where electricity is consumed close to the point of generation, reducing transmission losses and the dependency on the conventional power grid.

Solar Rooftop Segment in India: Grid-Connected Rooftop Capacity

The solar power sector in India has rapidly expanded in recent years, playing a crucial role in supporting the government's sustainable growth objectives. It has become a key component in addressing the nation’s energy demands and enhancing energy security.

To drive this growth, the Government of India has introduced several initiatives aimed at boosting solar power generation. These include the Solar Park Scheme, VGF Schemes, CPSU Scheme, Defence Scheme, Canal Bank & Canal Top Scheme, Bundling Scheme, and the Grid-Connected Solar Rooftop Scheme. Additionally, multiple policy measures have been implemented to encourage the development of grid-connected solar power plants.

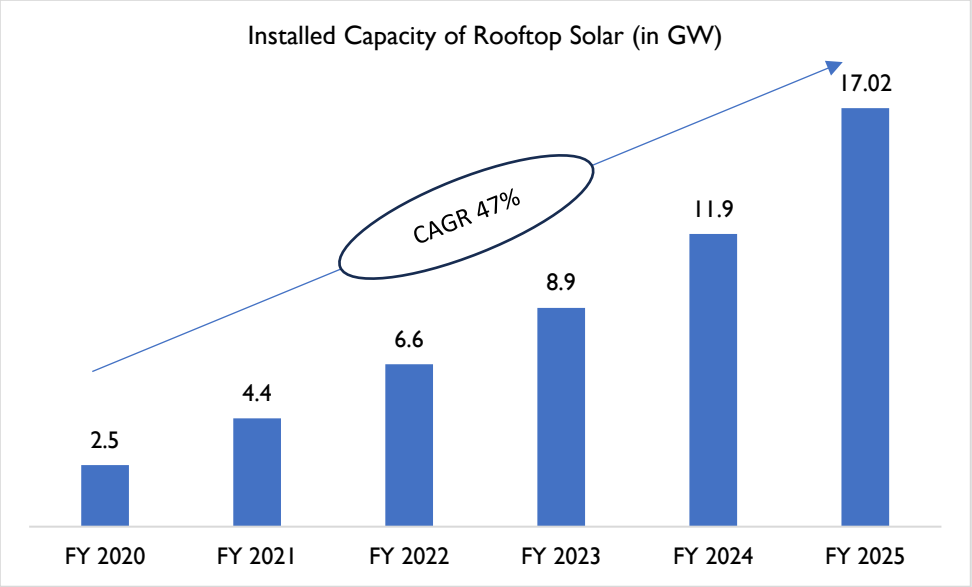
India has now ranked 5th globally in solar power deployment. As of 31 October 2025, India has commissioned solar projects totalling 129.92 GW of capacity. This includes 98.72 GW from ground-mounted solar, 22.42 GW from rooftop solar systems, 3.33 GW from hybrid solar, and 5.45 GW from off-grid solar installations.

India’s rooftop solar sector has seen significant growth, driven by the increasing awareness of renewable energy benefits and the government's strong push toward solar adoption. The country’s grid-connected

rooftop solar capacity has expanded in recent years, with both residential and commercial sectors contributing to this rise.

India has set an ambitious target of achieving 500 gigawatts (GW) of renewable energy capacity by 2030, a critical pillar of its climate and energy strategy. As of 31 March 2025, the country has already installed 220.10 GW of renewable energy capacity, according to the Ministry of New & Renewable Energy (MNRE). While India's clean-energy pipeline is bolstered by the fact that capacity has crossed 200 GW, recent projections suggest that investment in renewables could more than double to over US$ 32 billion in 2025, a significant scale-up to support further expansion. However, to stay on track for the 2030 goal, India will need to sustain an installation rate of around 50 GW per year, which is markedly higher than the 29.52 GW added in FY 2024–25.

The sector faces several challenges, including the complexities that hinder the conversion of issued tenders into on-ground projects and a slowdown in investment inflow. Addressing these issues is critical to speeding up renewable energy deployment and attracting necessary investments. This report outlines recommendations for both immediate and medium-term implementation, providing feasible solutions to overcome these challenges and drive growth in the renewable energy sector.



Source: Ministry of New and Renewable Energy

As of 2023, India's installed rooftop solar capacity was approximately 9 GW, far short of the target, though efforts are being made to close this gap through various subsidy programs and policy frameworks. Residential rooftop solar installations have been increasing, but the **commercial and industrial segments** have been the key drivers of capacity growth, largely due to higher power demand, larger available rooftop spaces, and better financial incentives for businesses to switch to solar energy. Grid-connected rooftop solar offers a solution for reducing electricity bills while contributing to environmental sustainability, making it an attractive option for various sectors.

[1] As of 31 March 2025, India's cumulative installed solar power capacity stands at 105.65 GW. This includes 81.01 GW from ground-mounted solar plants, 17.02 GW from grid-connected rooftop solar systems, 2.87 GW from the solar component of hybrid projects, and 4.74 GW from off-grid solar installations. These figures highlight the diverse contributions of various solar technologies toward the country's renewable energy goals, showcasing steady progress in expanding solar capacity across different segments.

Regulatory Support Required to Drive the Rooftop Solar Sector

Despite the growth, the rooftop solar market in India faces challenges that require stronger regulatory support to scale up. Some of the key regulatory measures that can drive the sector include:

- **Net Metering Policies:** Net metering allows consumers to export excess electricity generated by their solar panels to the grid and receive credits or monetary compensation. Though net metering policies exist in many states, variations in implementation and restrictive regulations in some areas have hindered growth. A uniform streamlined net metering policy across the country is essential to encourage greater rooftop solar adoption.
- **Subsidies and Incentives:** Continued government support through **capital subsidies** for residential systems and tax benefits for commercial/industrial users will be crucial. Additional incentives for battery storage systems can further enhance the viability of rooftop solar, especially for those seeking to become more energy independent.
- **Simplification of Approvals:** Lengthy and complicated approval processes for grid connection have also been a bottleneck for rooftop solar installations. Simplifying these procedures and improving coordination between utilities and regulatory bodies will accelerate the adoption rate.
- **Financing Options:** Easy access to low-cost financing is essential for rooftop solar, particularly for residential and small businesses. Regulatory support for innovative financial products, such as solar loans or pay-as-you-go models, can increase affordability and drive demand.

Utility-Scale Solar Technology

Utility-scale solar refers to large solar power plants, typically ranging from several megawatts (MW) to gigawatts (GW) in capacity, designed to supply electricity to the grid. These projects occupy vast land areas and contribute significantly to national renewable energy targets. India has emerged as a leader in the global utility-scale solar market, driven by government initiatives such as the National Solar Mission and favourable policies like competitive bidding for solar projects.

Utility-scale solar systems primarily consist of ground-mounted solar arrays that supply electricity directly to the grid. The energy generated is then distributed through the national grid to meet the demand of residential,

[1] Ministry of New and Renewable Energy

commercial, and industrial consumers. As of 31 October 2025, India's utility-scale (ground-mounted) solar capacity has grown to 98.72 GW, with major development continuing in states like Rajasthan, Gujarat, and Karnataka. These large-scale projects remain central to achieving India's target of 280 GW of installed solar capacity by 2030, and play a key role in advancing the nation's long-term clean energy ambitions. One of the key advantages of utility-scale solar is its ability to generate power at a lower cost per kilowatt-hour (kWh) due to economies of scale. However, these projects face challenges such as land acquisition, grid integration, and intermittency issues. Investments in transmission infrastructure and technological advancements in energy storage are critical to overcoming these barriers and ensuring the stable growth of utility-scale solar.

Hybrid Solar Technology

Hybrid solar systems combine solar PV with other energy sources, such as wind, battery storage, or diesel generators, to create a more reliable and efficient energy solution. Hybrid systems are particularly useful in areas with unreliable grid access or frequent power outages, as they offer flexibility in power generation and consumption.

Hybrid systems are gaining traction in India, especially in rural or remote locations where grid connectivity is limited. For example, solar-wind hybrid projects are being developed in states like Tamil Nadu and Gujarat, where the complementary nature of solar and wind resources ensures more consistent power generation throughout the day. The government has introduced specific policies to promote hybrid projects, including favourable tariffs and land-use incentives.

The integration of **battery storage** in hybrid systems further enhances their reliability by storing excess solar power generated during the day for use during night or cloudy periods. This feature addresses one of the major challenges of solar power – its intermittent nature – and ensures a continuous power supply, which is critical for commercial and industrial applications.

Application Basis

Solar technology can be broadly categorized based on its application into **residential**, **commercial**, and **industrial** sectors. Each application has different energy needs, installation scales, and financial incentives.

- **Residential:** Solar energy systems for residential applications typically involve small-scale rooftop installations. These systems are designed to meet the electricity needs of individual households, reducing their dependency on the grid and lowering electricity bills. In India, residential rooftop solar has been growing, supported by government subsidies and falling solar PV prices.
- **Commercial:** Commercial applications of solar energy often involve medium to large-scale rooftop installations for businesses, shopping malls, hotels, and office buildings. These systems provide significant

cost savings on electricity bills, especially for businesses operating in high electricity tariff zones. Additionally, companies can benefit from tax incentives, making solar a lucrative option.

- **Industrial:** Industrial solar installations are typically larger in scale and may involve both rooftop and ground-mounted systems. The industrial sector consumes a large amount of energy, and solar power provides a cost-effective solution to reduce operational costs. Many large factories and manufacturing units in India are investing in solar to reduce their carbon footprint and improve energy efficiency.

Basis of Project Size

Solar projects can also be classified based on their size – **small, medium,** and **large** – depending on the capacity and energy output.

- **Small Projects:** These are typically residential solar systems with a capacity ranging from a few kilowatts (kW) to 100 kW. Small solar projects are easy to install and maintain, and they offer significant savings on electricity bills for individual households or small businesses.
- **Medium Projects:** Medium-sized solar projects often fall between 100 kW to 1 MW. These are commonly found in commercial applications or large residential complexes. Medium-sized installations offer higher energy savings and are typically more financially attractive, especially with favorable net metering policies and government incentives.
- **Large Projects:** Large-scale solar projects, which can range from 1 MW to several hundred megawatts, are usually utility-scale or industrial projects. These projects are often developed by solar companies or energy providers and feed electricity into the grid. Large projects require significant land and capital investment but offer economies of scale, making solar energy generation more cost-efficient per unit of energy.

India's solar energy industry, driven by the rapid adoption of these technologies across different sectors, plays a key role in meeting the country's renewable energy goals. Expanding the use of rooftop solar, utility-scale plants, and hybrid systems will be essential in ensuring India's energy security and sustainability in the coming decades.

EPC Services in the Solar Power Generation Segment

The Engineering, Procurement, and Construction (EPC) model is vital for the effective execution of solar power projects, offering a comprehensive approach that covers the entire lifecycle of solar installations. This model addresses the inherent complexities of the solar industry, providing tailored engineering designs based on feasibility studies, site surveys, and environmental assessments. EPC companies are responsible for procuring high-quality components such as solar panels and inverters while ensuring compliance with industry standards. During construction, these firms manage all aspects of the project, from site preparation to installation and integration, while adhering to safety regulations to mitigate risks.

EPC services extend beyond construction to include rigorous commissioning and ongoing operation and maintenance (O&M) support. Once a solar installation is complete, systems undergo thorough testing to ensure optimal performance before handing over the project to the client, complete with operational guidelines. This model offers significant advantages, including a single point of responsibility that simplifies communication and project management. By streamlining processes and enhancing resource allocation, EPC providers play a crucial role in advancing India's solar market, ultimately facilitating the nation's transition toward renewable energy and sustainable development.

EPC Business Model and Revenue Streams

EPC Business Models

- **Integrated Project Management**

The EPC model emphasizes a holistic approach to managing solar power projects, encompassing all phases from initial design to final commissioning. This integration ensures seamless coordination among various project components, reducing delays and inefficiencies. EPC companies often employ project managers who oversee timelines, budgets, and quality control throughout the project lifecycle.

- **Single Point of Responsibility**

By functioning as a single contractor responsible for all aspects of the project, EPC firms simplify communication between stakeholders. This streamlined approach minimizes potential conflicts and miscommunication, as clients have one primary contact for updates, changes, and issues. It also fosters accountability, as the EPC provider is fully invested in the project's success.

- **Contractual Framework**

The EPC business model operates within clearly defined contractual agreements that specify the roles, responsibilities, and deliverables for all parties involved. These contracts outline the scope of work, timelines, payment schedules, and performance expectations, providing a structured foundation for project execution. Such transparency helps in managing client expectations and mitigating risks.

Revenue Streams

- **Engineering Services Fees**

Revenue from engineering services includes fees charged for design, technical planning, and feasibility studies. EPC companies leverage their expertise to create customized solar solutions tailored to specific site conditions and client needs. This phase may also involve conducting site surveys and environmental assessments to ensure regulatory compliance and optimal energy production.

- **Procurement Margins**

EPC firms generate profits through strategic sourcing of materials, including solar panels, inverters, and mounting structures. By establishing strong relationships with manufacturers, they can negotiate competitive pricing and favourable warranty terms. The procurement process not only contributes to project cost efficiency but also ensures the quality of components, which is crucial for the longevity of solar installations.

- **Construction Contracts**

Revenue from construction contracts comes from the actual installation of solar systems. This includes site preparation, installation of solar panels, electrical wiring, and system integration. The construction phase is critical as it directly impacts the project timeline and budget. EPC providers oversee all construction activities, ensuring adherence to safety regulations and industry standards.

- **Operation and Maintenance (O&M) Contracts**

Many EPC companies offer long-term O&M contracts to monitor and maintain system performance post-installation. These services include regular inspections, repairs, and performance optimization to ensure that solar installations generate energy efficiently throughout their lifespan. O&M contracts provide a stable revenue stream for EPC firms and foster long-term client relationships.

- **Performance Guarantees**

Some EPC providers offer performance guarantees, which are additional fees tied to achieving specific energy output or efficiency metrics. By ensuring that the solar power systems meet predetermined performance standards, EPC companies not only enhance their service offerings but also build trust with clients. This model incentivizes the EPC firm to prioritize quality and efficiency throughout the project lifecycle.

- **Consulting Services**

Revenue from consulting services encompasses fees for providing expert guidance on project development, financing, and regulatory compliance. EPC companies often possess in-depth knowledge of the solar industry, enabling them to offer valuable insights to clients seeking to navigate complex regulatory environments or optimize their energy strategies. This consulting revenue stream diversifies the EPC firm's offerings and enhances its market position.

Key Growth Drivers: Analysis of factors driving the growth in India

The Engineering, Procurement, and Construction (EPC) sector in India is witnessing robust growth, driven by several key factors that enhance its overall landscape. These drivers are not limited to any specific industry but encompass the broader EPC framework, leading to increased investments and project execution capabilities across various sectors.

- **Infrastructure Development**

India's ongoing infrastructure development initiatives are a significant catalyst for the EPC business. Government investments in transportation, highways, railways, airports, and urban infrastructure projects create substantial demand for EPC services. The National Infrastructure Pipeline (NIP) aims to invest around USD 1.5 trillion in infrastructure projects over the year 2020-2025, paving the way for extensive EPC opportunities across the country.

As India aims to become a USD 5 trillion economy, the anticipated initiatives in the Union Budget 2024 focused on infrastructure development are set to significantly benefit the Engineering, Procurement, and Construction (EPC) business. The increased funding for affordable housing will create ample opportunities for EPC companies to leverage their expertise in construction techniques and project management. Additionally, enhancements to rural infrastructure through the Pradhan Mantri Gram Sadak Yojana (PMGSY) and investments in irrigation and water supply schemes will drive demand for EPC services, opening up new markets and contributing to rural economic upliftment. The emphasis on renewable energy projects, transportation networks, and digital infrastructure will further accelerate the need for specialized EPC solutions. Strengthening public-private partnerships and introducing new financing mechanisms will likely attract private investments, positioning the EPC sector as a pivotal player in India's infrastructure landscape and driving economic growth while enhancing the quality of life for citizens.

- **Government Policies and Initiatives**

Proactive government policies, such as the Make in India initiative and the National Policy on Electronics, encourage domestic manufacturing and infrastructure development. These initiatives aim to reduce import dependence and promote self-sufficiency, thereby increasing the demand for EPC services in various sectors, including energy, manufacturing, and construction.

- **Public-Private Partnerships (PPP)**

The growing trend of public-private partnerships in infrastructure projects has opened new avenues for EPC firms. Collaborations between the government and private players enhance project financing and execution capabilities, fostering an environment conducive to large-scale infrastructure development. The PPP model allows for shared risks and resources, making it attractive for EPC companies to participate in high-value projects.

The Government of India's Ministry of Finance is actively promoting public-private partnerships (PPPs) as a key strategy for infrastructure development. The Infrastructure Finance Secretariat (IFS) has been established to harmonize policies and initiatives, aiming to boost private investment in critical sectors such as railways, roads, urban infrastructure, and power. The Private Investment Unit, which operates under the IFS, is responsible for formulating policies, managing financial support schemes like the Viability Gap Funding (VGF) and India Infrastructure Project Development Funding (IIPDF), and providing guidance for PPP projects.

Recent initiatives include the appraisal of 358 projects with a total estimated cost of ₹676,636.57 crore and the allocation of funds for leasing 25 airports managed by the Airports Authority of India. The government emphasizes the importance of private sector involvement as a "partner in progress" to enhance infrastructure, stimulate job creation, and ensure sustainable economic growth. The website serves as a repository for PPP policies, guidelines, and best practices, providing essential information for stakeholders in both government and the private sector.

- **Urbanization and Smart Cities**

Rapid urbanization in India is driving the demand for modern infrastructure and smart city initiatives. The Smart Cities Mission aims to develop 100 cities with advanced infrastructure, technology, and sustainable practices. EPC firms play a crucial role in executing these projects, leading to increased investments in urban development and related services.

India is set to enhance its manufacturing ecosystem and infrastructure with the approval of 12 new smart industrial cities and several railway projects, as announced by the Cabinet Committee on Economic Affairs (CCEA) led by Prime Minister Narendra Modi. The smart city projects, part of the National Industrial Corridor Development Programme (NICDP), will involve an investment of INR 286.02 billion (USD 3.41 billion) and aim to attract INR 1.52 trillion (USD 18.12 billion) in investments, generating approximately 1 million direct and 3 million indirect jobs. Key locations for these industrial hubs include Khurpia (Uttarakhand), Rajpura-Patiala (Punjab), and Zaheerabad (Telangana), among others. The initiative is designed to strengthen India's manufacturing base while targeting industries such as technical textiles, electric vehicles, and tourism.

Additionally, the CCEA has sanctioned INR 64.56 billion (USD 769.9 million) for three railway projects that will enhance logistics across Odisha, Jharkhand, West Bengal, and Chhattisgarh, adding around 300 km to the railway network. Key projects include the Jamshedpur-Purulia-Asansol line and new lines in Odisha and Chhattisgarh, aimed at facilitating the transportation of critical commodities. Furthermore, an equity support of INR 41.36 billion (USD 493.2 million) has been allocated for hydro-power projects in Northeast India, targeting a total capacity of 15,000 MW over the next eight years. These developments align with the PM GatiShakti National Master Plan, promoting seamless connectivity and driving economic growth.

- **Technological Advancements**

Innovations in construction techniques, project management software, and automation are transforming the EPC sector. The adoption of Building Information Modeling (BIM), modular construction, and digital project management tools enhances efficiency, reduces project timelines, and lowers costs. These technological advancements enable EPC firms to deliver projects more effectively and respond to market demands swiftly.

- **Sector Diversification**

EPC companies are increasingly diversifying their service offerings beyond traditional sectors such as infrastructure and construction. The entry into emerging sectors like renewable energy, healthcare, and environmental management is opening up new growth avenues. This diversification helps EPC firms mitigate risks associated with economic fluctuations in specific industries.

EPC contractors are diversifying into sectors such as railways, solar energy, and water management, which present substantial annual opportunities estimated at approximately INR 1 lakh crore for railways, INR 15,000 crore for solar initiatives, and INR 70,000 crore for water-related projects. This evolving scenario highlights a crucial transition in India's infrastructure development, moving from a predominantly government-led approach to increased private sector participation.

- **Increased Private Investments**

The influx of private equity and venture capital into the EPC space is driving growth. Investors are recognizing the potential of the EPC sector, particularly in infrastructure and energy projects. This increased funding supports expansion, innovation, and the ability to take on larger projects, enhancing the competitive landscape for EPC firms.

The projected growth of Build-Operate-Transfer (BOT) projects in India, especially within the road sector, indicates a significant shift in the dynamics of infrastructure funding. Starting from FY25, the private sector's share in capital expenditure (capex) is anticipated to rise as government-led investments begin to moderate. In the road sector, the government's capital expenditure—primarily supporting projects under the Hybrid Annuity Model (HAM) and Engineering, Procurement, and Construction (EPC)—is expected to slow down. Road construction awards are projected to increase from 8,581 km in FY24 to 10,000 km in FY25 and further to 12,000 km in FY26. This upward trajectory in project awards, previously stalled due to the election code of conduct, is likely to gain momentum following the formation of a new government. The rise in private sector investment, particularly in BOT projects, signals a potential transformation in the funding landscape for infrastructure development. The Bharat Mala scheme, a flagship government initiative, includes a significant portfolio of projects worth INR 2.4 lakh crore yet to be awarded.

- **Rising Energy Demand**

The continuous increase in energy demand in India necessitates the expansion of energy infrastructure, including power plants, transmission lines, and renewable energy projects. EPC firms are integral to the development and implementation of these energy projects, driving growth in the sector. The push for renewable energy sources offers substantial opportunities for EPC businesses.

The Indian government has initiated the Solar Mission with the ambitious objective of deploying 100 gigawatts (GW) of solar power by 2022. As of 31 March 2025, India has achieved a cumulative solar capacity of 105.7 GW, according to MNRE. For rooftop solar, while a target of 40 GW had been set for mid-2022, only 17.02 GW had been installed by March 2025, highlighting a significant shortfall in distributed solar deployment. To address this shortfall, a new subsidy scheme for rooftop solar was launched in April 2024, aiming to meet the target by 2026.

- **Focus on Sustainability**

The global shift towards sustainability and environmental responsibility is influencing EPC practices in India. The demand for eco-friendly construction methods and sustainable project execution is on the rise. EPC companies that prioritize sustainable practices and comply with environmental regulations are likely to gain a competitive edge in the market.

EPC business in India is poised for significant growth due to a combination of factors, including government support, technological advancements, and increasing private investments. The emphasis on infrastructure development, urbanization, and sustainability further enhances the prospects for EPC firms, positioning them as key players in India's economic development trajectory.

Key Success Factors for EPC Companies in India

The success of Engineering, Procurement, and Construction (EPC) companies in India, particularly in the solar power sector, is contingent upon several critical factors that enable these firms to navigate industry complexities and seize growth opportunities.

- **Technical Expertise and Innovation**

A highly skilled workforce proficient in engineering, project management, and construction is imperative for EPC companies. Continuous training and development programs are essential to ensure that employees remain informed about the latest technologies and best practices. Moreover, the integration of cutting-edge technologies, such as Building Information Modeling (BIM), Internet of Things (IoT) for smart projects, and automation, significantly enhances project efficiency and quality, allowing companies to deliver superior results in a competitive market.

- **Strong Project Management Capabilities**

Effective project management is vital for ensuring that projects are completed on time and within budget. This involves meticulous planning, efficient resource allocation, and proactive risk management to anticipate and mitigate potential issues. Additionally, robust supply chain management is crucial for procuring high-quality materials at competitive prices, which supports project timelines and budgetary constraints. Together, these capabilities contribute to the overall success of EPC projects.

- **Diversification of Services**

Providing a broad spectrum of services—from design and engineering to procurement and maintenance—enables EPC companies to cater to diverse client needs and market segments. This comprehensive offering allows firms to build stronger client relationships and adapt to varying market demands. Furthermore, geographical diversification into international markets helps mitigate risks associated with domestic economic fluctuations and creates additional revenue streams, enhancing the firm's stability and growth potential.

- **Strong Relationships with Stakeholders**

Establishing long-term relationships with clients fosters trust and encourages repeat business, which is vital for sustained growth. Understanding client requirements and delivering customized solutions enhances client satisfaction and loyalty. In addition, collaboration with government agencies facilitates smoother project approvals and access to incentives or subsidies, thereby streamlining operations and providing firms with a competitive edge in the market.

- **Financial Stability**

Maintaining a robust financial position is essential for EPC companies to invest in new technologies, expand operations, and withstand economic downturns. Access to capital enables firms to pursue innovative projects and enhance their service offerings. Effective risk management strategies are also critical, as they help address potential challenges such as cost overruns, regulatory changes, and project delays, ensuring sustained profitability in a volatile market environment.

- **Commitment to Sustainability**

Adopting sustainable practices not only aligns with global trends but also enhances the company's reputation in an increasingly environmentally conscious market. This includes using eco-friendly materials and ensuring minimal environmental impact during construction processes. Furthermore, with India's commitment to increasing its renewable energy capacity, EPC companies that specialize in solar and other green technologies are well-positioned for substantial growth, capitalizing on the demand for sustainable energy solutions.

- **Government Support and Policy Alignment**

Aligning business strategies with national policies, such as the National Solar Mission, provides EPC firms with a competitive advantage through access to funding and incentives. Understanding and effectively navigating the regulatory landscape is also essential, as it ensures compliance and helps avoid potential legal challenges that could delay projects. By leveraging government initiatives, EPC companies can enhance their operational efficiency and contribute to the broader goals of India's renewable energy sector.

The success of EPC companies in India is rooted in a blend of technical expertise, strong project management capabilities, service diversification, stakeholder relationships, financial stability, sustainability commitments, and alignment with government policies. By focusing on these key success factors, EPC firms can bolster their competitiveness in the rapidly evolving solar power sector and make significant contributions to India's renewable energy objectives.

Challenges Faced by EPC Players in India

EPC (Engineering, Procurement, and Construction) companies in India encounter a range of challenges that can hinder their operations and impact their overall effectiveness in delivering projects, particularly in the renewable energy sector. Below are some of the primary challenges faced by EPC players in India:

- **Regulatory Hurdles**

The complex regulatory landscape in India presents significant challenges for EPC companies. Obtaining necessary approvals and clearances can be time-consuming and often involves navigating bureaucratic red tape. Frequent changes in regulations and policies can further complicate compliance, leading to project delays and increased costs.

- **Funding and Financial Constraints**

Access to adequate financing is a persistent challenge for EPC firms, particularly for large-scale projects. Limited availability of funds, high-interest rates, and stringent lending criteria can restrict the ability of companies to secure the necessary capital for project execution. This financial pressure can affect the planning and delivery of projects, ultimately impacting profitability.

- **Skilled Labor Shortage**

The EPC industry in India faces a shortage of skilled labor, which is critical for the successful execution of projects. Despite a growing number of engineering graduates, there is often a gap between academic training and practical skills required in the field. This shortage can lead to project delays, quality issues, and increased labor costs as companies compete for a limited talent pool.

- **Supply Chain Disruptions**

EPC companies rely heavily on a robust supply chain for timely procurement of materials and equipment. Disruptions caused by global supply chain issues, transportation delays, or fluctuating material prices can significantly impact project timelines and budgets. Companies must develop effective supply chain management strategies to mitigate these risks and ensure consistent material availability.

- **Technological Adaptation**

While adopting advanced technologies can enhance project efficiency, the initial investment and learning curve associated with new technologies can pose challenges for EPC players. Many firms may struggle with integrating digital tools, such as Building Information Modeling (BIM) and IoT, into their existing processes. This can hinder their ability to leverage technology for improved project outcomes.

- **Environmental Concerns and Compliance**

Increasing environmental awareness and stricter sustainability regulations necessitate that EPC companies adopt environmentally friendly practices in their operations. Compliance with environmental regulations can add complexity to project planning and execution, requiring companies to invest in sustainable technologies and practices, which can increase project costs.

- **Competition and Price Sensitivity**

The EPC sector in India is highly competitive, with numerous players vying for projects. This intense competition often leads to price undercutting, resulting in reduced profit margins. Companies must balance the need to remain competitive with the necessity of delivering quality services while managing costs effectively.

- **Project Management Challenges**

The execution of large-scale projects involves managing multiple stakeholders, tight timelines, and varying client expectations. Ineffective project management can lead to delays, cost overruns, and quality issues. EPC firms need to implement robust project management frameworks to ensure effective coordination and execution of projects.

- **Ineffective Communication**

EPC projects involve multiple stakeholders, including contractors and subcontractors, often spread across different locations. This complexity can lead to communication breakdowns, resulting in costly rework and delays. To mitigate this risk, it is vital to establish clear communication channels. Owners should seek contractors with integrated teams to minimize reliance on subcontractors and simplify stakeholder management, ensuring everyone is informed of progress and any changes.

- **Budget Overruns**

Unexpected increases in material costs, changes in project scope, and inaccurate estimations can lead to budget overruns, sometimes resulting in project failure. To manage this risk, creating detailed budgets and monitoring them throughout the project lifecycle is essential. Contractors should involve experienced estimators and comprehensive staff in budget preparation to enhance accuracy, ensuring all potential variables are accounted for to avoid financial pitfalls.

- **Project Timeline Delays**

Project timelines can be disrupted by various factors, including scope changes, shipping delays, and labor shortages. Such schedule delays jeopardize customer satisfaction and can trigger cost overruns. To mitigate this risk, owners should carefully vet contractors for proven project management methodologies. Techniques like the Critical Path Method (CPM) help in establishing realistic timelines, while cross-functional teams can streamline execution to maintain project momentum.

- **Accountability Deficiencies**

When problems arise, stakeholders who avoid responsibility can slow down resolution, increasing project costs and timelines. Establishing quality control measures at the project's outset is essential for ensuring performance standards are met. Using contractors that minimize reliance on subcontractors can reduce accountability issues, fostering a collaborative environment where responsibilities are clearly defined and addressed.

- **Design and Quality Assurance Issues**

Poor initial design can lead to performance issues later in the project. To prevent this risk, adopting a project-centred delivery approach that uses proven technologies allows for better customization. This ensures that designs meet the unique specifications of the end-user, leading to enhanced performance and satisfaction.

Outlook for the EPC Market

The outlook for India's Engineering, Procurement, and Construction (EPC) market remains highly positive, supported by strong government-led infrastructure spending and a robust pipeline of ongoing projects. National Infrastructure Pipeline (NIP), India has committed an investment of INR 108.88 lakh crore for 2020–2025, with projects worth nearly INR 44 lakh crore already under active implementation, ensuring sustained EPC demand across sectors. Record capital expenditure in FY 2025 such as the highest-ever allocation of INR 2.52 lakh crore to the Ministry of Railways and continued expansion of highways under the Ministry of Road Transport and Highways further strengthens the sector's growth prospects. In addition, government-backed initiatives in renewable energy, including the target of achieving 500 GW of renewable capacity by

2030, are driving a large pipeline of EPC opportunities in solar parks, wind farms, hydropower, and transmission networks. Urban infrastructure programs like the Smart Cities Mission and AMRUT 2.0 continue to boost EPC requirements in mobility, water supply, and municipal development. Government policy support has also revived private-sector participation, with private infrastructure investment expected to rise to nearly 12% in FY 2025 from about 9% previously. Overall, the EPC market is set for strong expansion in FY 2025 and beyond, backed by the government's sustained focus on infrastructure creation, transport modernization, renewable energy deployment, and public-private partnership models.

Solar PPA Industry

PPA Structure and Contractual Terms

A Power Purchase Agreement (PPA) serves as a financial arrangement between a solar project developer and an energy consumer, typically a business or institution. This contract enables the consumer to procure electricity generated by a solar energy system installed on their property or in proximity, without incurring the initial capital expenditure for the solar infrastructure.

The Indian government is set to implement significant changes to its electricity market, particularly regarding Power Purchase Agreements (PPAs), which will now be contracted for 12-15 years instead of the previous 25-year norm. This decision aims to revamp the market, which currently has a mere 7% share in overall power sources, as highlighted by the total traded volume of 1,02,276 million units in 2022-23, compared to 16,24,465 million units generated from all sources, including renewable energy. A government-formed group, led by Alok Kumar, submitted recommendations to enhance the electricity market, involving various stakeholders such as ministries and state governments. Union Minister RK Singh emphasized the need for India to develop its own solutions rather than relying on international practices, underscoring the country's success in controlling electricity prices during the global energy crisis. These changes are part of a broader initiative to improve the electricity market and promote renewable energy sources in India.

Key Components of a Solar PPA

PPAs generally have a duration of 10 to 25 years, facilitating long-term energy procurement. The agreements specify the power purchase rate, which is often set lower than current market rates, thereby providing immediate cost savings to consumers. The project scope and installation details are also outlined, including the size, capacity, and location of the solar system, along with the responsibilities for installation and operation.

Ownership of the solar infrastructure typically remains with the solar developer throughout the agreement, which also includes financing for equipment, installation, and maintenance. Performance guarantees are often incorporated, ensuring that the solar system operates at designated efficiency levels, with provisions for

compensation to consumers if performance falls short. Additionally, PPAs may feature escalation clauses, usually ranging from 1% to 5%, to accommodate inflation and anticipated increases in grid electricity prices.

Contractual Terms

- Payment Structure: Specifies how and when payments will be made, often linked to the actual energy produced.
- Termination Clauses: Outlines conditions under which either party can terminate the agreement, including penalties or obligations upon termination.
- Liabilities and Indemnities: Details responsibilities regarding liabilities, including damages or losses incurred during installation or operation.
- Dispute Resolution: Includes procedures for resolving disputes related to contract interpretation or performance issues to ensure clarity and fairness.

Advantages of a Solar PPA

One of the primary advantages of a PPA is the absence of upfront costs, allowing consumers to enjoy stable and typically lower electricity expenses without significant initial investment in solar technology. Additionally, PPAs mitigate performance risks associated with owning and operating solar systems while enabling consumers to benefit from renewable energy. The model accelerates return on investment (ROI), as traditional solar installations often require substantial upfront capital; PPAs allow businesses to allocate resources to core operations while benefiting from reduced energy costs.
The structure and contractual terms of Power Purchase Agreements are strategically designed to promote solar energy adoption while delivering financial benefits to both developers and consumers. By defining clear responsibilities, pricing structures, and performance guarantees, PPAs empower businesses to effectively leverage renewable energy solutions while mitigating risks tied to traditional energy procurement methods. This model has gained significant traction in the commercial and industrial sectors, which are increasingly focused on enhancing sustainability and managing operational costs efficiently.

Types of Power Purchase Agreements (PPAs)

- Fixed Price PPA: In this type of agreement, the consumer pays a predetermined fixed rate for electricity generated over the contract's duration. This arrangement provides price certainty and stability, helping consumers budget their energy costs effectively.

- Indexed PPA: This agreement ties the price of electricity to a specific index, such as market prices for energy or inflation rates. This allows the price to fluctuate based on market conditions while still providing a general pricing framework.

- Escalating PPA: An escalating PPA includes annual price increases, often set at a fixed percentage (typically between 1% to 5%). This type of agreement accounts for inflation and anticipates future increases in grid electricity prices.
- Pay-as-Bid PPA: In this model, consumers pay based on the actual bids received from developers, with prices determined during a competitive bidding process. This can help consumers secure lower rates depending on the competitiveness of the bids.
- Virtual Power Purchase Agreement (VPPA): A VPPA is a financial contract rather than a physical delivery of electricity. It allows consumers to purchase renewable energy certificates (RECs) from a solar project while receiving a fixed payment, often used by large corporations to meet sustainability goals without direct energy delivery.
- Corporate PPA: This type of PPA is specifically designed for corporate buyers, allowing them to procure renewable energy directly from a developer. Corporate PPAs typically involve long-term contracts that help companies meet their sustainability targets while ensuring a stable energy supply.

Benefits and Risks of Power Purchase Agreements (PPAs)

Benefits

- **Cost Savings**: Power Purchase Agreements often allow consumers to procure electricity at rates lower than those offered by traditional energy suppliers. This pricing structure not only results in immediate financial benefits but also offers long-term savings as the cost of solar energy remains stable compared to fluctuating fossil fuel prices. By locking in a lower rate through a PPA, businesses can significantly reduce their overall energy expenditures, improving their financial performance.
- **No Upfront Capital Investment**: One of the most attractive features of PPAs is that they eliminate the need for significant upfront capital investments in solar infrastructure. This advantage is especially beneficial for businesses that may have limited cash flow or prefer to allocate their resources to other operational areas. The solar developer typically handles the costs associated with the design, installation, and maintenance of the solar system, allowing the consumer to access renewable energy without the burden of large initial expenses.
- **Predictable Energy Costs**: Many PPAs incorporate fixed pricing or predictable escalation clauses, enabling businesses to forecast their energy costs accurately over the contract's duration. This predictability aids in budgeting and financial planning, allowing companies to avoid the volatility often associated with energy markets. As a result, businesses can achieve greater financial stability and allocate resources more effectively.

- **Risk Mitigation**: By entering into a PPA, consumers can transfer many operational risks related to the performance and maintenance of the solar system from themselves to the solar developer. This arrangement ensures that the developer is responsible for ensuring the system operates efficiently and meets the performance guarantees outlined in the agreement. As a result, businesses can focus on their core operations without worrying about the complexities and potential issues that can arise from owning and operating a solar system.
- **Sustainability Goals**: Engaging in a PPA enables businesses to enhance their sustainability credentials by committing to renewable energy sources. This commitment can positively impact their brand reputation, as consumers and stakeholders increasingly favour environmentally responsible practices. By adopting solar energy, companies can reduce their carbon footprint and contribute to global efforts to combat climate change, positioning themselves as leaders in corporate social responsibility.
- **Accelerated Return on Investment (ROI)**: PPAs enable businesses to realize a faster return on investment compared to traditional solar installations, where substantial upfront capital is required. Energy savings can often be seen immediately, allowing companies to reinvest these savings into other growth initiatives. This quick turnaround can enhance a company's cash flow and contribute to overall financial health.

Risks

- **Contractual Obligations**: Consumers entering into a PPA must adhere to specific contractual obligations, which can include penalties for early termination or failing to meet agreed-upon energy consumption levels. These obligations can pose risks if business conditions change unexpectedly, potentially leading to additional costs or operational constraints. Therefore, businesses need to carefully evaluate their energy needs and the PPA terms to ensure alignment with their long-term goals.
- **Performance Risks**: Although many PPAs include performance guarantees, there is always a risk that the solar system may not operate as expected. If the system fails to deliver the promised energy output or efficiency, consumers may experience financial losses. Companies must ensure that they thoroughly assess the developer's track record and the terms of the performance guarantees to mitigate this risk effectively.
- **Market Price Fluctuations**: In indexed or escalating PPAs, the purchase price of electricity may be tied to fluctuating market rates. While these arrangements can provide benefits when market prices are low, they may also expose consumers to higher costs if market prices rise significantly. This potential for increased costs can diminish the initial savings and should be considered during the decision-making process.

- **Dependency on Developer**: By entering a PPA, consumers may become reliant on the developer for the solar system's performance and ongoing maintenance. If the developer fails to meet their obligations, it can lead to operational disruptions and increased costs for the consumer. To address this risk, businesses should thoroughly vet developers, ensuring they have a solid reputation and the necessary expertise to deliver on their commitments.
- **Complexity of Agreements**: The intricacies involved in PPA contracts can sometimes lead to misunderstandings or disputes regarding terms, pricing, or performance expectations. Businesses must invest time and resources to thoroughly review and understand the contract before signing. Engaging legal or financial advisors with experience in energy contracts can help mitigate this risk by ensuring that all terms are clearly defined and understood.
- **Regulatory Changes**: The renewable energy landscape is influenced by government policies and regulations that can change over time. Such changes may affect the terms of the PPA, potentially leading to increased costs or operational challenges for consumers. Businesses should stay informed about regulatory developments and be prepared to adapt their strategies accordingly to minimize the impact of such changes on their energy procurement plans.

PPA Market Trends and Outlook

The corporate renewable power purchase agreement (PPA) market in India suggests a potential rebound in 2021, despite significant challenges faced in the previous year due to the COVID-19 pandemic. India ranked as the second largest market for corporate renewable electricity sourcing globally, adding 1.4 GW of capacity in 2019. However, 2020 experienced a sharp decline, with only 800 MW added, primarily due to state-level restrictions and the adverse effects of the pandemic.

The demand for corporate renewable PPAs is expected to rise due to the sustainability commitments of major corporations such as Dalmia Cement, Infosys, Tata Motors, and Starbucks, which have pledged to meet 100% of their electricity needs through renewable sources. Moreover, various developers, including AMP Energy and CleanMax, are planning significant capacity expansions. With power demand recovering to pre-COVID levels and the ongoing evolution of the corporate renewable PPA market, 2021 appears to be a pivotal year for advancing India's decarbonization goals and shaping the future of renewable energy procurement in the country.

A Power Purchase Agreement (PPA) enables an entity to procure electricity directly from a power producer. In India, state-owned and licensed distribution companies (discoms) primarily act as off-takers, procuring power from generating companies (genos) and subsequently distributing it to end-users, including commercial and industrial sectors, agriculture, and households. Discoms, such as the Maharashtra State Electricity

Distribution Company Limited (MSEDCL), which serves the entire state of Maharashtra, are responsible for raising monthly invoices for the power supplied and meeting the demand within their respective supply areas.

The trend of corporate power purchase agreements (PPAs) is primarily driven by larger companies, yet there is significant potential for smaller firms to enter the renewable energy market by pooling their power needs or partnering with established entities as anchor tenants, which can help mitigate long-term commitment risks. Examples of successful group captive projects include the Nellai Power Plant in Tamil Nadu, which operates under a model requiring participants to purchase at least 51% of generated power and hold a minimum of 26% equity in the project. Similarly, Watsun Infrabuild Private Limited operates a utility-scale power plant, with 51% of its capacity contracted to distribution companies, offering competitive tariff discounts for its industrial and commercial customers. Recent regulatory developments, including the 2022 Open Access Rules, have made it easier for small consumers to procure renewable energy by lowering the minimum capacity threshold from 1 MW to 100 kW. Additionally, these rules establish a uniform regime for Renewable Purchase Obligations (RPOs), expanding opportunities for corporate PPAs. However, while the popularity of corporate PPAs rises, complexities surrounding Change in Law (CIL) provisions, performance guarantees, and responsibility for unforeseen events pose challenges that must be carefully navigated in negotiations. Overall, the future of corporate PPAs in India is set to evolve, becoming increasingly complex and tailored to meet the unique needs of both corporate buyers and energy generators.

Competitive Landscape

The solar energy sector in India has experienced substantial growth, propelled by government initiatives, technological advancements, and rising demand for renewable energy. Key players in the Engineering, Procurement, and Construction (EPC) market include leading firms such as Tata Power Solar, Adani Solar, Sterling and Wilson Solar, etc. each distinguished by their unique strengths and comprehensive service offerings. In the Power Purchase Agreement (PPA) market, trends like the increasing participation of corporations pursuing sustainability through renewable contracts, declining solar technology costs resulting in competitive tariffs, and regulatory support are shaping the landscape. However, challenges such as regulatory hurdles, supply chain disruptions, and land acquisition issues persist. Despite these obstacles, the competitive environment remains dynamic, with significant opportunities for growth as India strives to meet its ambitious renewable energy targets.

Profiling of Key Peer Players

Name	Overview
Solex Energy Limited	Solex Energy Limited, incorporated in 2014 and headquartered in Surat, Gujarat, operates in the solar energy sector with activities spanning solar photovoltaic module manufacturing and solar project execution. The company is engaged in providing solar solutions across residential, commercial, and industrial segments, with project execution covering rooftop and ground-mounted solar installations. The company has established manufacturing capabilities for solar PV modules, supporting its project execution activities. Solex offers a range of products and services, including solar modules, engineering, procurement, and construction (EPC) solutions, system design, installation, operation, and maintenance services. Its presence across manufacturing and project execution enables it to participate across multiple stages of the solar value chain, particularly in distributed solar applications.
Solarium Green Energy Limited	Solarium Green Energy Limited, incorporated in 2022 and headquartered in Ahmedabad, Gujarat, is engaged in providing solar energy solutions with a focus on engineering, procurement, and construction (EPC) services. The company operates in the rooftop and distributed solar segment, catering to residential, commercial, and industrial customers. Its activities include design, installation, and

	commissioning of solar power systems across multiple locations in India. The company provides turnkey solar solutions, including system integration, project execution, and operation and maintenance services. Its offerings include rooftop solar systems, on-grid solutions, and customized solar installations for commercial and industrial applications. The company's focus on distributed solar deployment and EPC execution aligns with players operating in the commercial and industrial solar segment.
Sahaj Solar Limited	Sahaj Solar Limited, incorporated in 2010 and headquartered in Ahmedabad, Gujarat, operates in the solar energy sector with activities spanning both solar photovoltaic module manufacturing and EPC services. The company is engaged in providing solar solutions across residential, commercial, industrial, and government segments, including the execution of rooftop and ground-mounted solar projects. The company has established manufacturing capabilities for solar PV modules, supporting its project execution activities. Sahaj Solar offers a range of products and services, including solar modules, solar pumps, rooftop solar systems, and turnkey EPC solutions, along with installation, operation, and maintenance services. Its presence across manufacturing and project execution enables it to cater to distributed and institutional solar requirements.

Company Profile: Ricans Solar Energy Limited

Business Overview

The Company operates in the solar energy sector under the brand "RICANS" as an Engineering, Procurement and Commissioning (EPC) service provider, engaged in the development and execution of solar power projects. The Company offers end-to-end turnkey solar solutions, including design, engineering, procurement and supply, construction and erection, testing, commissioning, and the associated transmission infrastructure for solar power plants across various categories of electricity consumers in India. The Company's project portfolio includes residential rooftop installations, commercial and industrial rooftop systems, as well as ground-mounted solar projects for power generation and energy management.

Rican's EPC contracts are typically executed on a turnkey basis, covering a comprehensive range of services. These include site assessment and feasibility analysis, selection of optimal plant configurations, financial and technical evaluation of technology options, assessment of technology and grid connectivity risks, detailed engineering, and structuring of contracts. The Company also undertake procurement, supply chain and logistics management, construction and site execution, manpower deployment, and financial planning, along with providing warranties and guarantees. Further, operations and maintenance (O&M) services are provided to clients through the group company, Solar ONM Services Private Limited, which include module cleaning, testing, repair and replacement of components, and periodic inspection of solar installations.

The Company's business operations are primarily organized under two models**: Capital Expenditure (CAPEX)** and **Renewable Energy Service Company (RESCO).** Under the CAPEX model, customers undertake the capital investment, while the Company provide EPC services. Under the RESCO model, the company enters into agreements with rooftop owners, wherein the electricity generated is consumed by such owners against payment of a pre-agreed tariff over the tenure of the contract. In this model, the solar assets, including panels and related infrastructure, are owned by the Company. While a significant portion of revenue is derived from the CAPEX model, the Company have also executed a 260kW project in Faridabad under the RESCO model.

As on the date of this Draft Red Herring Prospectus, the Company has one associate company, namely Trovesol Sun Limited.

Business Segment

The Company operates across two business verticals within the solar energy sector; each aimed at promoting the adoption of renewable energy. The primary verticals include:

1. Capital Expenditure (CAPEX) Model

Under the CAPEX (Capital Expenditure) model, the Company act as the Engineering, Procurement and Commissioning (EPC) contractor and undertake the end-to-end execution of solar power projects for customers. The scope of services includes engineering design, procurement of materials and equipment, construction and installation, testing and commissioning, as well as facilitating grid connectivity and obtaining requisite approvals. Under this model, the ownership of the solar power system rests with the customer.

This model is widely adopted across residential, commercial and industrial segments, where customers prefer direct ownership of solar assets and the ability to consume the electricity generated for their own use. The customer undertakes the entire capital investment, either through internal accruals or external financing arrangements, including bank funding.

2. Renewable Energy Service Company (RESCO) Model

Under the RESCO model (also referred to as the OPEX or BOOT – Build, Own, Operate, Transfer model), the Company undertakes the development, financing, ownership, and operation of the solar power project. The Company make the capital investment in setting up the rooftop or ground-mounted solar power plant, while the customer enters into a long-term Power Purchase Agreement (PPA) with the company.

Pursuant to the PPA, the Company supply electricity generated from the solar power plant to the customer, and the customer pays a pre-determined tariff on a per kWh basis over the tenure of the agreement. This structure enables customers to procure solar power without any upfront capital investment, thereby reducing their energy costs while avoiding ownership and operational responsibilities.

Types of Solar Installation

Rooftop Solar Installations

The Company provide grid-connected rooftop solar power systems for residential, commercial, and industrial consumers. These systems are installed on available rooftop spaces and are designed to generate electricity for captive consumption. Rooftop installations enable users to offset a portion of their grid electricity consumption, resulting in cost savings and improved energy efficiency. Such systems are engineered in accordance with applicable regulatory requirements and are suitable for varying load profiles across households as well as commercial and industrial establishments.

Ground-Mounted Solar Installations

The Company also undertake the development and execution of ground-mounted solar power projects, which are installed on open land parcels and are typically suited for larger capacity installations. These projects are designed for efficient large-scale energy generation where rooftop space is either unavailable or insufficient. The scope includes design, engineering, procurement, installation, and commissioning of such projects, ensuring optimal land utilization and performance. Ground-mounted systems may be deployed for captive consumption or under long-term power supply arrangements, depending on customer requirements.

Financials KPI Benchmarking

Particular	Unit	Ricans Solar Energy Limited				Solex Energy Limited				Solarium Green Energy Ltd				Sahaj Solar Limited			
		As at end of the Fiscal				As at end of the Fiscal				As at the end of the Fiscal				As at end of the Fiscal			
		H1 FY 2026	Fiscal 2025	Fiscal 2024	Fiscal 2023	H1 FY 2026	Fiscal 2025	Fiscal 2024	Fiscal 2023	H1 FY 2026	Fiscal 2025	Fiscal 2024	Fiscal 2023	H1 FY 2026	Fiscal 2025	Fiscal 2024	Fiscal 2023
Total Income	₹ in Lakhs	1,123.31	2,050.18	1,045.90	335.18	41,568.42	66,582.03	36,801.53	16,438.83	11,984.72	23,108.94	17,780.83	9,892.50	11,159.74	33,082.14	20,171.55	18,588.43
Revenue from Operations	₹ in Lakhs	1,116.50	2,002.58	1,043.75	334.34	41,462.85	66,222.31	36,592.11	16,171.29	11,692.64	23,007.64	17,739.69	9,878.98	11,112.34	32,979.34	20,117.41	18,536.16
EBITDA	₹ in Lakhs	247.27	208.66	107.92	5.51	5,985.72	7,311.64	2,841.35	1,132.32	1,344.50	2,590.19	2,419.77	600.91	1,061.50	4,220.66	2,437.16	1,132.48
EBITDA Margin	in %	22.15%	10.42%	10.34%	1.65%	14.44%	11.04%	7.76%	7.00%	11.50%	11.26%	13.64%	6.08%	9.55%	12.80%	12.11%	6.11%
Profit After Tax (PAT)	₹ in Lakhs	178.71	179.75	74.32	0.66	3,049.21	4,202.78	873.48	271.07	921.29	1,858.62	1,574.06	315.77	512.79	2,754.33	1,315.30	628.24
PAT Margin (%)	in %	16.01%	8.98%	7.12%	0.20%	7.35%	6.35%	2.39%	1.68%	7.88%	8.08%	8.87%	3.20%	4.61%	8.35%	6.54%	3.39%
Total Asset	₹ in Lakhs	940.02	626.54	313.15	188.03	75,305.23	48,025.08	21,196.15	14,078.12	29,735.70	23,442.41	7,809.78	4,465.37	32,986.41	30,414.14	14,936.41	9,083.55
Net worth	₹ in Lakhs	590.48	411.78	81.73	7.41	18,829.36	16,062.82	4,624.17	3,762.69	15,131.83	14,146.73	2,052.60	478.54	11,356.48	10,862.06	3,257.98	1,648.37
Total Debt	₹ in Lakhs	110.88	134.51	57.65	114.04	26,744.14	14,749.91	9,615.98	6,594.14	11,683.34	6,798.84	3,180.66	2,776.53	8,871.74	5,740.14	5,679.05	1,359.28
Debt-Equity Ratio	In Times	0.19	0.33	0.71	15.39	1.42	0.92	2.08	1.75	0.77	0.48	1.55	5.80	0.78	0.53	1.74	0.82
Return on Capital Employed (ROCE)	in %	44.51%	76.92%	227.96%	-2.85%	17.15%	38.63%	21.77%	9.74%	8.63%	29.12%	97.71%	34.31%	7.72%	51.17%	78.98%	52.55%
Return on Equity (ROE)	in %	35.66%	72.85%	166.76%	8.82%	17.48%	40.63%	20.83%	7.46%	6.29%	22.95%	124.38%	81.12%	4.62%	39.01%	53.62%	48.22%
Return On Asset	in %	22.82%	38.26%	29.66%	0.56%	4.94%	12.14%	4.95%	2.54%	3.46%	11.89%	25.65%	8.32%	1.62%	12.15%	10.95%	8.27%
Capital Employed	₹ in Lakhs	621.21	420.90	81.92	7.44	36,279.23	23,386.20	9,692.13	8,634.54	15,843.17	14,197.39	2,966.00	1,827.38	13,549.66	12,202.69	3,779.56	2,096.83

Note: We used consolidated Financial Statements.

Formula Used

Parameter	Formula
Total Revenue	Total Income includes Revenue from Operations and Other income.
Revenue From Operations	Revenue from operations means the revenue from operations as appearing in the restated statement of profit & loss for the relevant year/period.
EBITDA	PBT - Other Income + Finance Cost + Depreciation & Amortisation
EBITDA Margin (%)	EBITDA / Revenue From Operations
Profit after tax (PAT)	Profit after tax (PAT) refers to Restated Profit/(Loss) for the year from Continuing Operations as appearing in the Restated Financial Information
PAT Margin (%)	PAT /Revenue From Operations
Return on Equity (ROE)	PAT/Average Equity
Return on Asset (ROA)	ROA = PAT/Average Assets
Return on Capital Employed (ROCE)	EBITDA - Depreciation & Amortisation / Average Capital Employed
Capital Employed	Total Assets - Current Liabilities
Debt to Equity Ratio	Debt to Equity Ratio is calculated as Total Borrowings divided by Shareholders' Equity as at the end of the year.
Total Debt	Long-term + Short-term borrowings
Net Worth	Total Assets – Total Liabilities