Industry Report on Solar EPC and PPA Industry

For Ricans Solar

October 2024

Disclaimer

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Global Macroeconomic Scenario

The global economy, which grew by 3.3% in 2023, is expected to record a sluggish growth of 3.2% in 2024 before rising modestly to 3.3% in 2025. Between 2021 – 2022, global banks were carrying a historically high debt burden after COVID-19. Central banks took tight monetary measures to control inflation and spike in commodity prices. Russia's war with Ukraine further affected the global supply chains and inflated the prices of energy and other food items. These factors coupled with war-related economic sanctions impacted the economic activities in Europe. Any further escalation in the war may further affect the rebound of the economy in Europe.

While China, the largest manufacturing hub of world, was facing a crisis in the real estate sector and prices of properties were declining between 2020 - 2023, with the reopening of the economy, consumer demand is picking up again. The Chinese Government took several steps to help the real estate sector including cracking down on debt-ridden developers, announcing stimulus for the sector and measures to encourage the completion and delivery of unfinished real estate projects. The sector is now witnessing investments from developers and demand from buyers.

Global headline inflation is set to fall from an estimated 6.8% in CY 2023 to 5.8% in CY 2024 and to 4.4% in CY 2025. This fall is swifter than anticipated across various areas, amid the resolution of supply-related problems and tight monetary policies. Reduced inflation mirrors the diminishing impact of price shocks, particularly in energy, and their subsequent influence on core inflation. This decrease also stems from a relaxation in labour market pressure, characterized by fewer job openings, a slight uptick in unemployment, and increased labour availability, occasionally due to a significant influx of immigrants.

Global GDP Growth Scenario

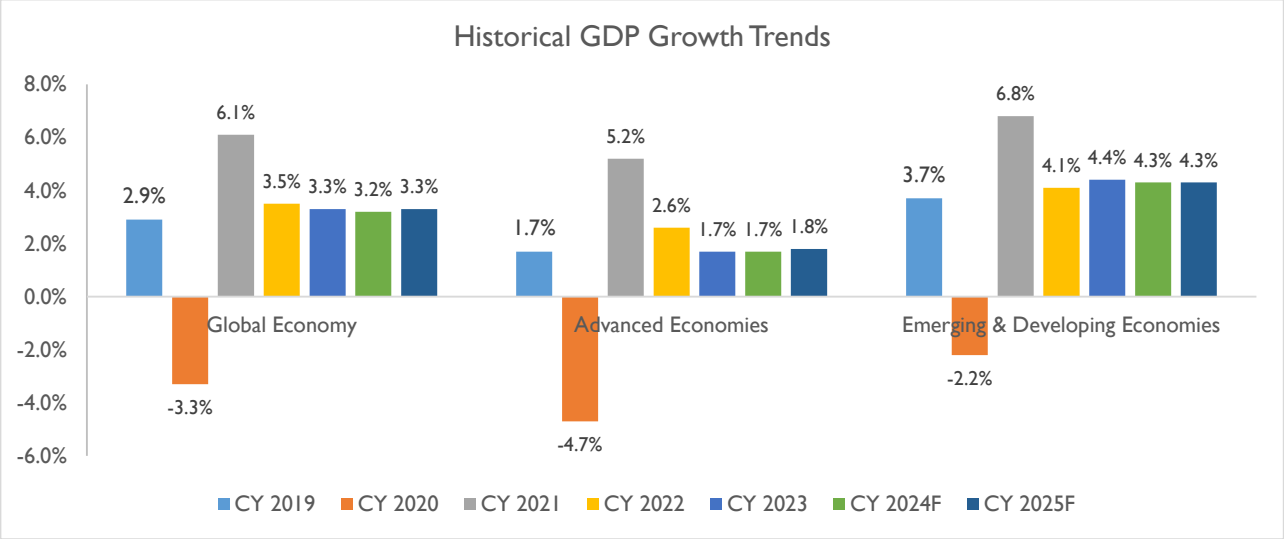
The global economy started to rise from its lowest levels after countries started to lift the lockdown in 2020 and 2021. The lockdown was a key factor as it affected economic activities resulting in a recession in the year CY 2020, as the GDP growth touched -3.3%.

In CY 2021 disruption in the supply chain affected most of the advanced economies as well as low-income developing economies. The rapid spread of Delta and the threat of new variants in mid of CY 2021 further increased uncertainty in the global economic environment.

Global economic activities experienced a sharper-than-expected slowdown in CY 2022. One of the highest inflations in decades, seen in 2022, which forced most of the central banks to tighten their fiscal policies. Russia’s invasion of Ukraine affected the global food supply resulting in a further increment in the cost of living.

Further, despite initial resilience earlier in 2023, marked by a rebound in reopening and progress in curbing inflation from the previous year's highs, the situation remained precarious. Economic activity lagged its pre-pandemic trajectory, particularly in emerging markets and developing economies, leading to widening

disparities among regions. Numerous factors are impeding the recovery, including the lasting impacts of the pandemic and geopolitical tensions, as well as cyclically driven factors such as tightening monetary policies to combat inflation, the reduction of fiscal support amidst high debt levels, and the occurrence of extreme weather conditions. As a result, global growth declined from 3.5% in CY 2022 to 3.3% in CY 2023.

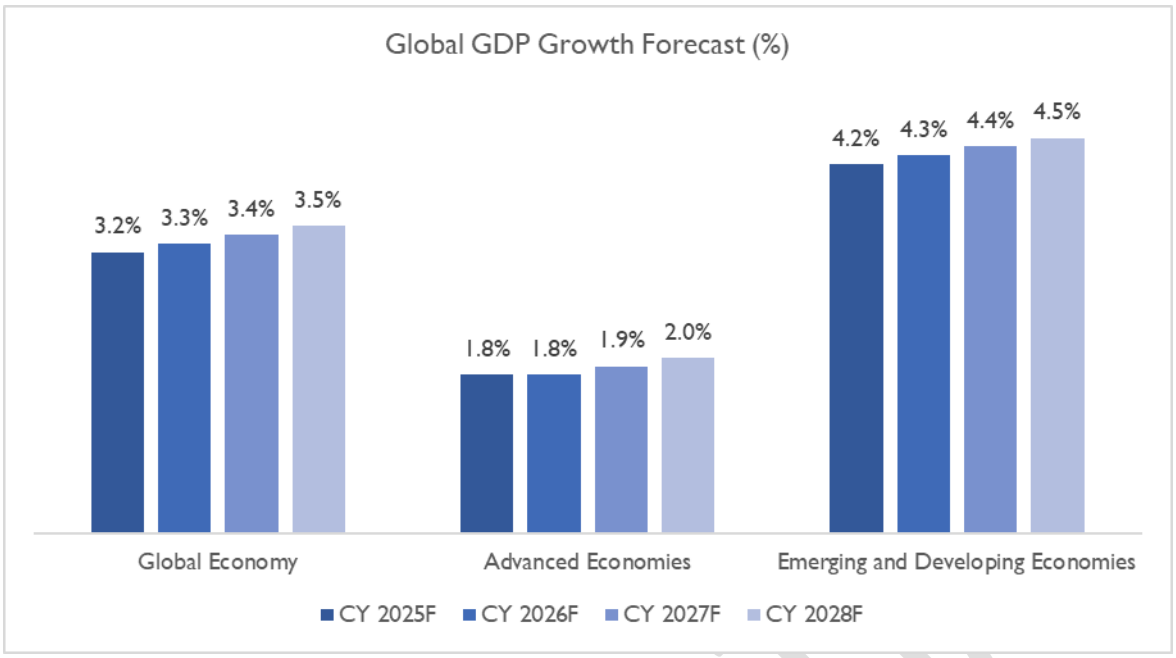


Source – IMF Global GDP Forecast Release July 2024

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.)

In the current scenario, global GDP growth is estimated to have recorded a moderate growth of 3.3% in CY 2023 as compared to 3.5% growth in CY 2022. While high inflation and rising borrowing costs are affecting private consumption, on the other hand, fiscal consolidation is affecting government consumption.

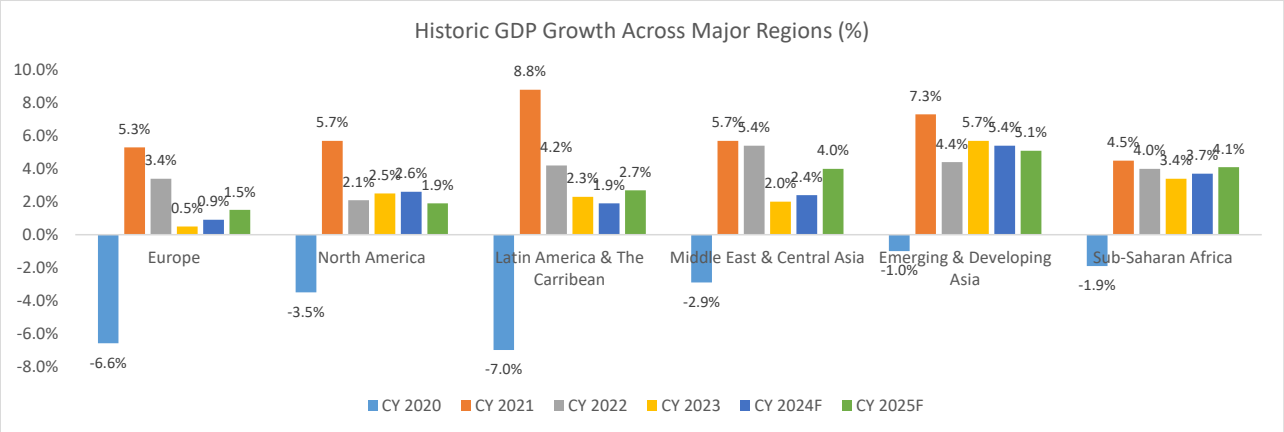
Slow growth in developed economies will affect the GDP growth in CY 2024 and global GDP is expected to record a flat growth of 3.2% in CY 2024. The crisis in the housing sector, bank lending, and industrial sectors are affecting the growth of global GDP.-After touching the peak in 2022, inflationary pressures slowly eased out in 2023. This environment weighs in for interest rate cuts by many monetary authorities.



Source – IMF Global GDP Forecast Release 2024, D&B Estimates

GDP Growth Across Major Regions

GDP growth of major regions including Europe, Latin America & The Caribbean, Middle East & Central Asia, and Sub-Saharan Africa, were showing signs of slow growth and recession between 2020 – 2023, but leaving Latin America & The Caribbean, 2024 is expected to show resilience and growth. Meanwhile, GDP growth in Emerging and Developing Asia (India, China, Indonesia, Malaysia etc.) is expected to decrease from 5.4% in CY 2023 to 5.2% in CY 2024, while in the United States, it is expected to decrease from 2.5% in CY 2023 to 2.1% in CY 2024.

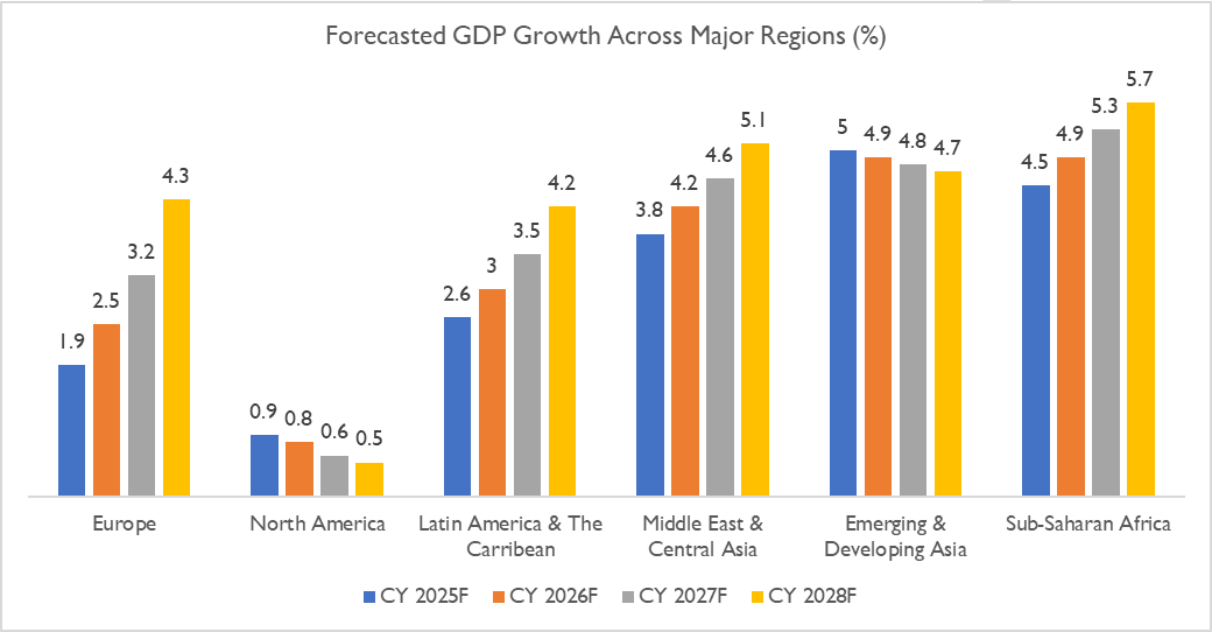


Source-IMF World Economic Outlook July 2024 update.

Except for Emerging and Developing Asia, Latin America & The Caribbean and the United States, all other regions are expected to record an increase in GDP growth rate in CY 2024 as compared to CY 2023. GDP growth in Latin America & The Caribbean is expected to decline due to negative growth in Argentina. Further,

growth in the United States is expected to come down at 2.1% in CY 2024 due to lagged effects of monetary policy tightening, gradual fiscal tightening, and a softening in labour markets slowing aggregate demand.

Although Europe experienced a less robust performance in 2023, the recovery in 2024 is expected to be driven by increased household consumption as the impact of energy price shocks diminishes and inflation decreases, thereby bolstering real income growth. Meanwhile, India and China saw greater-than-anticipated growth in 2023 due to heightened government spending and robust domestic demand, respectively. Sub-Saharan Africa's expected growth in 2024 is attributed to the diminishing negative impacts of previous weather shocks and gradual improvements in supply issues.



Source-IMF, OECD, and World Bank, D&B Estimates

Global Economic Outlook

At the midpoint of the year, so far in 2024 we have seen divergence in outcomes and prospects around the world in terms of economic growth, inflation, and policy responses. On balance, global short-term economic prospects have improved over the course of the year. We expect this momentum to continue through the second half of 2024 and into 2025 as inflation eases further and monetary policy continues to loosen, supporting steady growth. Macroeconomic risks, in our view, have become more balanced.

The U.S. has performed better than other developed economies, particularly those in Europe where the consumer sentiment has been relatively weak – though the picture in Europe has been varied. A sustained recovery in tourism this year has boosted the economies of Greece and Spain, whereas Germany, France, and Italy have been held back by the slower recovery of manufacturing. Nonetheless, the European Central Bank (ECB) lowered the three key interest rates in June – for the first time since September 2019 – which will support stronger regional growth.

Growth in the Chinese Mainland has held up well so far this year despite challenges from the property market amid ongoing rebalancing, and the export cycle is supporting growth in the rest of Asia. In Latin America, larger economies, such as Brazil and Mexico, tend to be performing more moderately than smaller economies, such as Chile and Peru, indicating slower regional growth overall.

Globally, industrial production has been relatively sluggish because of restrictive trade policies, persistent supply chain disruptions, high interest rates, and anaemic growth. We expect industrial production to gather steam later this year and into 2025 on the back of a gradual recovery in global trade, stimulated by stronger domestic demand for goods.

Policy responses have diverged so far this year and are set to remain so in the near term. Central banks have begun rate cutting cycles in several developed economies, including the Eurozone, Canada, Sweden, and Switzerland. However not every economy has followed suit. Disinflation has not been as predictable as it was in 2023, and underlying price pressures mean inflation is likely to remain bumpy this year – hence, policy will remain more restrictive than was anticipated at the start of the year. With relatively stronger economic growth and stickier inflation, the timing of the first interest rate cut by the U.S. Federal Reserve (the Fed) and the onward path of interest rates remains ambiguous.

The global economy is showing signs of stabilizing, yet growth will remain subdued this year before picking up pace in 2025. We forecast global growth of around 2.5% in 2024, half a percentage point softer than in the decade following the financial crisis. The weaker outlook reflects fiscal consolidation, lagged tight monetary policy, restrictive trade policies, and elevated levels of geopolitical uncertainty. Looking ahead to 2025, global growth is likely to pick up slightly to 2.8% as the impact of these factors declines and stronger growth becomes more entrenched.

Emerging economies look set for softer growth in general this year. On a regional basis, growth is likely to be markedly slower in Eastern Europe, but only slightly softer in Asia Pacific and Latin America, with growth only moderately slower in key economies such as the Chinese Mainland, India, and Brazil. Outcomes in developed economies are also mixed but largely remain subdued because of tight policy settings.

India Macroeconomic Analysis

GDP Growth Scenario

India's economy showed resilience with GDP growing at 8.2% in CY 2023. The GDP growth in CY 2023 represents a return to pre pandemic era growth path. Even amidst geopolitical uncertainties, particularly those affecting global energy and commodity markets, India continues to remain one of the fastest growing economies in the world.

Country	Real GDP Growth (CY 2023)	Projected GDP Growth (CY 2024)	Projected GDP Growth (CY 2025)
India	8.20%	7.00%	6.50%
China	5.20%	5.00%	4.50%
Russia	3.60%	3.20%	1.50%
Brazil	2.90%	2.10%	2.40%
United States	2.50%	2.60%	1.90%
Japan	1.90%	0.70%	1.00%
Canada	1.20%	1.30%	2.40%
Italy	0.90%	0.70%	0.90%
France	1.10%	0.90%	1.30%
South Africa	0.70%	0.90%	1.20%
United Kingdom	0.10%	0.70%	1.50%
Germany	-0.20%	0.20%	1.30%

Source: World Economic Outlook, July 2024

Countries considered include - Largest Developed Economies and BRICS (Brazil, Russia, India, China, and South)

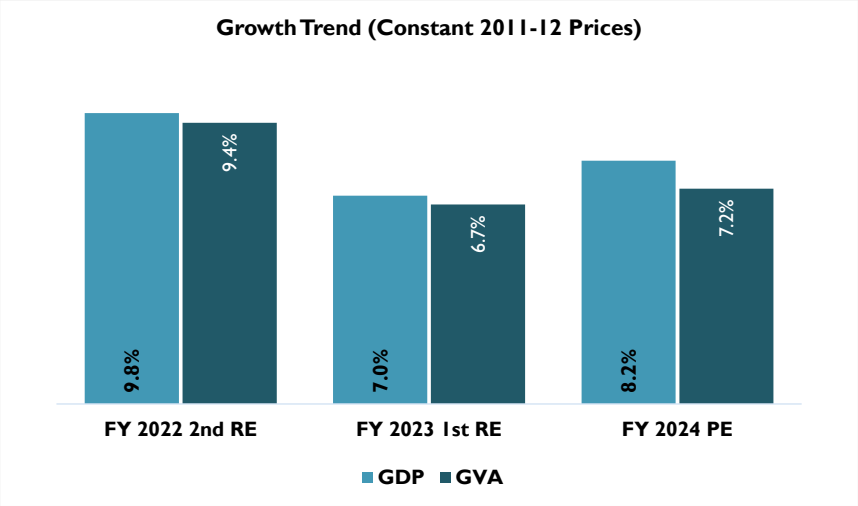
Countries have been arranged in descending order of GDP growth in 2023).

There are few factors aiding India's economic recovery – notably its resilience to external shocks and rebound in private consumption. This rebound in private consumption is bringing back the focus on improvements in domestic demand, which together with revival in export demand is a precursor to higher industrial activity. Already the capacity utilization rates in Indian manufacturing sector are recovering as industries have stepped up their production volumes. As this momentum sustains, the country may enter a new capex (capital expenditure) cycle. The universal vaccination program by the Government has played a big part in reinstating confidence among the population, in turn helped to revive private consumption.

Realizing the need to impart external stimuli, the Government stepped up its spending on infrastructure projects which in turn had a positive impact on economic growth. The capital expenditure of the central government increased by 37.4% increase in capital expenditure (budget estimates), to the tune of INR 10 trillion in the Union Budget 2023-2024. The announcement also included a 30% increase in financial assistance to states at INR 1.3 trillion for capex. The improvement was accentuated further as the Budget 2024-2025 announced an 11.1% increase in the capital expenditure outlay at INR 11.11trillion, constituting 3.4% of the GDP. This has provided much-needed confidence to the private sector, and in turn, attracted private investment.

On the lending side, the financial health of major banks has witnessed an improvement which has helped in improving the credit supply. With capacity utilization improving, there would be demand for credit from the corporate sector to fund the next round of expansion plans. The banking industry is well poised to address that demand. Underlining the improving credit scenario is the credit growth to the micro, small, and medium enterprise (MSME) sector as the credit outstanding to the MSME sector by scheduled commercial banks in the fiscal year 2024 grew by 14% to INR 10.31 trillion compared to INR 9.02 trillion as on 24 March 2023. The extended Emergency Credit Linked Guarantee Scheme (ECLGS) by the Union Government has played a major role in improving this credit supply.

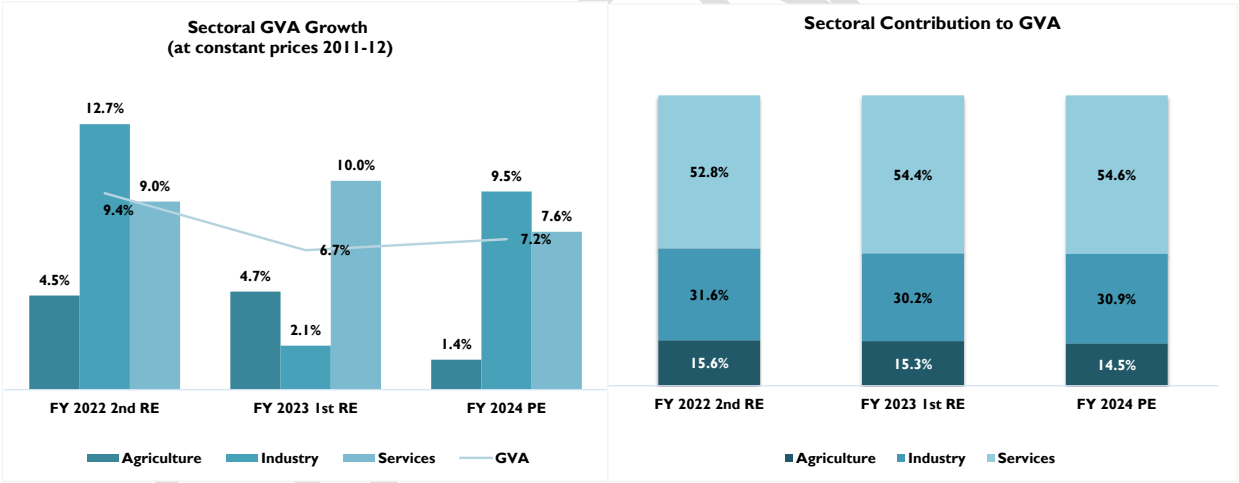
As per the provisional estimates 2023-24, India's GDP in FY 2024 grew by 8.2% compared to 7.0% in the previous fiscal on the back of solid performances in manufacturing, mining, and construction sectors. The year-on-year increase in growth rate is also partly due to by a strong growth in investment demand led by public capital expenditure.



Source: Ministry of Statistics & Programme Implementation (MOSPI), National Account Statistics, 2023-24

RE stands for Revised Estimates, SAE stands for Second Advance Estimates

Sectoral Contribution to GVA and annual growth trend



Source: Ministry of Statistics & Programme Implementation (MOSPI)

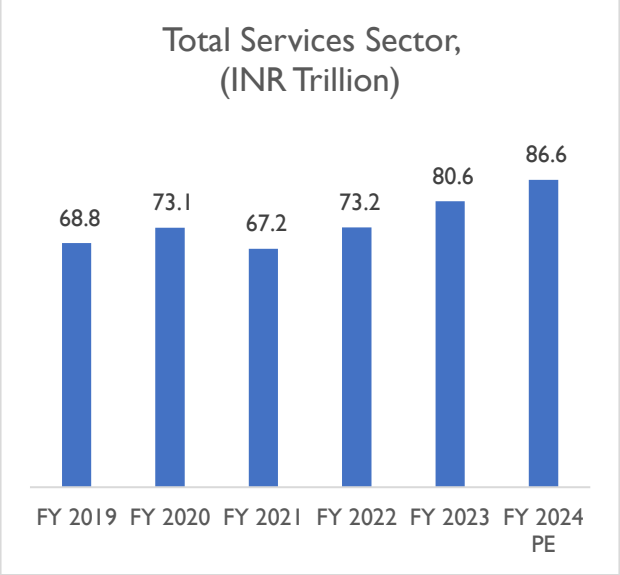
Sectoral analysis of GVA reveals industrial sector recovered sharply registering 9.5% y-o-y increase in FY 2024 against 2.1% in the previous fiscal. In the industrial sector, growth across major economic activity such as mining, manufacturing and construction sector rose significantly and it registered a growth of 7.1%, 9.9% and 9.9% in FY 2024 against a y-o-y change of 1.9%, -2.20%, and 9.44% in FY 2023, respectively. Utilities sector observed a marginal moderation in y-o-y growth to 7.5% against 9.44% in the previous years.

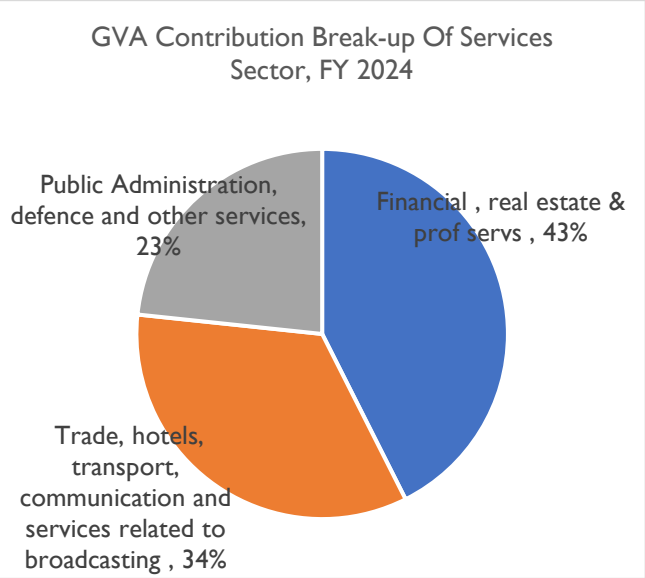
Talking about the services sector's performance, with major relaxation in covid restriction, progress on COVID-19 vaccination and living with virus attitude, business in the service sector gradually returned to normalcy in FY 2023. Economic recovery was supported by the service sector as individual mobility returned

to the pre-pandemic level. The trade, hotel, transport, communication, and broadcasting segment continued to strengthen in FY 2023 and grow in FY 2024, although the growth hasn't shown substantial increases. In FY 2024, services sector grew by 7.6% against 10% y-o-y growth in the previous year.

Expansion in Service Sector

Services sector is a major contributor to the country's overall economic growth. In absolute terms, services sector GVA has increased from INR 68.78 trillion in FY 2019 to INR 86.6 trillion in FY 2024 (as per the provisional estimated), registering a CAGR of nearly 5%. Within Services sector, the GVA by financial, real estate and professional services-the largest contributing segment observed 6.3% CAGR while Public Administration, defence and other services[1] observed 4.5% CAGR and Trade, hotels, transport, communication, and services related to broadcasting witnessed 3.1% CAGR between FY 2019-24.





Sources: MOSPI, CMIE Economic Outlook and Dun & Bradstreet Research Estimates[2]

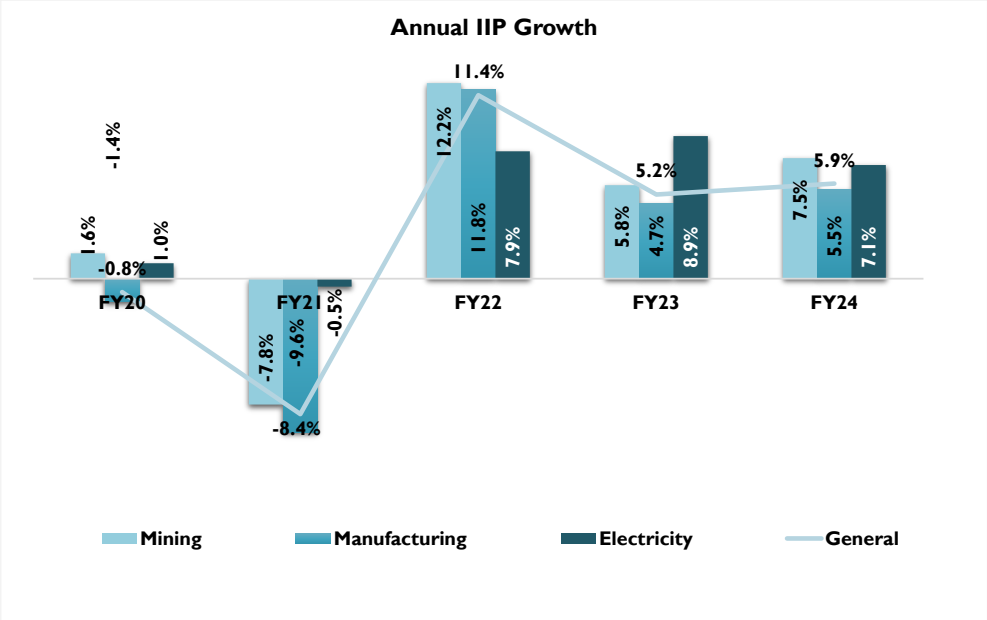
India's HSBC Services Purchasing Managers' Index**,** an important indicator to track service sector performance, measured 60.3 in July 2024 against 60.5 in the previous month. Since August 2021, the services sector has consistently remained above the threshold of 50, which distinguishes growth from contraction.

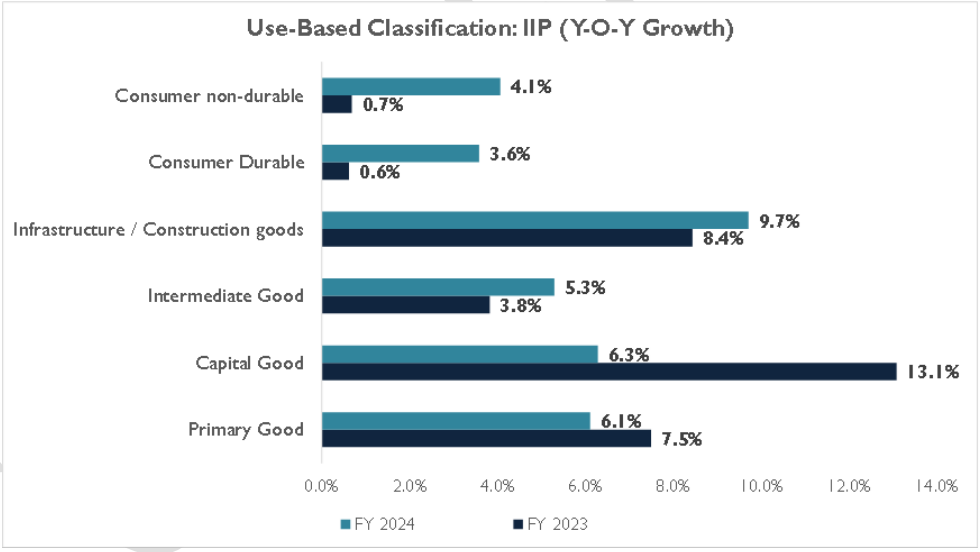
IIP Growth

Industrial sector performance as measured by IIP index; in FY 2024 it is growing at 5.9% (against 5.2% in FY 2023). Previously IIP index exhibited temporary recovery in FY 2022 from the low of Covid induced slowdown in industrial growth during FY 2020 and FY 2021. Manufacturing index, with 77.6% weightage in overall index, grew by 5.5% in FY 2023 against 4.7% y-o-y growth in FY 2022 while mining sector index too

[1] Other services include Education, Health, Recreation, and other personal services.
[2] Projection as Based on CMIE Growth rate till FY 2029 and FY 2030 is based on Dun & Bradstreet assumption.

grew by 7.5% against 5.8% in the previous years. Mining & manufacturing both shown improvement according to previous except the Electricity sector Index, witnessed an improvement of 7.1% against 8.9% in the previous year.

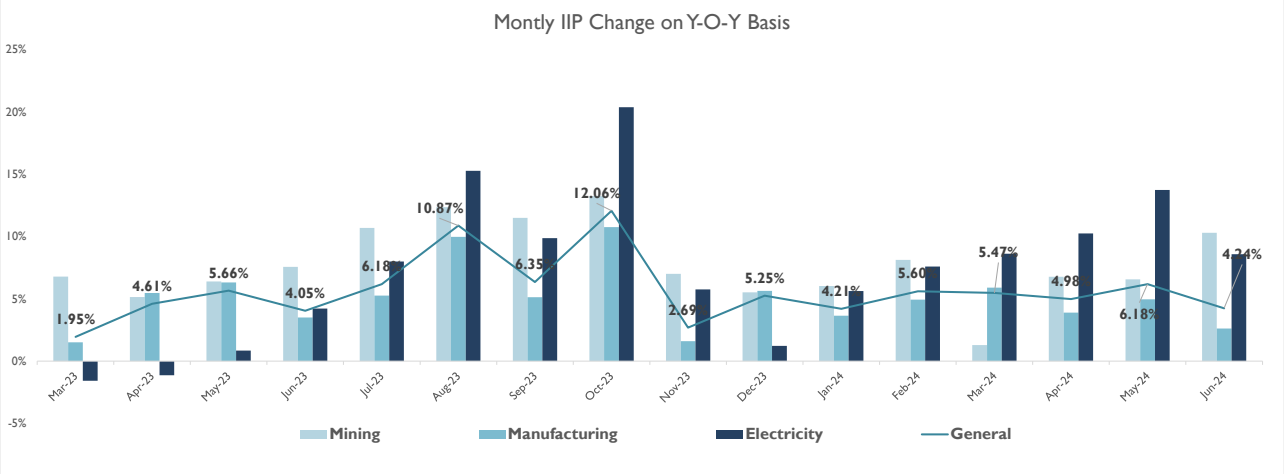




Source: Ministry of Statistics & Programme Implementation (MOSPI)

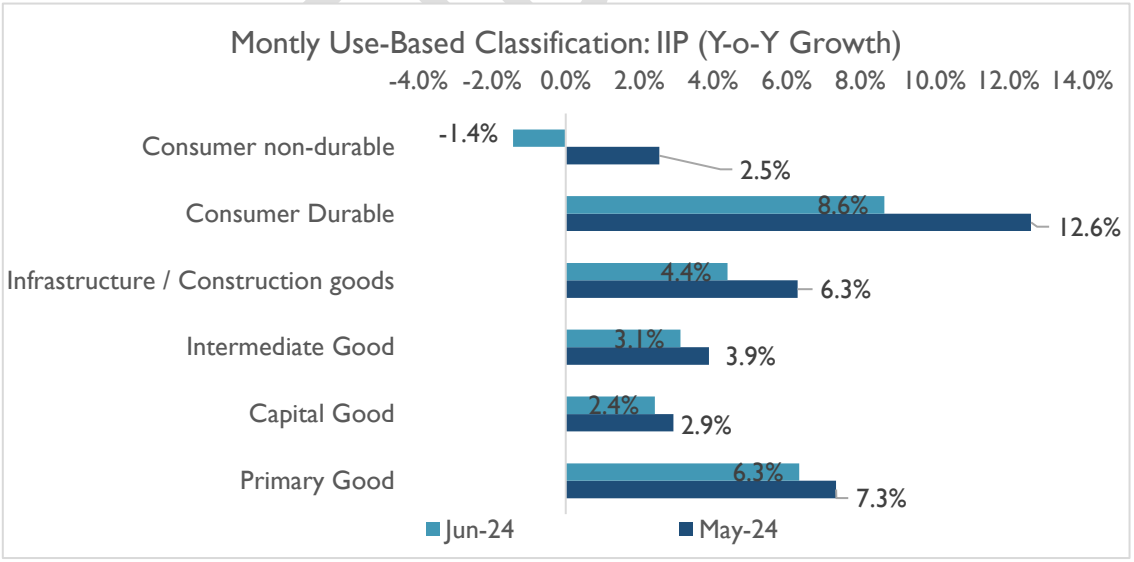
As per the use-based classification, most of the segments has shown growth for FY 2024 as compared to FY 2023. Capital good and primary goods were segments which faced less growth as compared to previous year. The contracting IIP data points towards adverse operating business climate as global headwinds, high inflation, and monetary tightening cumulatively impacted the broader industrial sector performance. In contrast all the segments except the above two have shown growth.

Monthly IIP Growth Trend



Source: Ministry of Statistics & Programme Implementation (MOSPI)

In the current fiscal FY 2025, the monthly IIP measured index has reported steady improvement over the last fiscal. However, the IIP index slowed to a 5-month low and just grew by 4.24% y-o-y in June against 6.18% in the previous month on the back of slowing growth in the manufacturing section. In June 2024, the manufacturing index growth slowed to 2.6% against 6.3% y-o-y growth in June 2023 and 5% in May 2023 while the electricity sector index and mining index exhibited substantial improvement and they grew by 8.6% and 10.3% in June 2024 against 0.9% and 6.4% growth in April 2023, respectively.

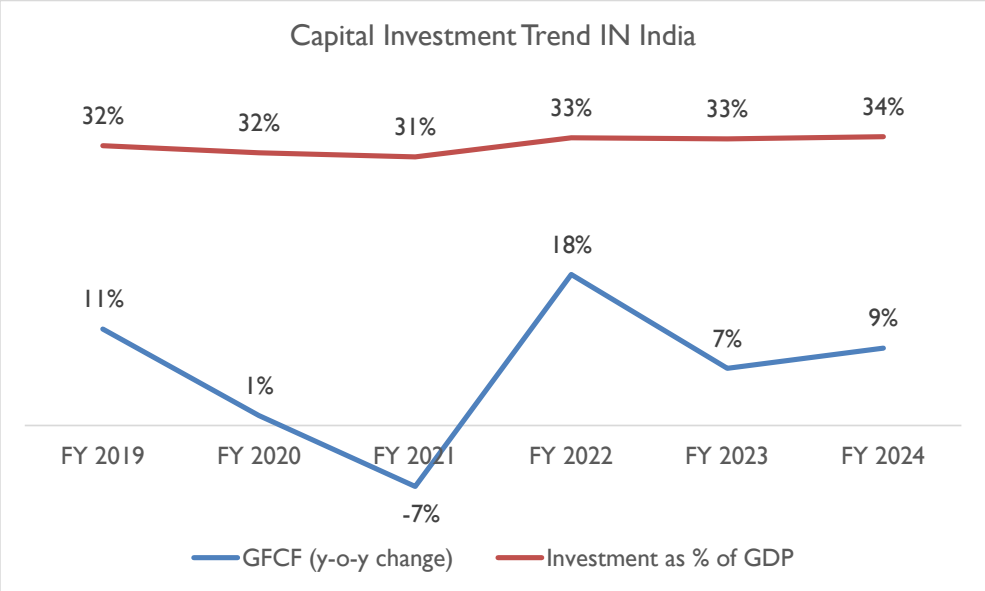


Sources: MOSPI

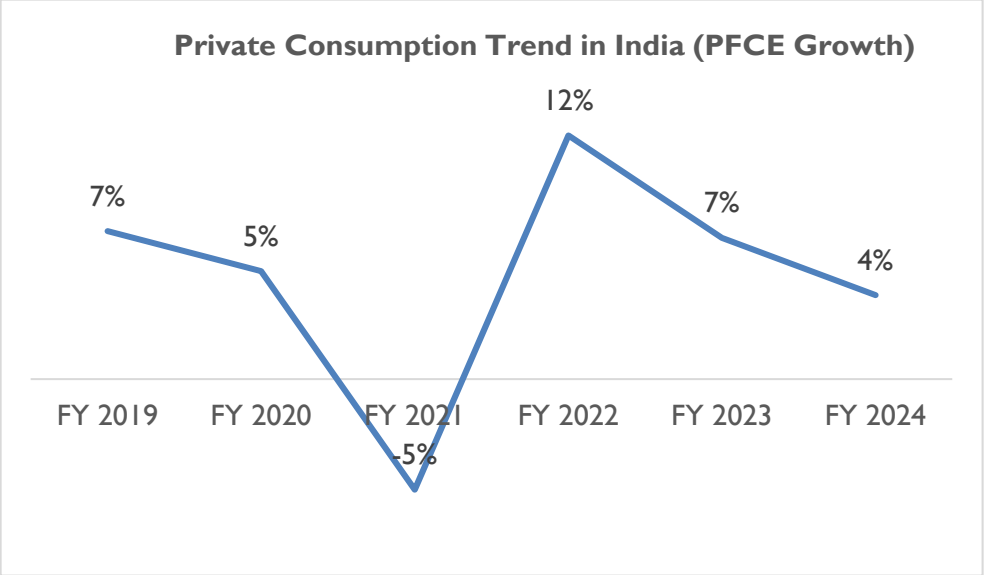
As per the use-based classification, growth in all segments slowed in June 2024 as compared to the previous month. Consumer non-durable declined by 1.4% in June 2024 against 2.5% increase in the previous month. In May 2024, all segments showed a substantial increase in growth.

Investment & Consumption Scenario

Other major indicators such as Gross fixed capital formation (GFCF), a measure of investments, gained strength during FY 2024 as it grew by 9% on a y-o-y basis against 7% yearly growth in the previous fiscal, while GFCF to GDP ratio measured an all-time high settled higher at 34%.



Sources: MOSPI

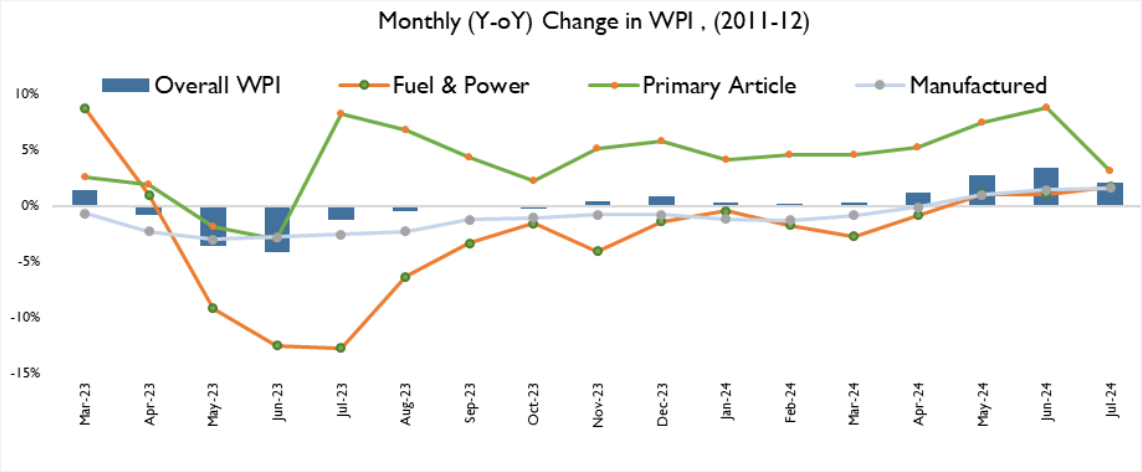


Sources: MOSPI

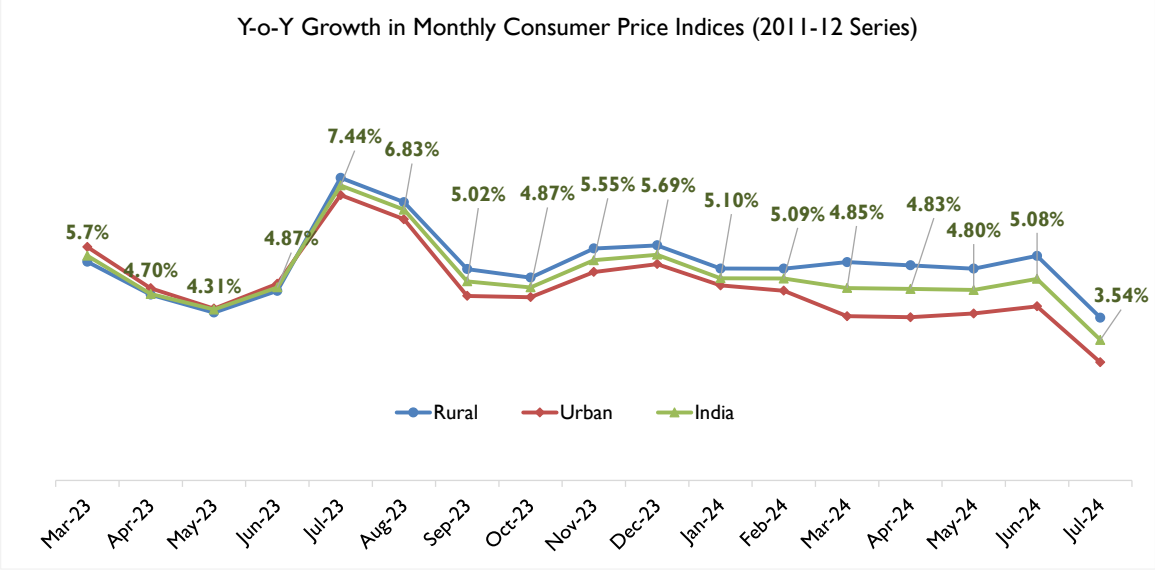
Private Final Expenditure (PFCE) a realistic proxy to gauge household spending, observed decelerated and registered 4% y-o-y growth in FY 2024 against 7% in FY 2023.

Inflation Scenario

The inflation rate based on India's Wholesale Price Index (WPI) exhibited significant fluctuations across different sectors from March 2023 to July 2024. Overall WPI saw a sharp decline to -1.2% in July 2023, primarily driven by steep drops in Fuel & Power and Manufactured Products, reflecting reduced global demand and falling input costs. However, a recovery was noted by June 2024, with WPI reaching 3.4%, supported by a strong rise in Primary Articles and a rebound in Fuel & Power prices. By July 2024, while Primary Articles growth moderated to 3.1%, the WPI remained positive at 2.0%, indicating stabilization in the market after earlier volatility.



Source: MOSPI, Office of Economic Advisor.



Source: CMIE Economic Outlook

Retail inflation rate (as measured by the Consumer Price Index) in India showed notable fluctuations between March 2023 and July 2024. Rural CPI inflation peaked at 7.63% in July 2023, before declining to

4.10% in July 2024. Urban CPI inflation followed a similar trend, rising to 7.20% in July 2023 and then dropping to 2.98% in July 2024. Overall, the national CPI inflation rate increased to 7.44% in July 2023 but moderated to 3.54% by July 2024, indicating a gradual easing of inflationary pressures across both rural and urban areas over the period. CPI measured below 6% tolerance limit of the central bank since September 2023. As a part of an anti-inflationary measure, the RBI has hiked the repo rate by 250 bps since May 2022 to the current 6.5% while it has been holding the rate at 6.5% since 8 Feb 2023.

India's Growth Outlook

India's economy has exceeded expectations, registering an 8.2% growth in FY24. High-frequency indicators such as automobile sales, e-way bills, cargo traffic, and exports signal sustained growth momentum into Q2 FY25. However, the rural demand outlook is tied to the monsoon, where inconsistent rainfall could impact the agriculture sector and inflation. The government is proactively boosting grain storage capacity to mitigate these risks. On the credit front, the Reserve Bank of India (RBI) has kept the policy rate unchanged, with inflation expected to average around 5% in FY25. Despite stable policy rates, lending rates may rise due to the incomplete transmission of earlier hikes, while strong credit growth in the private sector suggests potential capacity expansion. Supply-side challenges persist, particularly in food storage infrastructure. The government has launched a massive initiative to enhance grain storage capacity by 70 million tonnes over the next five years. The recent long-term agreement for operating Iran's Chabahar Port is also set to bolster trade and supply chain resilience.

In terms of trade, India's recent agreements, particularly with the European Free Trade Association (EFTA) and Oman, are opening new markets and opportunities for exports. The proposed mega-distribution hub in the UAE by 2025 will further support India's global trade ambitions, particularly in Africa, Europe, and the US.

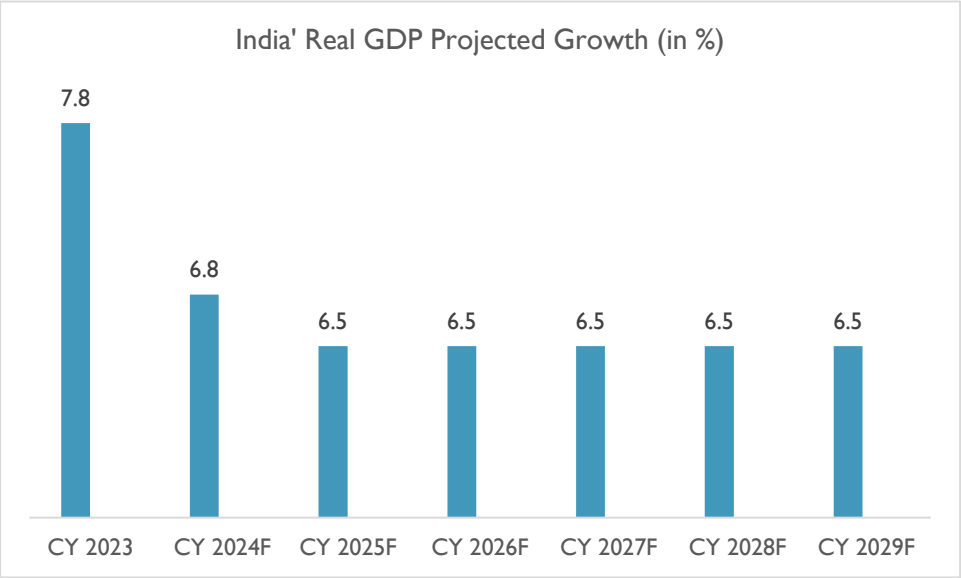
Politically, the continuation of the National Democratic Alliance (NDA) government signals sustained reforms, with optimism around labour and land reforms. The government is also taking steps to control retail inflation by managing food prices and import duties. The external environment remains cautious, with geopolitical tensions, particularly in Gaza, posing potential risks to global stability.

Overall, India's short-term growth outlook remains positive, underpinned by strong domestic demand, proactive government measures, and expanding global trade relationships, despite some challenges in the rural economy and supply chain infrastructure.

India's Projected Economic Growth

Looking ahead to 2024, India's projected GDP growth of 6.8% in 2024 stands out as the fastest among major emerging markets, significantly outpacing China's 4.6%, and Brazil's 2.2%. This robust growth

trajectory is expected to sustain at 6.5% annually from 2025 to 2029, reflecting strong economic fundamentals and continued momentum.



Source: IMF

This decent growth momentum in near term (CY 2024) is accompanied by a slowdown in inflation, as well as various other factors in the medium to long term that will support the economy. These include enhancements in physical infrastructure, advancements in digital and payment technology, improvements in the ease of doing business and a higher quality of fiscal expenditure to foster sustained growth.

On the demand side, improving employment conditions and moderating inflation are expected to stimulate household consumption. Further, the investment cycle is gaining traction, propelled by sustained government capital expenditure, increased capacity utilization and rising credit flow. Additionally, there are positive signs of improvement in net external demand, as reflected in the narrowing merchandise trade deficit. Despite the supply disruptions, exports clocked positive y-o-y growth in December 2023 and January 2024.

From uplifting the underprivileged to energizing the nation's infrastructure development, the Government has outlined its vision to propel India's advancement and achieve a 'Viksit Bharat' by 2047 in the interim budget announced on 1st Feb 2024. Noteworthy positives in the budget include achieving a lower-than-targeted fiscal deficit for FY2024 and setting a lower-than expected fiscal deficit target for FY2025, proposing dedicated commodity corridors and port connectivity corridors, providing long-term financing at low or nil interest rates to the private sector to step up R&D (Research & Development) in the sunrise sectors.

Achieving a reduced fiscal deficit of 5.8% in FY2024 and projecting a lower than-anticipated fiscal deficit of 4.9% as announced in the interim budget in July 2024 for the current fiscal year (FY 2025) are positive

credit outcomes for India. This showcases the country's capability to pursue a high-growth trajectory while adhering to the fiscal glide path. There has been a significant boost to capital expenditure for two consecutive years; capital expenditure – which is budgeted at 3.4% of GDP (INR 11.1 trillion/USD 134 billion) for fiscal year 2024-25 – is at a 21-year high (3.3% of GDP in fiscal year 2023-24. The enhancement of port connectivity, coupled with the establishment of dedicated commodity corridors (energy, mineral and cement), is poised to enhance manufacturing competitiveness. This strategic move aims to fulfil India's export targets and reduce logistics costs.

India's optimistic economic outlook is underpinned by its demographic dividend, which brings a substantial workforce that boosts labor participation and productivity. The burgeoning middle class and urbanization contribute to increased domestic consumption, driven by rising incomes and purchasing power. Extensive investments in infrastructure, encompassing roads, railways, ports, and digital connectivity, are enhancing productivity and efficiency, with government initiatives like the Smart Cities Mission and PM Gati Shakti creating a conducive growth environment. This digital transformation, catalyzed by initiatives such as Digital India, is fostering a tech-driven economy marked by enhanced internet penetration, digital payments, and e-governance, thereby fueling growth in sectors like fintech, e-commerce, and digital services. The push to position India as a global manufacturing hub through Make in India and PLI (Production Linked Incentive) schemes is further boosting industrial output, exports, and domestic production capabilities. Compared to other major emerging markets facing demographic and economic challenges, India's combination of demographic strengths, policy reforms, and strategic initiatives positions it as a standout performer and a significant driver of global economic growth in the foreseeable future.

Some of the key factors that would propel India’s economic growth.

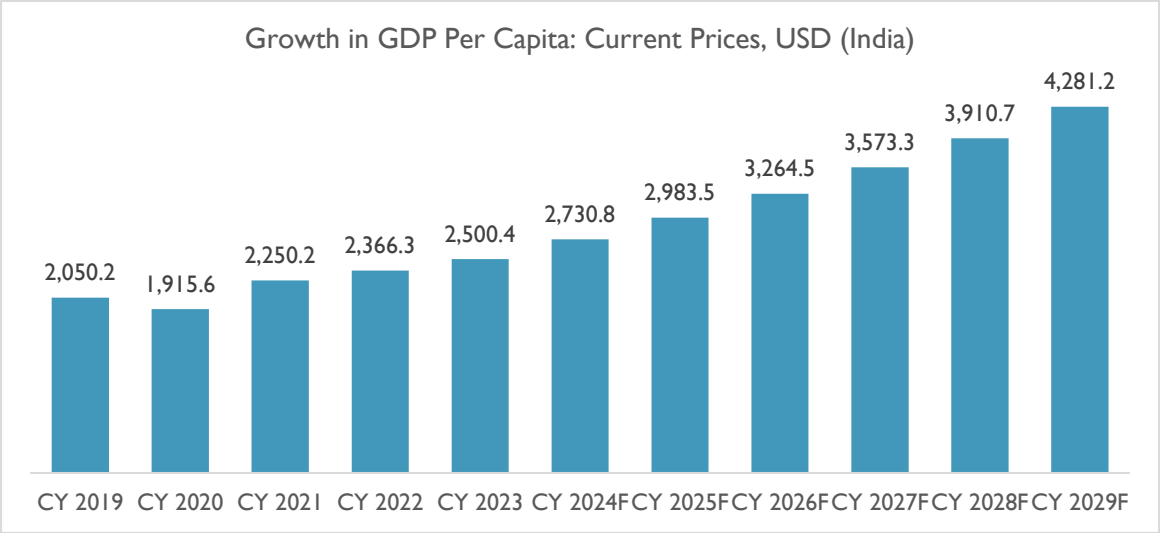
Strong Domestic Demand

Domestic demand has traditionally been one of the strong drivers of Indian economy. After a brief lull caused by Covid-19 pandemic, the domestic demand is recovering. Consumer confidence surveys by Reserve Bank / other institutions points to an improvement in consumer confidence index, which is a precursor of improving demand. India has a strong middle-class segment which has been the major driver of domestic demand. Factors like fast paced urbanization and improving income scenario in rural markets are expected to accelerate domestic demand further. PFCE as a percentage of GDP increased to 58% during FY 2022 and FY 2023 while in FY 2024 it settled at 56%. There are two factors that are driving this domestic demand: One the large pool of consumers and second the improvement in purchasing power. As per National Statistics Office (NSO), India’s per capita net national income (at constant prices) stood at INR 1.06 lakhs in FY 2024 against 99,404 in FY 2023 and 87,623 in FY 2018. This increase in per capita income has impacted the purchasing pattern as well as disposable spending pattern in the country. Consumer driven domestic demand is majorly fueled by this growth in per capita income.

India’s Per capita GDP trends

India is poised to become the world's third-largest economy with a projected GDP of USD 5 trillion within the next three years, driven by ongoing reforms. As one of the fastest-growing major economies, India currently holds the position of the fifth-largest economy globally, following the US, China, Japan, and Germany. By 2027-28, it is anticipated that India will surpass both Germany and Japan, reaching the third-largest spot. This growth is bolstered by a surge in foreign investments and a wave of new trade agreements with India's burgeoning market of 1.4 billion people. The aviation industry is witnessing unprecedented orders, global electronics manufacturers are expanding their production capabilities, and suppliers traditionally concentrated in southern China's manufacturing hubs are now shifting towards India.

To achieve its vision of becoming the world's third-largest economy by 2027-28, India will need to implement transformative industrial and governmental policies. These policies will be crucial for sustaining the consistent growth of the nation's per capita GDP over the long term.



Source: IMF

From CY 2024-29, India's per capita GDP is projected to grow at a compound annual growth rate of 9.4%. This growth will be driven by the service sector, which now accounts for over 50% of India's GDP, marking a significant shift from agriculture to services.

Digitization Reforms

Ongoing digitization reforms and the resultant efficiency gains accrued would be a key economic growth driver in India in the medium to long term. Development of digital platforms has helped in the seamless roll out of initiatives like UPI (Unified Payments Interface), Aadhaar based benefit transfer programs, and streamlining of GST (Goods and Services Tax) collections. All of these have contributed to improving the economic output in the country. Some of the key factors that have supported the digitization reforms include – the growth in internet penetration in India together with drop in data tariffs, growth in smartphone penetration, favorable demographic pattern (with higher percentage of tech savvy youth population) and

India's strong IT (Information Technology) sector which was leveraged to put in place the digital ecosystem. All these factors are expected to remain supportive and continue to propel the digitization reforms in India.

Increased adoption of digital technology and innovation, inclusive and sustainable practices, business-friendly and transparent regulations, and heightened corporate research and development (R&D) investments will further bolster the country's growth. These factors will collectively support employment growth across both private and public sectors, including micro, small, and medium enterprises (MSMEs).

Renewable Energy Landscape in India[3]

India has emerged as a global leader in renewable energy, ranking 4th globally for total renewable power capacity additions, 4th in wind power capacity, and 5th in solar power capacity, as per the REN21 Renewables 2024 Global Status Report. At COP26, India pledged to achieve 500 GW of non-fossil fuel-based energy by 2030, marking the world's largest renewable energy expansion plan. As of August 2024, India's installed non-fossil fuel capacity stands at over 207.76 GW, which is about 46% of the country's total power capacity. The solar energy capacity alone has surged by 30 times over the past nine years, reaching 89.43 GW. India's estimated solar energy potential is 748 GWp, positioning the country as a key player in the global renewable energy market.

The renewable energy sector in India benefits from favourable government policies, including 100% Foreign Direct Investment (FDI) under the automatic route. The government has also allocated INR 10,000 crore in the Union Budget 2024-25 for solar power development, a 110% increase from the previous year, along with other incentives such as the PM-Surya Ghar Muft Bijli Yojana and Basic Customs Duty exemptions on critical minerals for the renewable sector.

India's renewable energy capacity, which includes wind, solar, biomass, hydro, and waste-to-energy, totals approximately 199.52 GW. With solar power accounting for 89.43 GW and wind power contributing 47.19 GW, India is well-positioned to meet its ambitious goals of reducing carbon emissions, with a commitment to achieve net-zero by 2070. Additionally, 50 solar parks with a combined capacity of 37.49 GW have been approved, while offshore wind energy and the National Green Hydrogen Mission are key growth areas, targeting 30 GW of wind capacity and 5 MMT of green hydrogen production by 2030.

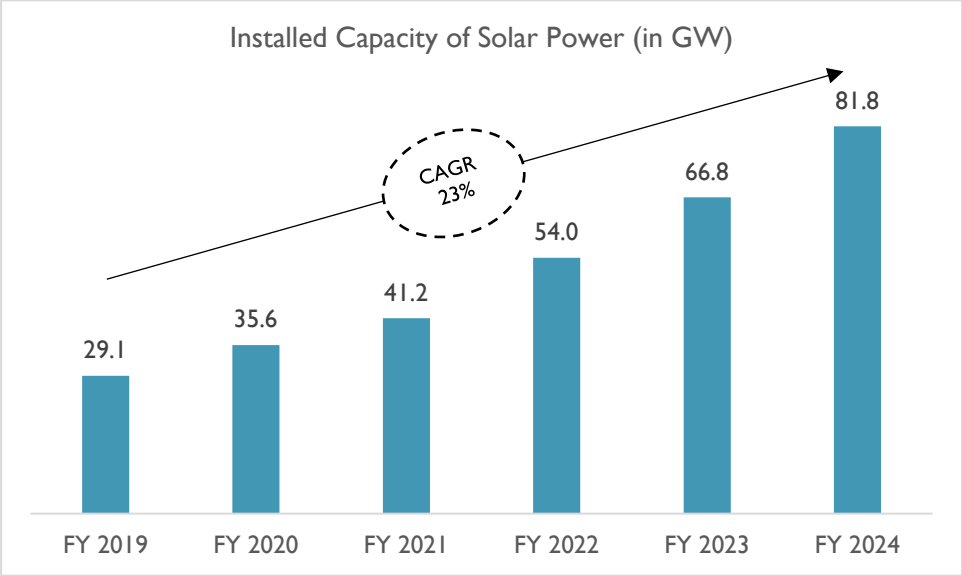
The Production Linked Incentive (PLI) Scheme is a crucial initiative supporting India's renewable energy sector, specifically targeting solar PV manufacturing. Launched under the Aatmanirbhar Bharat initiative, the scheme aims to build 65 GW of annual manufacturing capacity, providing direct and indirect employment opportunities while promoting import substitution. The renewable energy landscape in India continues to attract significant investment, with numerous projects and opportunities, reflecting the country's strong commitment to sustainable growth and energy security.

[3] Industry Report, Invest India

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 August 2024, India has achieved a cumulative installed solar power capacity of 89.43 GW. This includes 69.19 GW from ground-mounted solar plants, 13.89 GW from grid-connected solar rooftop systems, 2.59 GW from the solar component of hybrid projects, and 3.76 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.

India has witnessed remarkable technological advancements in solar power, with the installed solar capacity growing 30 times over the past nine years. The National Institute of Solar Energy estimates India's solar potential at 748 GWp, leveraging approximately 300 sunny days annually across many regions. The deployment includes various technologies like rooftop solar, ground-mounted solar farms (notably Bhadla and Pavagada Solar Parks), and innovative projects such as floating solar installations on 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 29.1 GW in FY 2019, the country's solar power capacity surged to 81.8 GW by FY 2024, reflecting a notable compound annual growth rate (CAGR) of 23%. 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 2024, India aims to achieve a solar power capacity of 280 GW by 2030, with

current installations reaching 85 GW. Rajasthan leads with 23 GW, driven by projects like the Bhadla Solar Park, the world's largest fully operational solar park. Gujarat follows with 10.13 GW, emphasizing projects like the Charanka Solar Park and plans for a massive renewable energy park in Kutch. Karnataka ranks third with 9.05 GW, anchored by the Pavagada Solar Park. Tamil Nadu and Maharashtra round out the top five states with 8.1 GW and 4.8 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 6263.71 MW spread across 126.74 km2, making it the world's largest solar park as of 2020. Securing a long-term power purchase agreement ensures the sale of generated electricity, underscoring India's commitment to renewable energy transition. Moreover, India's initiatives extend to innovative projects like the Kutch Solar Project, aimed at providing electricity to remote regions through advanced technologies such as solar ponds and integrated solar stills with greenhouses. These efforts highlight India's strategic focus on sustainable development and reducing reliance on fossil fuels, positioning it 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.

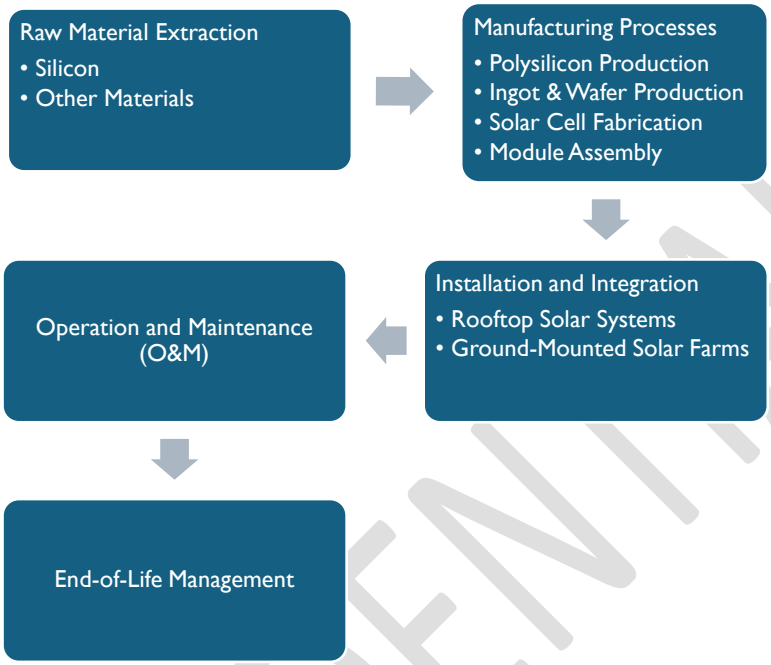
- Renew Power Initiatives: Renew Power has made substantial investments in hybrid projects that combine solar PV with energy storage systems. This innovative approach not only improves grid stability but also helps meet peak demand, making renewable energy more accessible and dependable.
- By leveraging 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 is making significant strides in solar module manufacturing, driven by various government initiatives, including the Production-Linked Incentive (PLI) scheme and the Approved List of Models and Manufacturers (ALMM). These measures aim to boost domestic production and enhance the country's competitiveness in the global solar market. While India still trails behind leaders such as China and Vietnam, recent advancements and export strategies are positioning it to become the second-largest solar module manufacturing region by 2025, with a current capacity of 64.5 GW and a growing global market share.

[4]India's solar industry saw significant growth in 2023, with the installation of 20.8 GW of solar modules and 3.2 GW of solar cell manufacturing capacity. By the end of the year, the country's cumulative solar module manufacturing capacity reached 64.5 GW, while solar cell manufacturing capacity stood at 5.8 GW. Around 60% of the module manufacturing capacity is now equipped to produce solar modules in the M10 and G12 wafer sizes, reflecting advancements in technology. Monocrystalline modules dominated production, followed by polycrystalline, TOPCon, and thin film modules.

Gujarat led the way in photovoltaic manufacturing, contributing 46.1% of the country's total solar module production in 2023. Telangana emerged as the top producer for solar cells, accounting for 39% of the annual capacity. Imports and exports of solar components also saw a rise, with India importing 16.2 GW of solar modules and 15.6 GW of solar cells, while exports of modules and cells increased significantly compared to the previous year.

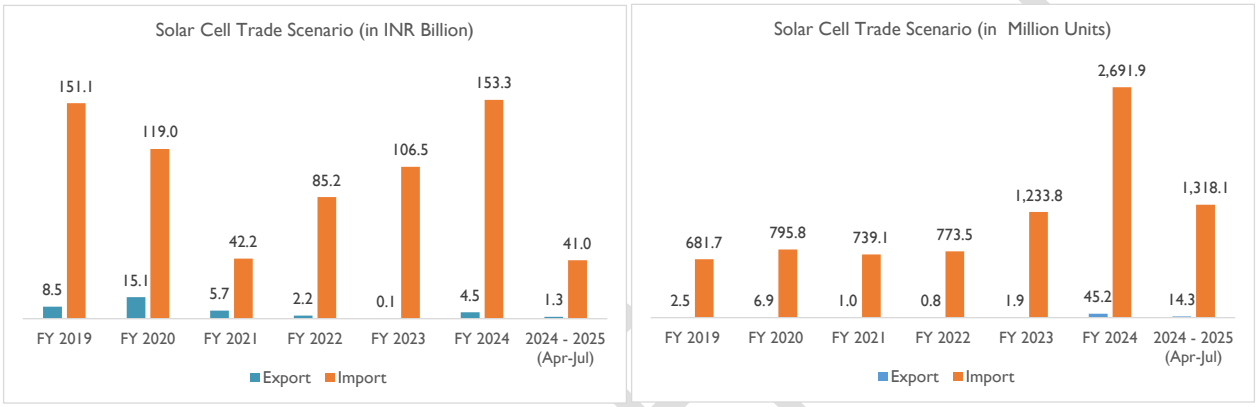
Looking ahead, solar module manufacturing capacity is projected to surpass 150 GW by 2026, with cell manufacturing expected to reach over 75 GW. While the expansion of domestic production is promising, Indian manufacturers face challenges in maintaining competitiveness due to cheaper imports from countries like China. The need to address geopolitical and trade complexities remains a critical factor for the continued growth of the solar manufacturing sector.

[4] Mercom Capital

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.



Source: Ministry of Trade and Commerce

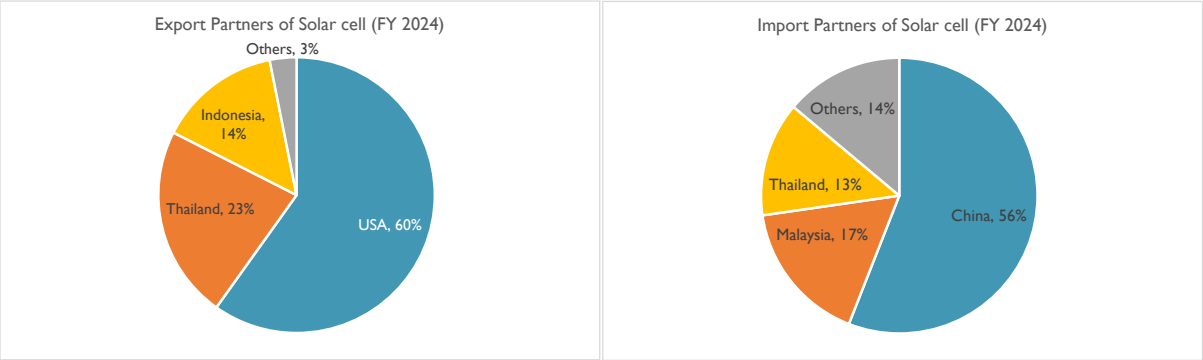
In terms of volume, the import of solar cells has sharply increased from 681.7 million units in FY 2019 to a substantial 2,691.9 million units in FY 2024. On the export front, volumes showed significant variability, peaking at 45.2 million units in FY 2024, up from just 0.1 million units in FY 2023. 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.

The first four months of FY 2025 (April-July) continue to reflect this trend, with exports standing at INR 1.3 billion and imports reaching INR 41.0 billion. In terms of units, India exported 14.3 million solar cells, while imports remained high at 1,318.1 million units. Despite efforts to scale up domestic production, the increasing imports point to a high domestic demand for solar cells that local manufacturers are yet to fully meet. These figures highlight the need for further capacity expansion and technology upgrades to reduce import dependence and bolster India's position in the global solar supply chain.

Trading Partner

India's export of Solar cells in FY 2024 was largely concentrated in a few key markets, with the United States accounting for 60% of total exports, followed by Thailand at 23% and Indonesia at 14%. The significant share of exports to the U.S. reflects the strong demand for solar energy components in the country and India's growing reputation as a competitive supplier. The export market diversification, with a focus on Southeast

Asian countries like Thailand and Indonesia, signals India's strategic expansion into regions with increasing solar energy adoption.

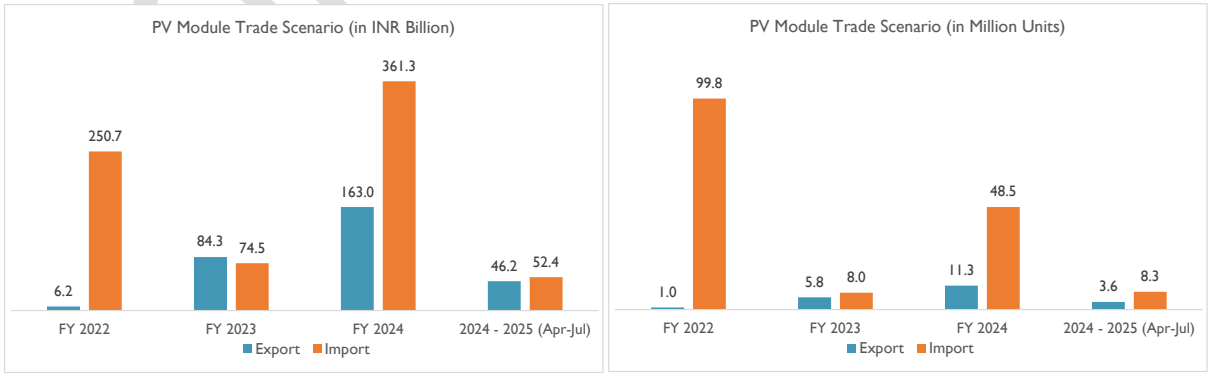


Source: Ministry of Trade and Commerce

On the import front, China remained India's primary source for solar cells, contributing 56% of total imports in FY 2024. This heavy reliance on Chinese imports underlines the ongoing dependence on low-cost manufacturing hubs despite India's efforts to boost domestic production. Malaysia and Thailand also supplied 17% and 13% of imports, respectively, indicating India's preference for sourcing from established Asian manufacturers. The reliance on imports from multiple countries highlights the gap between domestic demand and local production, suggesting a continued need for technological upgrades and capacity expansion within India to reduce import dependency.

Solar PV module

India's photovoltaic (PV) module trade scenario has experienced significant shifts between FY 2022 and FY 2024, 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

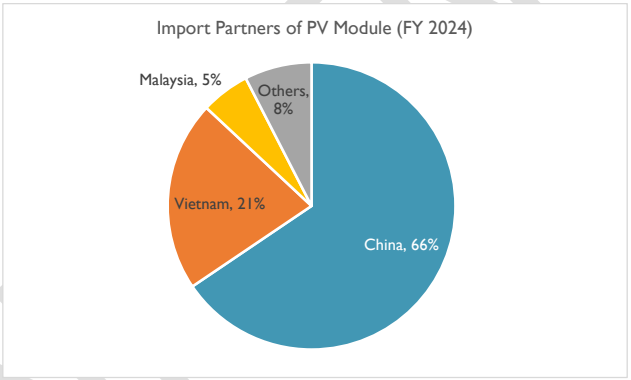
However, FY 2023 marked a turning point, with exports surging to INR 84.3 billion and imports declining to INR 74.5 billion. This shift suggests that India's efforts to enhance domestic PV module production started yielding results, with manufacturers exporting more modules and reducing import dependency. 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 the first four months of FY 2025 (April-July), exports reached INR 46.2 billion, while imports stood at INR 52.4 billion. Although imports remained higher, the robust 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 2024, China dominated India's imports of photovoltaic (PV) modules, accounting for 66% 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 21%, emerged as another key supplier, benefiting from competitive pricing and favourable trade conditions. Malaysia and other countries accounted for smaller shares, with 5% and 8%, respectively, indicating a concentration of imports from major Asian manufacturing hubs.



Source: Ministry of Trade and Commerce

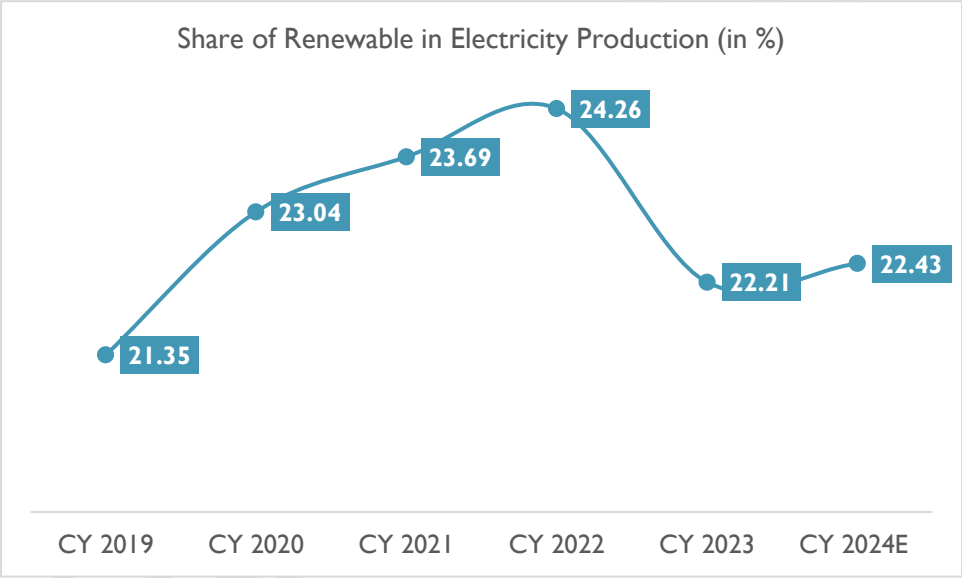
On the export side, **India's PV module exports were almost exclusively directed to the United States, with a staggering 99% share in FY 2024**. This reflects strong demand from the U.S., likely driven by policies promoting renewable energy adoption and efforts to diversify its supply chain away from China. The minimal export to other markets, comprising only 1%, 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.



Source: MNRE, D&B Estimates

The Indian government has launched the Solar Mission with an ambitious goal of deploying 100 gigawatts (GW) of solar power by 2022, with a current capacity of 73 GW as of 2023. Additionally, a target of 40 GW of rooftop solar capacity was set for mid-2022; however, only 10 GW had been installed by the end of 2023. In response to this shortfall, a new subsidy scheme for rooftop solar was introduced in April 2024, aiming to achieve the target by 2026. As energy demand continues to surge, particularly in rural areas with limited access to conventional electricity, solar energy emerges as a viable solution to bridge the energy access gap and ensure reliable, affordable electricity for both urban and rural populations.

- **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) have emerged as crucial enablers for achieving India's energy transition objectives. As of March 2024, India's BESS capacity reached 219.1 MWh, with solar PV and BESS accounting for 90.6% of the total installed capacity. Notably, BSES Rajdhani Power Ltd has launched India's first standalone utility-scale BESS project—a 20 MW/40 MWh system—receiving regulatory approval under the Electricity Act of 2003. This project, funded by the Global Energy Alliance for People and Planet (GEAPP), sets a benchmark for future BESS projects. GEAPP aims to secure 1 GW of BESS commitments in India by 2026, supporting the nation's target of achieving 47 GW by 2032. With variable renewable energy exceeding 12% in certain regions, India has issued tenders for 57 GW and auctioned 11.5 GW of energy storage projects, further solidifying its commitment to renewable energy development.

- **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.

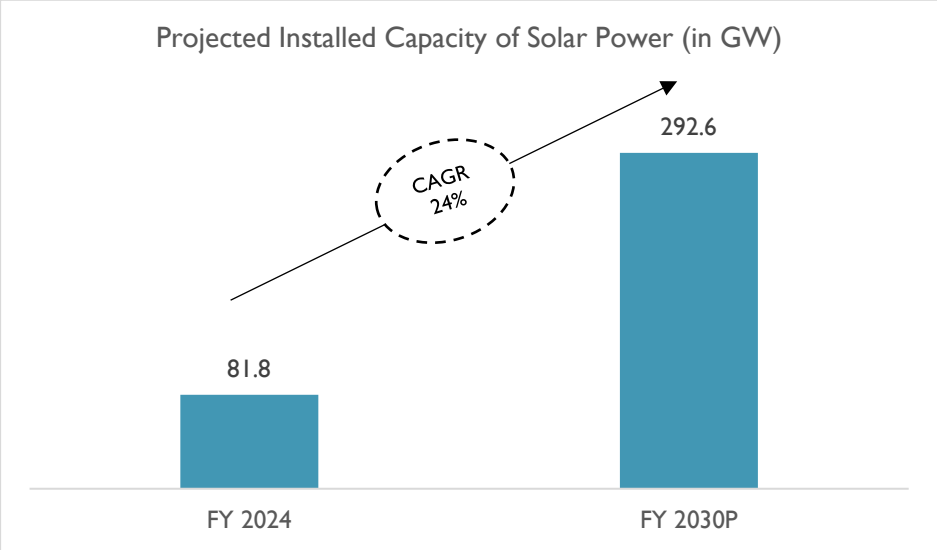
Beyond residential financing, solar manufacturing and energy storage solutions are gaining attention from investors. Investments in battery storage technology, particularly lithium-ion, are seen as a key solution to address the variability of solar power generation. The expanding market for solar energy, 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 August 2024, India's installed solar capacity has surged to approximately 89.4 GW, a dramatic increase from just 2.6 GW in 2014, highlighting the sector's 33-fold growth 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. By fiscal year 2019, the installed solar capacity reached 29.1 GW, showcasing a solid foundation for future expansions. The growth trajectory continued, with capacity increasing to 35.6 GW in FY 2020 and 41.2 GW in FY 2021. This upward trend culminated in significant milestones, as the installed capacity surged to 54.0 GW by FY 2022 and further accelerated to 66.8 GW in FY 2023. As of FY 2024, India has achieved an installed solar capacity of 81.8 GW, indicating a robust pace of development in the solar sector. Looking ahead, projections suggest that the country is on track to reach 292.6 GW of solar power capacity by FY 2030. This ambitious goal aligns with India's broader renewable energy targets and underscores the importance of solar power in the nation's energy landscape. The substantial increases in capacity over the past years not only highlight the effectiveness of government policies and initiatives but also reflect growing investments and advancements in technology, positioning India as a key player in the global renewable energy

The growth of India's solar sector is bolstered by proactive policies such as the Production-Linked Incentive (PLI) scheme, which has an allocation of INR 24,000 Cr ($2.9 Bn) aimed at enhancing domestic manufacturing of solar PV modules and decreasing reliance on imports. Additionally, the government has approved the

establishment of 50 solar parks, cumulatively contributing 37.49 GW to large-scale solar installations. The overall renewable energy capacity, including large hydro, has risen by approximately 128% since 2014, reaching over 207.76 GW by August 2024, with solar power playing a significant role in this expansion.

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.

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.

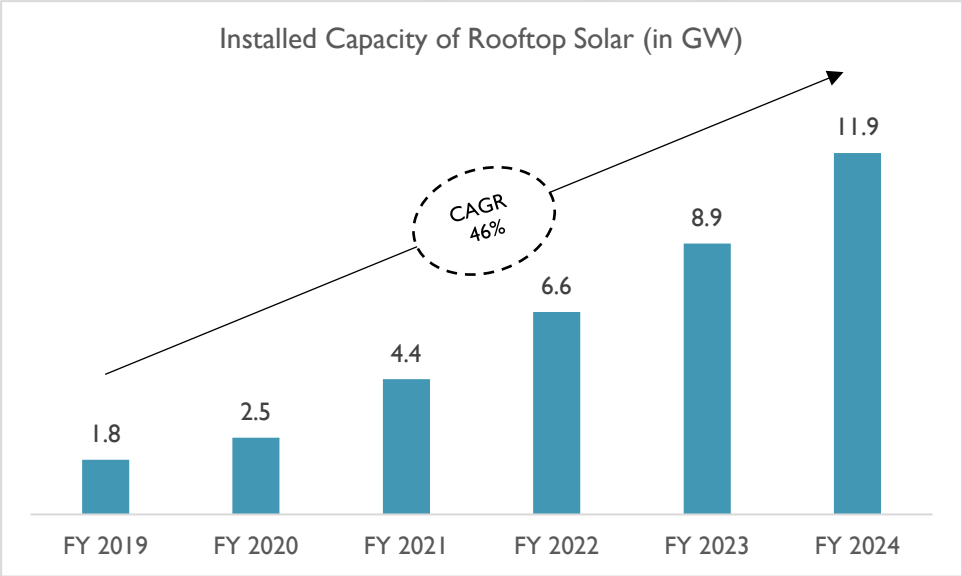
India has now ranked 5th globally in solar power deployment. As of June 30, 2023, the country has commissioned solar projects with a total capacity of 70.10 GW. This includes 57.22 GW from ground-mounted solar projects, 10.37 GW from rooftop solar systems, and 2.51 GW from off-grid solar installations.

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.

[5]India has set an ambitious target of achieving 500 gigawatts (GW) of renewable energy capacity by 2030, a critical step toward ensuring sustainable energy independence. As of March 2024, the country has made notable progress, with approximately 190 GW (including large hydro) of renewable energy capacity installed. However, to reach the 2030 target, an annual installation rate of around 50 GW is necessary. In contrast, during the fiscal year (FY) 2023-24, India added just over 18 GW of renewable energy capacity. Additionally, investments in the sector saw a marginal decline, falling from USD 11.7 billion in FY 2022-23 to USD 11.4 billion in FY 2023-24. This indicates that the country will need to accelerate its efforts, requiring more than 2.5 times the current installation rate.

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

[5] JMK Research and Analytics

solution for reducing electricity bills while contributing to environmental sustainability, making it an attractive option for various sectors.

[6]As of August 2024, India has achieved a cumulative installed solar power capacity of 89.43 GW. This includes 69.19 GW from ground-mounted solar plants, 13.89 GW from grid-connected solar rooftop systems, 2.59 GW from the solar component of hybrid projects, and 3.76 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.

[6] Ministry of New and Renewable Energy

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, commercial, and industrial consumers. As of 2023, India's utility-scale solar capacity crossed 50 GW, with ongoing large-scale projects in states like Rajasthan, Gujarat, and Karnataka. These projects are central to achieving India's target of 280 GW of installed solar capacity by 2030.

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 2023, the country has achieved a solar capacity of 73 GW. Additionally, a target of 40 GW for rooftop solar capacity was established for mid-2022; however, only 10 GW had been installed by the end of 2023. 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 Engineering, Procurement, and Construction (EPC) sector in India is set for significant growth in 2024-2025, with revenues projected to increase by 12-14% in the upcoming fiscal year. This optimistic outlook stems from robust order books supported by healthy domestic and international demand, alongside a consistent pace of execution in the infrastructure sector. EPC companies are expected to collectively generate revenues of approximately INR 3.5 lakh crore in FY 2023, accounting for a substantial share of India's overall construction investment.

The Engineering, Procurement, and Construction (EPC) market in India is poised for significant growth, driven by government initiatives and a strong focus on infrastructure development. The Indian government's National Infrastructure Pipeline (NIP) and Atmanirbhar Bharat campaign aim to enhance investments in transportation, energy, and urban development, creating robust demand for EPC services. Additionally, India's commitment to achieving net-zero emissions by 2070 and targeting 500 GW of renewable energy capacity by 2030 will lead to a surge in projects in solar, wind, and hydroelectric power. Rapid urbanization, supported by the Smart Cities Mission, further boosts demand for EPC services in sustainable urban infrastructure. Furthermore, public-private partnerships (PPP) are gaining momentum, facilitating investment and offering new project opportunities for EPC firms.

The positive trajectory of the EPC market is underpinned by a strong government push for infrastructure development, which is enhanced by rising public-private partnerships. The capital outlay for infrastructure projects has remained resilient, demonstrating the government's commitment to upgrading the country's infrastructure capabilities. Additionally, private sector investment is projected to increase to around 12% in

2024-2025 from 9% the previous year, driven by a revival in the build-operate-transfer model in the roads sector and greater private involvement in power capacity expansions.

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 favor 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

Company Name	Business Profile
KP Green Energy	Established in 2011, KP Green Energy provides full-fledged customized solutions for the successful installation and performance of solar PV projects, based in Indore, Madhya Pradesh. Additionally, the company is also engaged in trading and supplying Solar Water Heater, offering an optimum quality Petrol Pump Canopy Fascia, canopy light, driveway, DAG, electrical panel, Solar Petrol Pump, Inverter & Battery, Commercial Water Cooler, and yard light. Moreover, company's in-house design and production teams deliver innovative and strategic solutions across all project phases, from initial to completion. This comprises of site and technology evaluation, management using energy infrastructure, material procurement and logistics, and project design.
Oriana Power	Established in 2013, Oriana Power is specialised in providing innovative solar energy solutions to industrial and commercial clients in the renewable energy sector. It offers a comprehensive range of renewable energy solutions, including solar, wind, biogas, green hydrogen, and energy storage systems, catering to a wide spectrum of energy needs. The company has delivered low carbon energy solutions by installing on-site solar projects, including rooftop and ground-mounted systems, as well as offering open access to off-site solar farms. Their operations consist of two primary segments the Capital Expenditure (CAPEX) model and the Renewable Energy Service Company (RESCO) model. In CAPEX model, they handle the Engineering, Procurement, Construction and Operation of solar projects, while the

	RESCO model allows customers to access solar energy benefits without upfront investments. In 2020, the company commissions first floating solar project installed in a reservoir of Vishakhapatnam. The company have an extensive global presence, particularly in the Middle East and Africa, as well as a substantial local impact in 21 Indian states.
Sahaj Solar	Surana Solar Limited, formerly known as Surana Ventures Limited, was established in 2006 as a key player in the Surana Group. The company entered the solar energy sector in 2008, focusing on manufacturing solar photovoltaic (PV) modules. The company operates manufacturing units in Fabcity and Cherlapally, Hyderabad, with a combined installed capacity of 60 MW for solar PV modules. Surana Solar's products, sold under the brand 'Surana Solar,' are renowned for their high quality, supported by rigorous quality processes throughout production. The company is involved in both manufacturing solar PV modules and installing rooftop solar systems for various commercial, domestic, and industrial applications.

Financial Performance

Expense Snapshot

The financial performance of the Solar EPC and PPA Industry can be described as growing industry, with significant revenue growth and stable profit margins. Between FY 2021 and 23, total sales have grown by a CAGR of 67%.

	Raw Material	Power & Fuel	Salary & Wage	SG&A	Interest
FY 2021	23%	0%	4%	4%	3%
FY 2022	38%	0%	3%	3%	2%
FY 2023	28%	0%	3%	4%	1%

The financial expense analysis of Solar EPC and PPA players in India from FY 2021 to FY 2023 shows significant variability, particularly in raw material costs. In FY 2021, raw materials accounted for 23% of total expenses, but this spiked to 38% in FY 2022. This sharp rise could be attributed to global supply chain disruptions caused by the COVID-19 pandemic, leading to higher procurement costs for solar panels, inverters, and other essential materials. Additionally, inflationary pressures and shortages in critical components might have driven up costs during this period. By FY 2023, raw material costs declined to 28%, reflecting a potential stabilization in supply chains or better sourcing strategies by these companies, although prices still remained above pre-pandemic levels.

Another noteworthy observation is the absence of power and fuel expenses, which consistently accounted for 0% of total costs throughout the period. This suggests that Solar EPC and PPA companies, operating within the renewable energy domain, likely utilize self-generated solar power or rely on minimal energy consumption during their operations. It also highlights the inherent advantage of these companies in avoiding fuel costs, unlike conventional energy players. The focus on renewable energy as their core business may allow them to reduce operational energy expenses significantly, enhancing their overall cost efficiency.

Regarding labor and administrative costs, salary and wage expenses remained fairly stable, decreasing slightly from 4% in FY 2021 to 3% in both FY 2022 and FY 2023. This trend implies effective cost control in employee-related expenses despite the industry's expansion and higher project volumes. Selling, General & Administrative (SG&A) expenses hovered around 3-4% across the three years, suggesting careful management of overhead costs as these companies scale their operations. Furthermore, interest expenses steadily decreased from 3% in FY 2021 to 1% in FY 2023, indicating improved debt management or access to more favorable financing. This trend may reflect the growing investor confidence in renewable energy projects, allowing companies to secure lower-cost capital while maintaining financial discipline.

Profitability Margins

	Operating Profit Margin	Net Profit Margin
FY 2021	9%	4%
FY 2022	19%	12%
FY 2023	23%	17%

The operating profit margin of Solar EPC and PPA players in India has shown a robust upward trend from FY 2021 to FY 2023, reflecting significant improvements in operational efficiency and cost management. In FY 2021, the operating profit margin stood at 9%, but by FY 2022, it had more than doubled to 19%. This surge can be attributed to a combination of factors, including economies of scale as companies took on larger solar projects and better control over raw material costs and overheads. The continued increase to 23% in FY 2023 suggests further optimization in project execution and perhaps better contract terms, allowing companies to enhance profitability despite fluctuations in market conditions.

The net profit margin, which also saw a remarkable improvement, underscores the financial strength these players have achieved in recent years. In FY 2021, net profit margins were modest at 4%, but they tripled to 12% in FY 2022. This increase likely reflects a reduction in non-operational costs such as interest and taxes, alongside the higher operational profits. The further rise to 17% in FY 2023 highlights an industry benefiting from a favourable policy environment, increased demand for renewable energy, and improved capital structure with access to cheaper financing, all of which contribute to stronger bottom-line results.

These trends in both operating and net profit margins indicate that Solar EPC and PPA companies are moving toward sustained profitability and financial resilience. Their ability to increase margins despite the challenges in raw material pricing and global economic uncertainties points to a maturing market, where companies are leveraging operational efficiencies, long-term contracts, and improved project execution capabilities to boost overall financial performance.

Financial Benchmarking: KPI[7]

(Annual Performance)

Financial Indicators in INR million	KP Green Engineering Limited		Oriana Power Limited		Sahaj Solar Limited	
Yearly	**FY'23**	**FY'24**	**FY'23**	**FY'24**	**FY'23**	**FY'24**
Total income	1,147.85	3,519.71	1,339.54	3,799.40	1,837.74	1,797.62
Revenue from Operation	1,142.09	3,490.49	1,329.36	3,773.14	1,832.54	1,793.37
Y-O_Y Growth	46.98%	205.62%	NA[8]	183.83%	178.38%	-2.14%
Raw material expenses	800.88	2581.67	1041.66	2,748.00	1,645.27	1,464.24
Employee Compensation	44.64	64.86	37.31	76.07	22.93	34.31
Finance cost	34.64	44.83	14.05	30.28	19.47	37.62
Depreciation & Amortization	15.13	18.31	0.87	3.49	13.83	10.20
PBT	163.42	476.67	177.52	755.99	77.04	180.68
Profit after tax	121.18	353.91	124.85	551.33	57.96	122.64
EBITDA	213.19	539.82	192.43	789.76	110.35	228.50
Total Equity	326.83	2,667.50	359.57	1,511.84	158.20	313.28
Long term debt	47.16	182.03	47.98	19.17	33.40	12.96
Debt Equity Ratio	0.14	0.07	0.13	0.01	0.21	0.04

Source – Yearly Financial Reports

In FY'24, KP Green Engineering Limited, Oriana Power Limited, and Sahaj Solar Limited showcased varied financial performances, reflecting their distinct growth trajectories and operational efficiencies. KP Green Engineering experienced remarkable growth with total income surging by 205.62% to INR 3,519.71 million and revenue from operations increasing to INR 3,490.49 million, supported by higher raw material expenses (INR 2,581.67 million) and EBITDA of INR 539.82 million. Oriana Power also demonstrated significant expansion, with total income growing by 183.83% to INR 3,799.40 million and EBITDA reaching INR 789.76 million, reflecting robust profitability. Conversely, Sahaj Solar's total income slightly declined by 2.14% to INR 1,797.62 million, with a relatively modest EBITDA of INR 228.50 million.

Profitability indicators highlight Oriana Power's superior performance, with profit after tax (PAT) at INR 551.33 million, followed by KP Green Engineering (INR 353.91 million) and Sahaj Solar (INR 122.64 million). In terms of financial leverage, KP Green Engineering and Oriana Power exhibited conservative debt-equity

[7] All the indicators are based on Standalone Financials
[8] Previous Year data for standalone is not available.

ratios of 0.07 and 0.01, respectively, compared to Sahaj Solar's 0.04. Overall, while KP Green Engineering and Oriana Power achieved substantial growth and profitability, Sahaj Solar displayed moderate performance with stable cost management.

Financial Benchmarking: KPI

(Interim Performance)

Financial Indicators in INR million	KP Green Engineering Limited	Oriana Power Limited	Sahaj Solar Limited
Half Yearly	**H1 FY'25**	**H1 FY'25**	**H1 FY'25**
Total income	2,664.96	3,541.10	954.35
Revenue from Operation	2,623.57	3,513.78	947.35
Y-O_Y Growth	152.43%	470.8%	71.05%
Raw material expenses	1,972.96	2,704.06	811.49
Employee Compensation	40.18	64.75	16.86
Finance cost	50.61	32.46	22.35
Depreciation /Amortization	23.93	2.46	5.33
PBT	363.51	699.23	56.25
Profit after tax	274.85	520.78	44.10
EBITDA	438.04	734.14	83.93
Total Equity	2,792.03	4,099.55	849.59
Long term debt	152.66	18.42	3.89
Debt Equity Ratio	0.05	0.004	0.005

Source – Half Yearly Financial Reports

In H1 FY'25, **KP Green Engineering Limited**, **Oriana Power Limited**, and **Sahaj Solar Limited** demonstrated diverse financial performances. Oriana Power reported the highest total income of INR 3,541.10 million, marking an impressive year-on-year growth of 470.8%, significantly outpacing KP Green Engineering's growth of 152.43% (total income of INR 2,664.96 million) and Sahaj Solar's 71.05% growth (total income of INR 954.35 million). Oriana Power also led in profitability with a PAT of INR 520.78 million and an EBITDA of INR 734.14 million, reflecting efficient cost and operational management. KP Green Engineering followed with a PAT of INR 274.85 million and an EBITDA of INR 438.04 million, while Sahaj Solar lagged with a PAT of INR 44.10 million and an EBITDA of INR 83.93 million.

Raw material expenses dominated the cost structures for all three, with Oriana Power and KP Green Engineering having significantly higher raw material costs (INR 2,704.06 million and INR 1,972.96 million,

respectively) than Sahaj Solar (INR 811.49 million). In terms of financial stability, all three companies maintained low debt-equity ratios, with Oriana Power at 0.004, KP Green Engineering at 0.05, and Sahaj Solar at 0.005, indicating minimal leverage. Overall, Oriana Power outperformed its peers in both growth and profitability, while KP Green Engineering showed robust expansion, and Sahaj Solar displayed steady but comparatively modest performance.

Company Profile: Ricans Solar

Founded in 2016 in Gurugram, Haryana with a clear vision to foster a smart and sustainable future for modern India, Ricans has positioned itself as a pioneering force in the renewable energy sector. Recognizing the pressing need for efficient and reliable green solutions in an era dominated by smart cities and increasingly eco-conscious consumers, Ricans emerged to transform the landscape of renewable energy provision. The company's inception was driven by the belief that conventional contracting methods could not adequately address the growing demand for sustainable solutions, leading to the creation of a more informative and accessible platform for consumers and green solution providers alike.

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Business Verticals:

Ricans operates across multiple business verticals within the solar energy sector, each aimed at promoting the adoption of renewable energy. The primary verticals include:

- **Residential On-Grid Solar:** Ricans offers customized solar solutions designed specifically for residential customers. These systems allow homeowners to generate their electricity, significantly reducing reliance on conventional power sources and lowering energy bills while contributing to environmental sustainability.
- **Industrial On-Grid Solar:** The company also caters to industrial clients by providing large-scale solar installations that help businesses reduce operational costs and decrease their carbon footprints. Ricans collaborates with industries to design and implement solar solutions that align with their specific energy needs and sustainability goals.
- **Ground Mount Solar Projects:** Ricans develops ground-mounted solar installations that optimize energy production by utilizing open land spaces effectively. This vertical focuses on harnessing solar energy in areas where rooftop installations may not be feasible, thereby maximizing the use of available land for clean energy generation.
- **Solar PPA/OPEX Projects:** Through its innovative Power Purchase Agreement (PPA) model, Ricans invests in the solar systems installed at customer premises. Clients are charged based on their actual energy consumption, typically at rates significantly lower than those offered by traditional grid electricity. This model allows customers to benefit from solar energy without the upfront investment typically associated with solar installations.

Product Profile:

Ricans boasts the largest and most diverse product portfolio in the solar energy market, ensuring that clients have access to a wide range of high-quality solar solutions. The company partners with leading solar equipment manufacturers to provide clients with state-of-the-art technology and equipment that maximize energy efficiency. By prioritizing consumer education, Ricans empowers clients to make informed decisions about renewable energy options, offering a seamless platform that connects them with expert consultants and modern solar technology. This commitment to innovation and customer satisfaction positions Ricans as a leader in the green energy sector.

Key Achievements:

- **Operational Capacity:** Ricans Solar has successfully completed over 30 MW of solar projects that are either operational or under construction. This substantial capacity underscores the company's commitment to expanding renewable energy access across India.
- **Project Portfolio:** The company has executed more than 100 projects across 24 states in India, showcasing its extensive reach and expertise in the solar market. This wide-ranging portfolio reflects Ricans' ability to adapt to diverse regional requirements and client needs.
- **Client Base:** Ricans has partnered with over 100 leading business houses and multinational corporations, establishing itself as a trusted renewable energy partner. This impressive clientele not only highlights the company's reliability but also demonstrates its capability to handle large-scale solar initiatives.
- **Fast ROI:** Their systems are designed for quick payback periods, typically around 4 years, making them an attractive investment for clients looking to reduce electricity costs significantly. This emphasis on return on investment (ROI) is critical for businesses considering the transition to renewable energy, ensuring that clients can benefit financially while contributing to sustainability efforts.
- **Extensive Product Portfolio:** Ricans has established itself as a market leader by offering the largest variety of solar products available. This extensive portfolio enables customers to tailor their solar solutions to meet specific needs, whether for residential, commercial, or industrial applications, ensuring that each client finds an optimal solution.
- **Strategic Partnerships:** By forging partnerships with top-tier solar equipment manufacturers and installation companies, Ricans guarantees the delivery of high-quality systems that fulfill the promise of energy production efficiency. These collaborations not only enhance the reliability of Ricans' offerings but also contribute to the overall growth and credibility of the renewable energy market in India.
- **Expert Team:** The success of Ricans is attributed to its top-caliber team, which consists of specialists in various fields, including engineering, procurement, construction (EPC), and operation and maintenance

(O&M). This diverse expertise ensures the reliable delivery of solar electricity to clients, backed by comprehensive support throughout the lifecycle of each project.

- **Innovative Business Model:** Ricans' Power Purchase Agreement model represents a significant innovation in the renewable energy sector. By taking on the initial investment burden for solar installations, the company provides an accessible entry point for clients to switch to solar energy. This approach not only enhances the financial viability of solar projects but also encourages widespread adoption of renewable energy practices among businesses and consumers.
- **Commitment to Sustainability:** Ricans is dedicated to promoting sustainable practices across all its operations. The company's initiatives not only focus on delivering clean energy solutions but also aim to educate the public about the importance of transitioning to renewable energy sources. Through workshops, seminars, and public awareness campaigns, Ricans actively engages with communities to foster a culture of sustainability and environmental responsibility.

Ricans stands as a beacon of innovation and sustainability in India's renewable energy sector. With its extensive product offerings, strategic partnerships, and commitment to customer satisfaction, the company is well-equipped to lead the charge towards a greener, more sustainable future.