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INDUSTRY REPORT ON SOLAR TRACKING AND MOUNTING PRODUCTS MARKET

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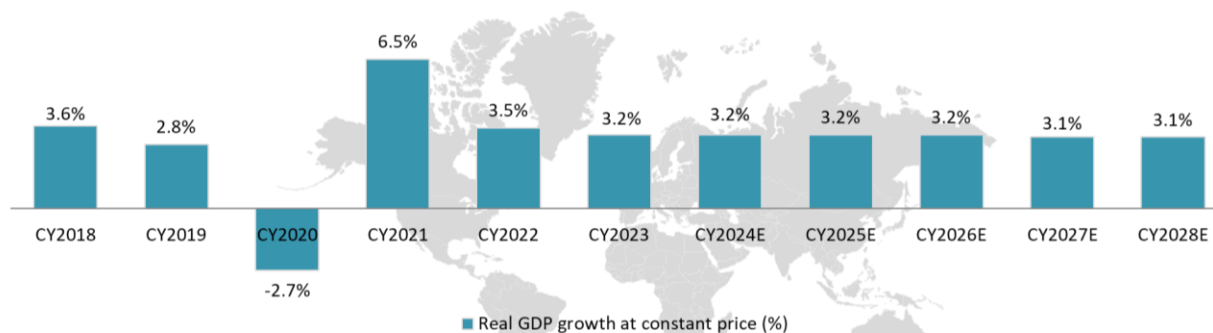
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1. MACROECONOMIC OVERVIEW OF GLOBAL ECONOMY

1.1 Real GDP review and outlook

The global economy faced significant stress over the past few years due to extended trade conflicts, a slowdown in worldwide investments, and the COVID-19 pandemic. It showed signs of slowing down from CY2018 and entered a recession in CY2020 due to the pandemic, which severely curtailed economic activity as countries imposed strict restrictions. The economy demonstrated resilience with sharp growth in CY2021. However, CY2022 brought new challenges including the Russia-Ukraine war, inflation, slowdowns in the US and Europe, and ongoing supply chain issues. By CY2023, these factors were moderated, leading to a stabilized global real GDP growth rate of 3.2%. This growth rate is expected to continue at the same pace over the next three years. However, by CY2027 and CY2028, growth is projected to moderate to 3.1%. The outlook is threatened by higher interest rates imposed by central banks to combat inflation and reduced government spending due to accumulated debt.

Exhibit 1.1: Real GDP Growth – Historic and Forecast, World, CY2018 – CY2028E



Source: IMF April 2024 forecast, Frost & Sullivan analysis

Exhibit 1.2: Real GDP Growth of Select Regions & Countries – Historic and Forecast, World, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
World	3.6%	2.8%	-2.7%	6.5%	3.5%	3.2%	3.2%	3.2%	3.2%	3.1%	3.1%
United States	3.0%	2.5%	-2.2%	5.8%	1.9%	2.5%	2.7%	1.9%	2.0%	2.1%	2.1%
China	6.8%	6.0%	2.2%	8.4%	3.0%	5.2%	4.6%	4.1%	3.8%	3.6%	3.4%
India	6.5%	3.9%	-5.8%	9.7%	7.0%	7.8%	6.8%	6.5%	6.5%	6.5%	6.5%
North America	2.8%	2.1%	-3.0%	5.7%	2.3%	2.5%	2.6%	1.9%	2.0%	2.1%	2.1%
Europe	2.3%	2.0%	-5.4%	6.3%	2.5%	0.4%	0.8%	1.5%	1.7%	1.6%	1.6%
Asia and Pacific	5.3%	4.1%	-0.8%	7.1%	4.0%	4.8%	4.4%	4.2%	4.1%	4.1%	4.0%
Middle East and Central Asia	2.8%	1.7%	-2.4%	4.5%	5.3%	2.0%	2.8%	4.2%	3.8%	3.9%	3.6%
Africa	3.4%	2.9%	-1.7%	4.9%	4.0%	3.2%	3.5%	4.0%	4.0%	4.2%	4.3%
Latin America	0.5%	0.0%	-6.4%	7.5%	4.0%	1.5%	1.4%	2.7%	2.6%	2.5%	2.4%

Source: IMF, World Economic Outlook, Frost & Sullivan Analysis

India remains the fastest-growing large economy, achieving a real GDP growth of 7.8% in CY2023, up from 7.0% in CY2022. This growth is expected to continue over the next five years, supported by stable domestic demand and private investments. In contrast, major economies had mixed outcomes in CY2023. The US economy grew by 2.5%, bolstered by increased consumer spending, investment, and government

expenditures. China's economy expanded by 5.2%, driven by the easing of COVID restrictions. Meanwhile, Europe experienced muted growth of just 0.4%, hindered by ongoing issues such as the war and high energy prices.

1.2 Inflation

After reaching a peak of 8.7% in CY2022, global inflation gradually eased to 6.8% in CY2023 and is projected to decline to 5.9% in CY2024. This anticipated decline is attributed to tighter monetary policies implemented by central banks, coupled with a decrease in international commodity prices. However, core inflation is likely to exhibit a slower decline, delaying the return to target levels in most regions until CY2025.

Exhibit 1.3: Inflation Rate – Historic and Forecast, World, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
World	3.6%	3.5%	3.2%	4.7%	8.7%	6.8%	5.9%	4.5%	3.7%	3.5%	3.4%
United States	2.4%	1.8%	1.2%	4.7%	8.0%	4.1%	2.9%	2.0%	2.1%	2.1%	2.1%
China	2.1%	2.9%	2.5%	0.9%	2.0%	0.2%	1.0%	2.0%	2.0%	2.0%	2.0%
India	3.4%	4.8%	6.2%	5.5%	6.7%	5.4%	4.6%	4.2%	4.1%	4.0%	4.0%
North America	2.7%	2.0%	1.4%	4.7%	7.9%	4.2%	3.0%	2.1%	2.1%	2.2%	2.2%
Europe	2.2%	2.0%	1.1%	3.5%	9.9%	6.3%	3.4%	2.7%	2.5%	2.4%	2.4%
Asia and Pacific	3.1%	3.4%	3.2%	3.0%	6.6%	5.1%	5.0%	4.3%	3.6%	3.4%	3.4%
Middle East	8.3%	6.3%	9.8%	12.1%	13.9%	12.5%	10.7%	9.2%	8.0%	7.4%	7.3%
Africa	11.2%	8.9%	10.5%	12.7%	14.2%	18.2%	18.4%	14.4%	9.9%	9.0%	8.1%

Source: IMF, World Economic Outlook, Frost & Sullivan Analysis

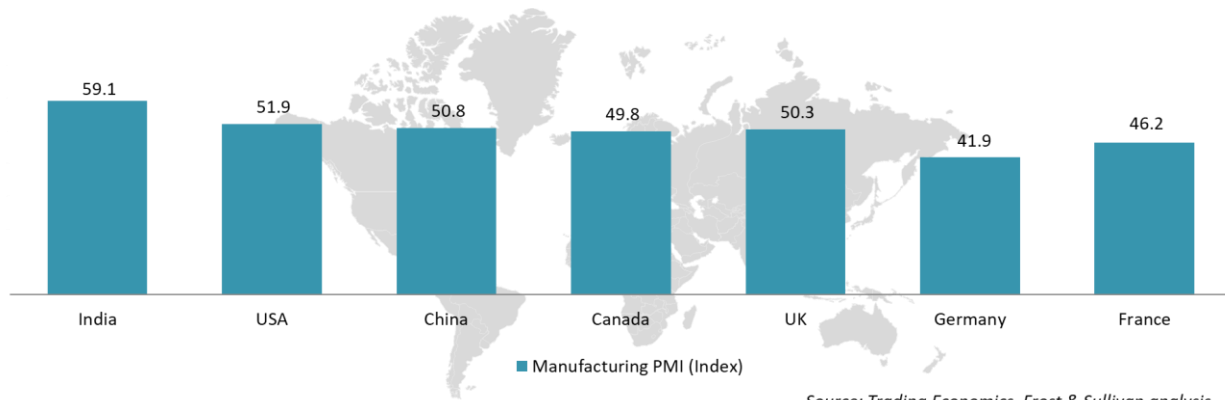
With disinflation and steady growth, the likelihood of a marked economic slowdown has receded, and risks to global growth are broadly balanced. On the upside, faster disinflation could lead to further easing of financial conditions. Stronger structural reform momentum could bolster productivity with positive cross-border spillovers. On the downside, new commodity price spikes from geopolitical shocks including continued attacks in the Red Sea and supply disruptions or more persistent underlying inflation could prolong tight monetary conditions.

1.3 Manufacturing Purchasing Manager’s Index (PMI)

Global manufacturing showed positive signs in March 2024, with output expanding (PMI 50.6) compared to December 2023 (48.9). This growth came despite ongoing challenges in the Red Sea. Confidence rose among manufacturers due to the potential easing of financial restrictions and reduced stockpiles globally (destocking). India led the pack with a significant PMI jump from 54.9 to 59.1, indicating strong growth. The US also saw a positive shift, moving from contraction (47.9) to expansion (51.9) in new orders. Europe faced some hurdles due to Red Sea disruptions impacting supply chains, but the overall outlook remained positive.

The global economy has shown tremendous resilience in CY2023 despite the fastest monetary policy tightening cycle in four decades, severe banking sector stress, and wars in Ukraine and Israel. A decline in global inflation made this economic outperformance even more special. Easing supply constraints, reduced labour shortages, cooling energy prices, and moderating demand growth have led to a notable easing of inflation pressures globally. All these trends are likely to continue in CY2024E and beyond and the global economy is poised to grow at a CAGR of 3.1% over the next 5 years.

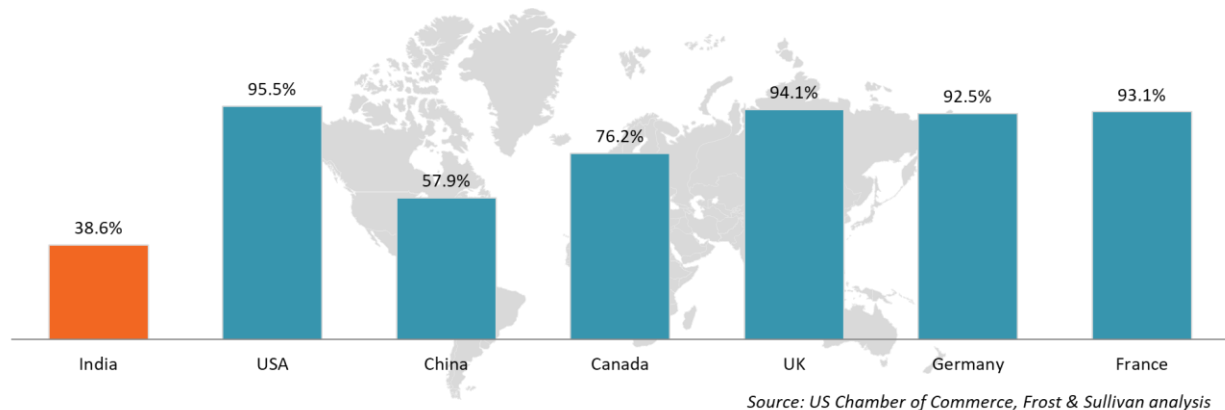
Exhibit 1.4: Manufacturing PMI, Select Countries, March 2024



1.4 International IP Index

As of February 2024, International IP Index, the US emerged as the global leader in intellectual property (IP) protection with a score of 95.5%. Europe dominated the runner-up positions with the UK (94.1%) and France (93.1%) following closely behind. China showed progress with a score of 57.9%. India placed 42nd with a score of 38.6%, indicating room for improvement in its IP framework. China implemented reforms to its IP laws, and Canada bolstered copyright enforcement through measures like issuing dynamic injunction orders.

Exhibit 1.5: Intellectual Property Index, Global, in %, February 2024



2. MACROECONOMIC OVERVIEW OF INDIAN ECONOMY

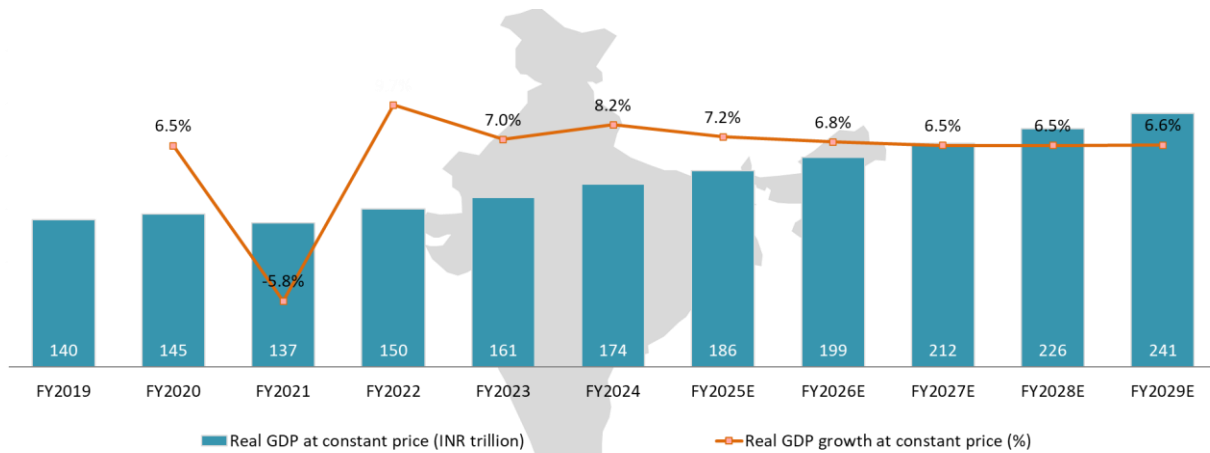
2.1 Indian Macro-economic overview

India's economy shines with a robust 8.2% growth in FY2024, outperforming many major economies. The government is actively pushing reforms to make India a global manufacturing hub, with a significant 17% YoY increase in capital expenditure planned for FY2025 (~ INR 11 trillion). The "Saptarishi" development plan prioritizes inclusive growth and infrastructure development. While the ambitious USD 5 trillion GDP target for FY2025 might see an 18-24 month delay due to the pandemic, India's strong performance positions it to surpass USD 4 trillion by FY2025 and reach USD 5 trillion by FY2027-FY2028, becoming the world's third-largest economy.

2.2 Review and outlook of Real GDP growth in India

The Indian economy has demonstrated robust performance, achieving 7.0% real GDP growth in FY2023 and 8.2% in FY2024, outperforming many major economies and showing resilience against global inflation. Structural reforms such as disinvestment, increased FDI limits, and a national logistics policy have supported manufacturing. The FY2025 budget outlines nine priorities for 'Viksit Bharat,' including productivity in agriculture, employment & skilling, inclusive development, manufacturing & services, urban development, energy security, infrastructure, innovation, and next-generation reforms. Initially targeting a USD 5 trillion economy by FY2025, India has revised this timeline by 18–24 months due to the pandemic. India’s GDP is projected to surpass USD 4 trillion in FY2025.

Exhibit 2.1: Annual Real GDP and growth, value in INR trillion, India, FY2018 - FY2029E



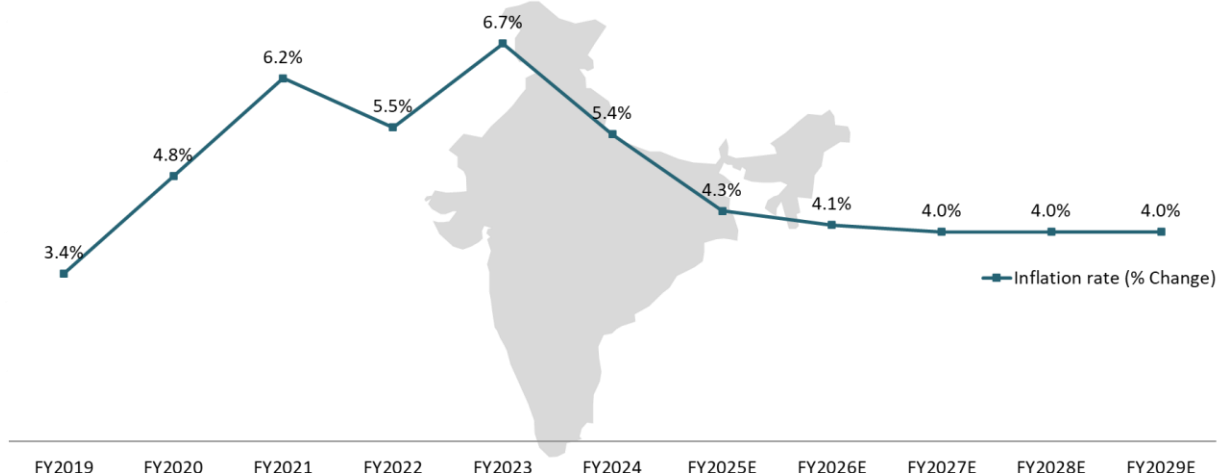
Source: MoSPI (Annual Estimates of GDP at constant price, 2011-12 series), IMF, ADB, S&P, Frost & Sullivan Analysis

To revive the economy post-COVID-19, the Indian government implemented a multi-faceted approach combining immediate relief with long-term growth strategies. Stimulus packages supported vulnerable groups and businesses, while infrastructure projects like the PM Gati Shakti National Master Plan aimed to boost job creation and logistics. Reforms in agriculture and labour sought to enhance efficiency, and a focus on green growth and youth empowerment highlighted the commitment to a sustainable economy. These efforts, along with stable domestic demand and private investments, are expected to drive a 6.7% CAGR in economic growth from FY2024 to FY2029E.

2.3 Inflation in India – historical and outlook

Inflation started showing an upward trend since FY2019 and increased to 6.7% in FY2023. Rising inflation emerged as a key macroeconomic concern in FY2023 with prices of almost every commodity touching new heights. However, in line with the global trend, the inflation in India moderated to 5.4% in FY2024 due to a drop in commodity prices and actions taken by the Reserve Bank of India (RBI). The RBI has left its inflation forecast for FY2025 unchanged at 4.3% even though there is a spike in crude oil prices and persisting worries about the supply chain due to the Red Sea crisis. In the medium term, RBI expects inflation to be stabilised at around 4.0% by FY2029.

Exhibit 2.2: India - Annual inflation rate, rate in %, India, FY2018 - FY2029E

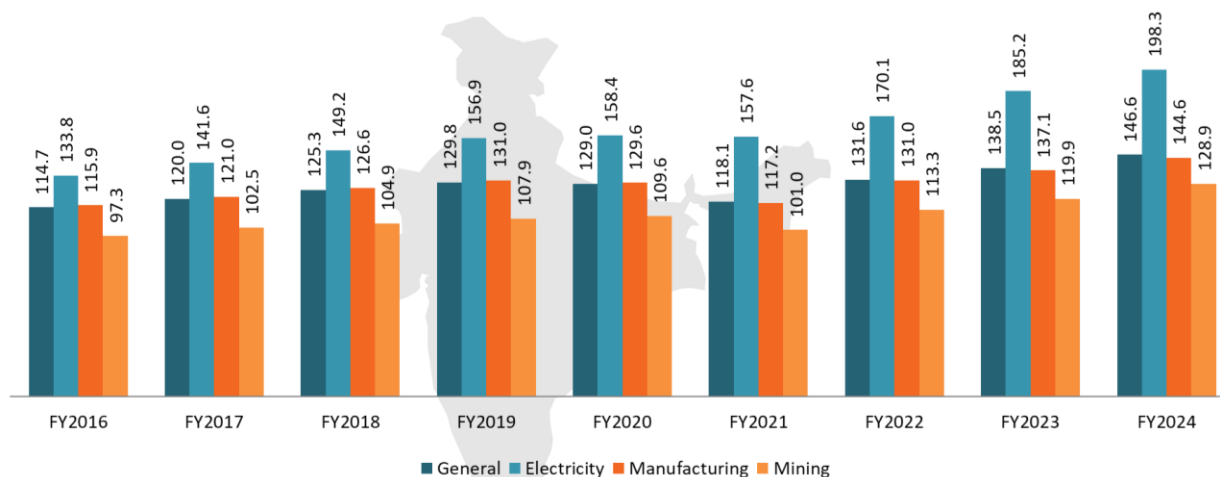


Source: CMIE, Frost & Sullivan Analysis

2.4 Index of Industrial Production (IIP)

Post-pandemic, since June 2021, industrial activity in the country started picking up and continued its momentum through FY2022 – FY2024 with industrial output recording a sharp growth across all the four constituent sectors in the last three consecutive years. FY2024 IIP provisional data indicates 5.8% cumulative growth in FY2024 and 5.5% growth for the manufacturing sector. The other three segments i.e., Mining, Electricity, and General have grown by 7.5%, 7.1%, and 5.8% respectively in FY2024. India’s Business Confidence Index (BCI) has also increased to 135.4 points in Q3 FY2024 from 132.5 points in the previous quarter. The survey also revealed that the business confidence in Q3 2024 was the highest in nearly eight years. The BCI however declined to 130.3 in Q4 FY2024 (source: Statista).

Exhibit 2.3: India - Index of Industrial Production (IIP) by sectors, FY2016 - FY2024

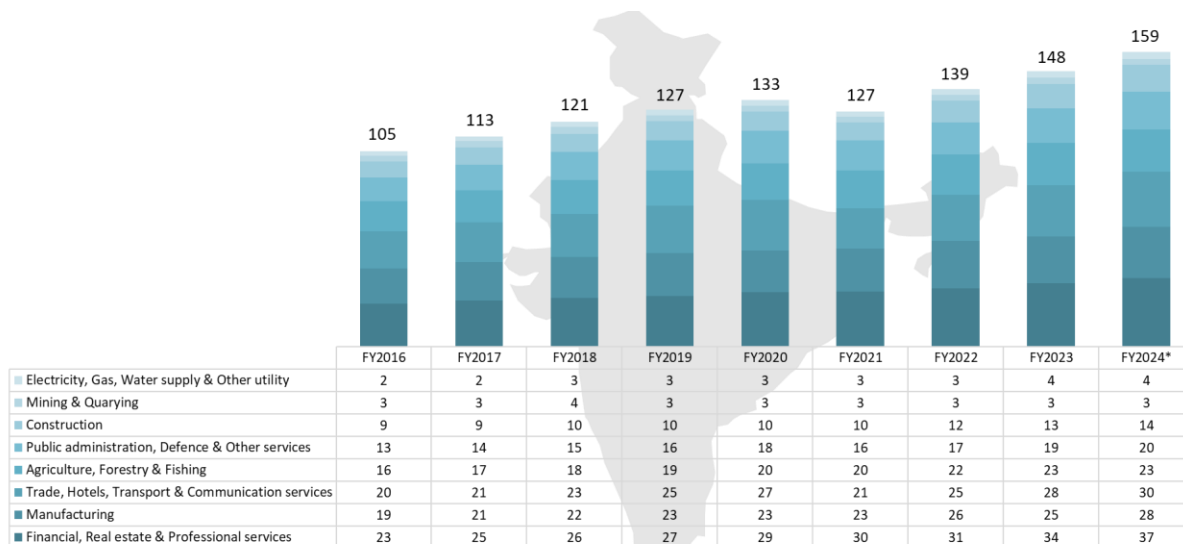


Source: MoSPI (Annual Estimates of GDP at constant price, 2011-12 series); RBI (Reserve Bank of India); Frost & Sullivan Analysis

2.5 Sectorial share of Gross Value Added (GVA)

The gross value added in India has grown steadily since suffering a decline of 4.5% in FY2021. The country's GVA has grown by 9.0% and 7.0% respectively in FY2022 and FY2023 and as per the second advance estimate, it is poised to grow at 7.3% in FY2024. Among the sectors, Construction GVA has achieved the highest growth of 8.8% CAGR since FY2020 (Pre covid level) while Financial, Real estate and professional Services GVA have grown at approximately 6.0% CAGR during this period.

Exhibit 2.4: India - Gross value added (GVA) at a basic price by economic activity, INR trillion, FY2016 - FY2024*

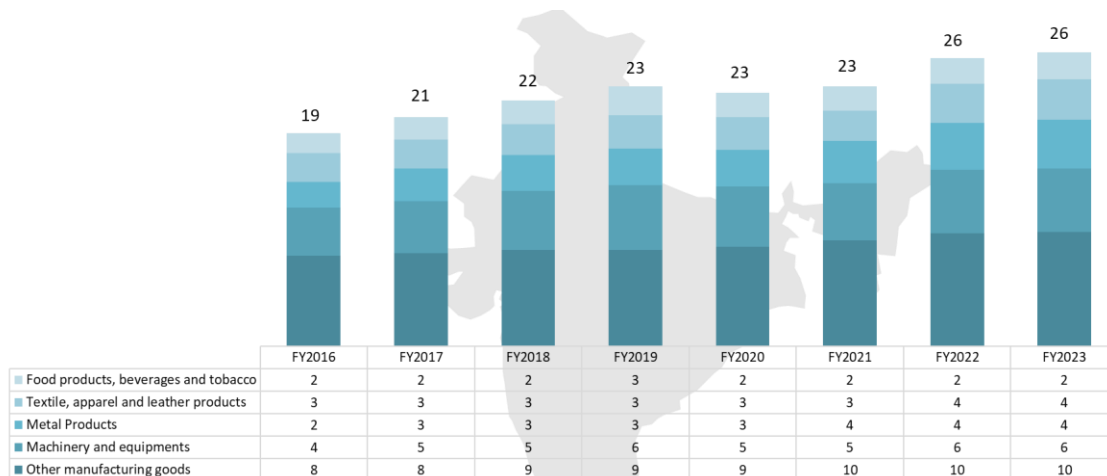


* Provisional Estimates

Source: MOSPI, Frost & Sullivan Analysis

India's manufacturing GVA has grown steadily, even during the COVID-19 pandemic. It peaked at 11.1% growth in FY2022 but moderated to 2.0% in FY2023, reaching INR 26 trillion. The FY2024 estimate is INR 27 trillion, reflecting a 6.5% annual growth. This growth is supported by the government's vision to establish India as a global manufacturing hub, with the sector's contribution rising from 16% to 17% due to initiatives like Make in India, Production Linked Incentive (PLI) schemes, and sector-specific policies.

Exhibit 2.5: India - Sector-wise split of GVA for manufacturing, value in INR trillion, FY2016 - FY2023

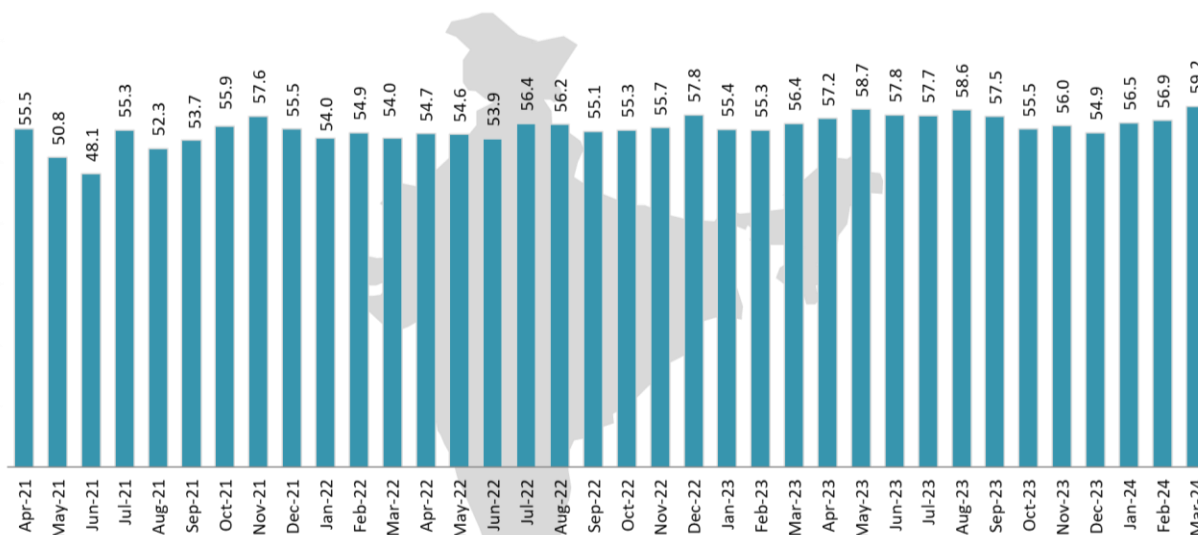


Source: National Statistical Office, Frost & Sullivan Analysis

2.6 India Manufacturing PMI (Purchase Managers Index)

The S&P Global India Manufacturing Purchasing Managers’ Index measures the performance of the manufacturing sector and is derived from a survey of 500 manufacturing companies.

Exhibit 2.6: Indian manufacturing PMI, April 2021 – March 2024



Source: S&P, Frost & Sullivan Analysis

The Manufacturing Purchasing Managers Index (PMI) is based on five components with the following weights: New Orders (30%), Output (25%), Employment (20%), Suppliers’ Delivery Times (15%), and Stock of Items Purchased (10%), with Delivery Times inverted for comparability. A PMI reading above 50 indicates sector expansion, below 50 signals contraction, and 50 represents no change. In May 2023, the Manufacturing PMI reached 58.7, the highest since October 2020, driven by strong demand and a 28-month high in output growth. However, it dropped to an 18-month low of 54.9 in December 2023 due to weaker new orders, reduced output, and slower export growth. It rebounded to 59.2 in March 2024

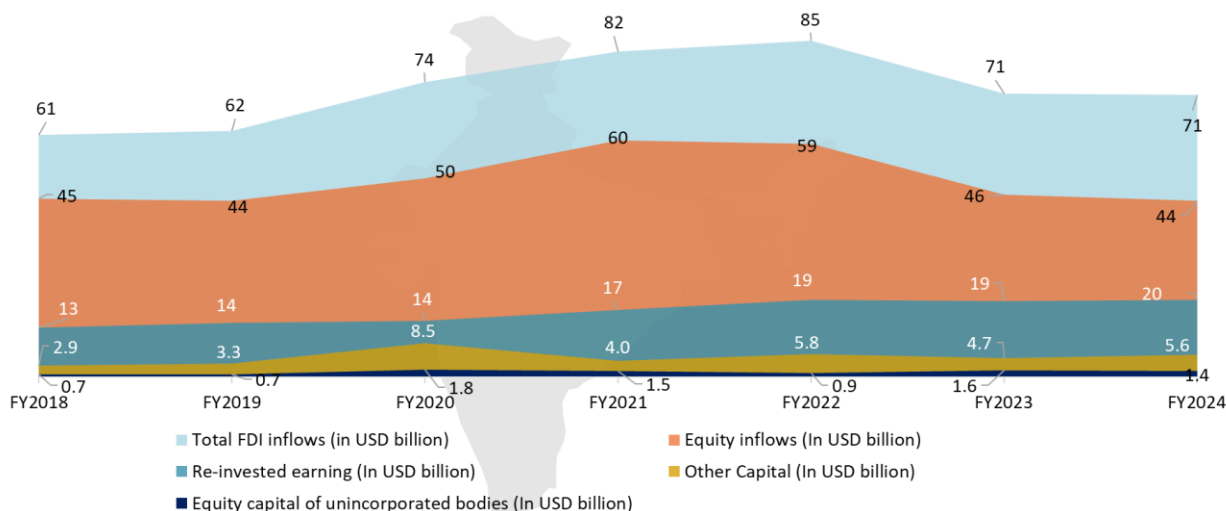
2.7 Foreign Direct Investment (FDI)

Foreign Direct Investment (FDI) in India has significantly increased in the last few years on the backdrop of improved ‘Ease of Doing Business’ ranking and proactive manufacturing policies from the Indian Government. The country received a record ~USD 435 billion FDI between FY2018 and FY2023. FDI reached a record ~USD 85 billion in FY2022 – the highest FDI in any fiscal year till date.

Even though the FDI declined to ~USD 71 billion in FY2023, it is still at par with the last 6 year’s average FDI in the country. India has achieved this feat despite the Indian government’s restrictions on FDI from China.

In FY2024, India has registered a gross FDI inflow of ~USD 71 billion. Despite high interest rates across the globe, India’s FDI inflows remained steady as compared to its peer developing economies, because of the ‘demand strength’ of the economy.

Exhibit 2.7: FDI inflow in India, in USD billion, FY2018 – FY2024

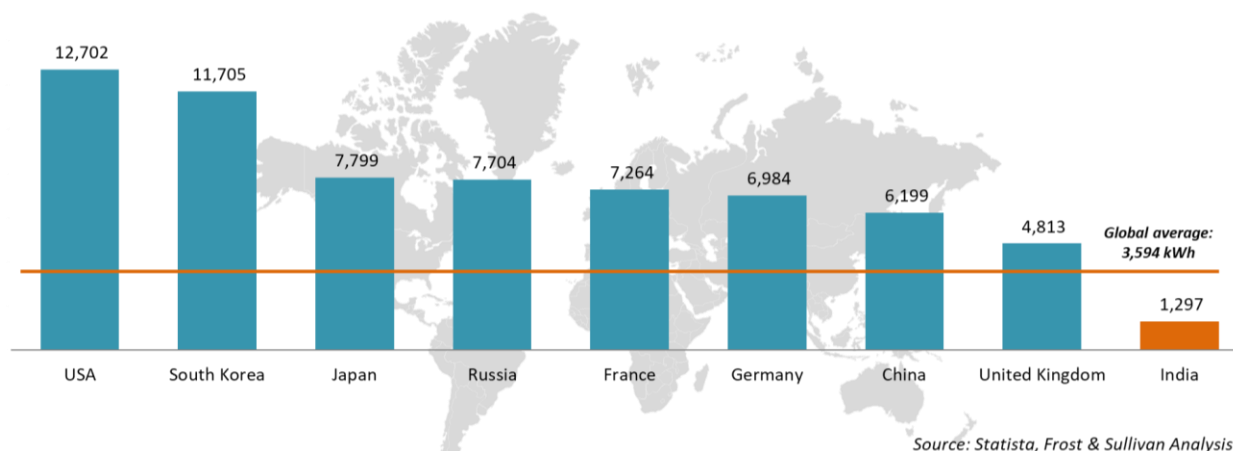


Source: RBI, Frost & Sullivan Analysis

2.8 Per capita electricity consumption

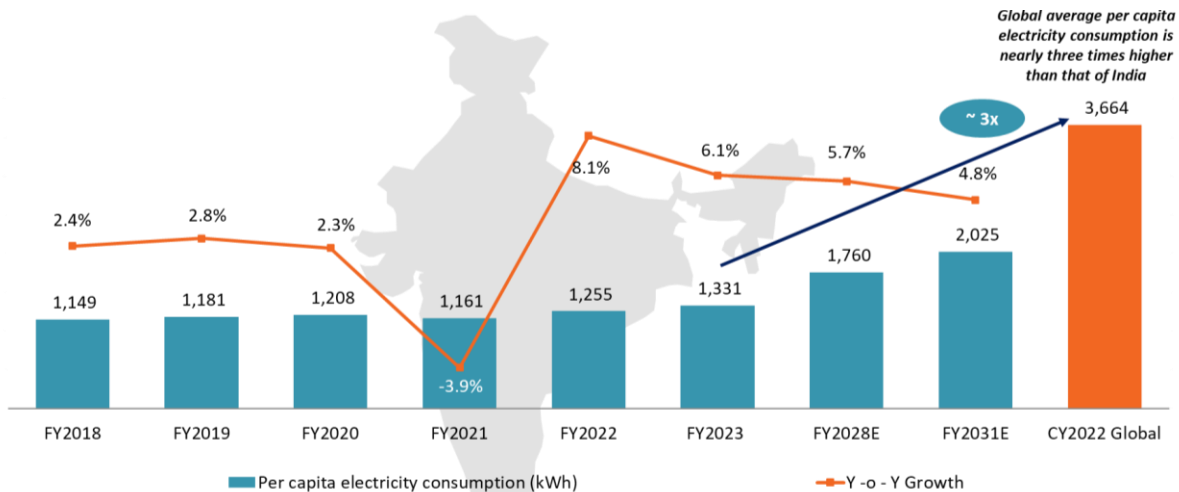
Per capita electricity consumption varies with factors like industry intensity, purchasing power, household size, and efficiency standards. Among the top 10 global economies, the USA leads in per capita consumption, while India’s is the lowest at 1,297 kWh, about one-third of the global average of 3,594 kWh as of CY2022. India’s consumption rose from 1,149 kWh in FY2018 to 1,331 kWh in FY2023, growing at 8.1% and 6.1% in FY2022 and FY2023, respectively. This increase is due to village electrification, economic growth, and higher consumer durable use. Projections suggest per capita consumption will exceed 1,700 kWh by FY2028E and reach 2,025 kWh by FY2031E. The Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) and Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA) aimed to electrify all villages and households, achieving 100% urban and 99.3% rural electrification by FY2022, according to World Bank data

Exhibit 2.8: Per capita electricity consumption of global leading economies vs India, in kWh, CY2022



Source: Statista, Frost & Sullivan Analysis

Exhibit 2.9: Per capita electricity consumption of India and growth, in kWh and %, FY2018 – FY2031E



Source: Central Electricity Authority, Statista, Frost & Sullivan Analysis

2.9 India is now emerging as a global manufacturing hub

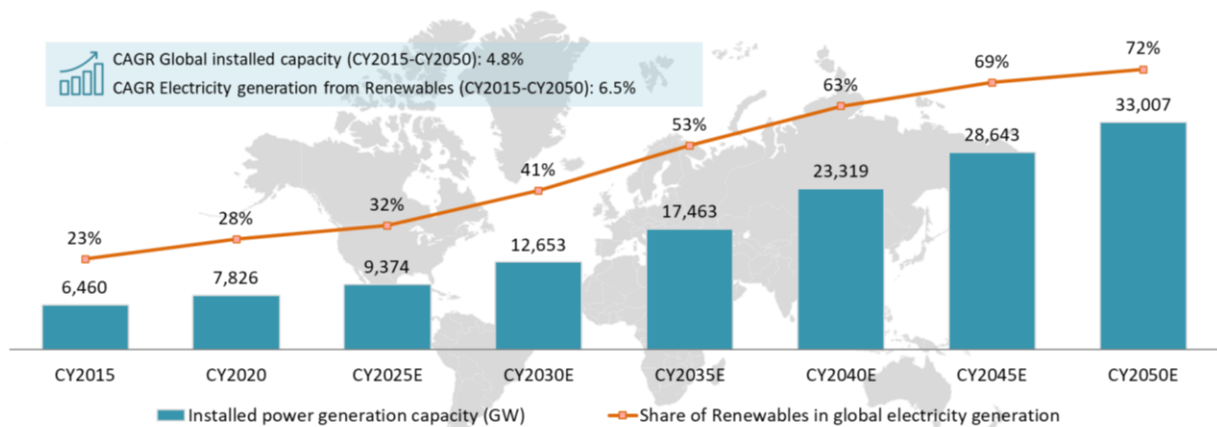
In FY2023, India recorded merchandise exports of USD 451 billion (INR 36 trillion), projected to reach USD 495-500 billion (INR 41 trillion) in FY2024. The country aims to become a global manufacturing hub with potential exports of USD 1 trillion by 2030). Manufacturing accounts for 17% of India’s GDP and employs over 62 million people. The government plans to raise this share to 25% by 2025 through various initiatives, including GST introduction, corporate tax cuts, Production Linked Incentive (PLI) schemes, and FDI policy reforms. An outlay of INR 1,995 billion (approx. USD 24 billion) has been announced for PLI schemes in 14 key sectors, expected to boost production, skills, employment, and exports. Reforms have increased FDI inflows from USD 45 billion in FY2015 to USD 71 billion in FY2023, with FY2024 inflows totalling USD 71 billion.

3. OVERVIEW OF GLOBAL POWER AND SOLAR SECTOR

3.1 Global installed power generation capacity

As per the latest data available, global installed power generation capacity has reached 9,063 GW at the end of CY2023.

Exhibit 3.1: Growth in global installed power generation capacity and share of Renewables, CY2015 – CY2050E



Source: Enerdata, Frost & Sullivan Analysis

Global installed power generation capacity has reached 9,063 GW at the end of CY2023. Asia-Pacific region accounts for approximately 40% share of this installed capacity, followed by 22% share by North America, and 18% share by Europe. India accounts for approx. 5% global installed power generation capacity at the end of CY2023. Global installed power generation capacity is expected to grow at 4.8% CAGR till CY2050E to reach approximately 33,000 GW. Nearly three-quarters of this capacity would be added through renewable sources.

3.2 Global installed Renewable Energy capacity

The Paris Agreement and COP meetings have driven global climate action, emphasizing low-carbon development and renewable energy (RE) capacity growth. From CY2016 to CY2023, global RE capacity grew at a 9.8% CAGR to reach 3,870 GW, with Asia leading at 51%, Europe at 20%, and North America at 14%.

Exhibit 3.2: Renewables installed capacity by geography, Global, in GW, CY2016 - CY2028E

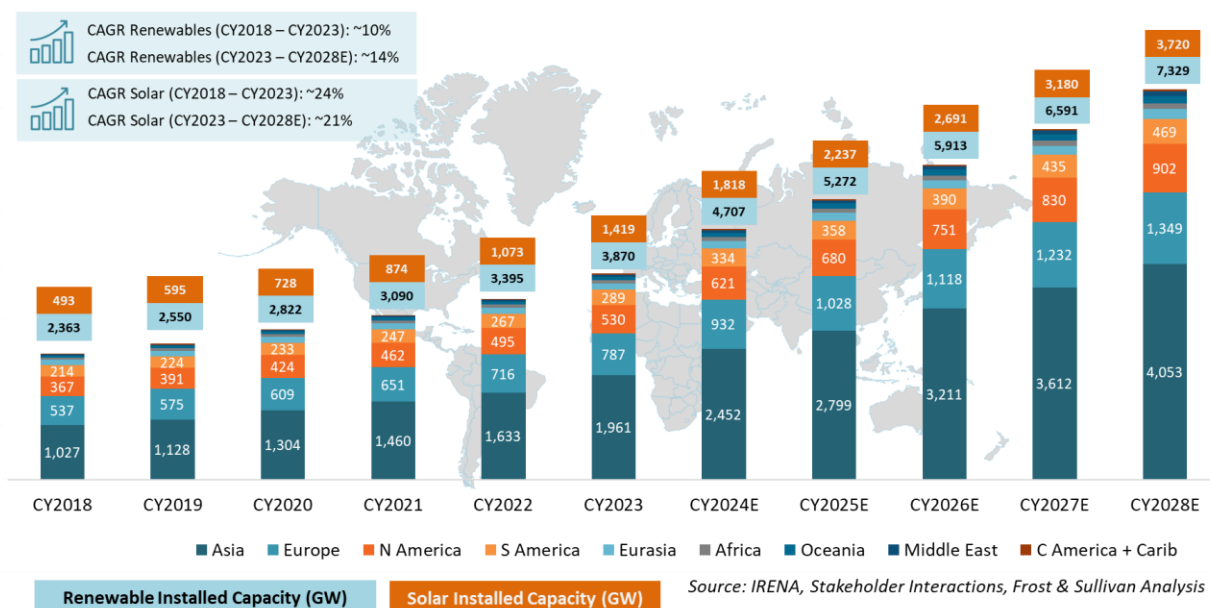
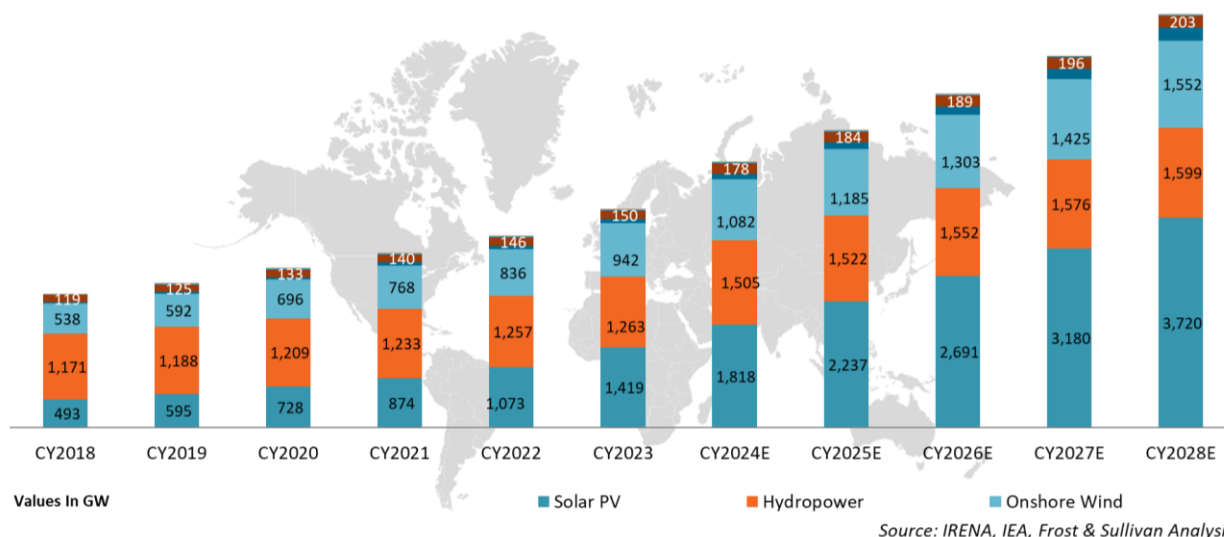


Exhibit 3.3: Cumulative renewable energy capacity by source, Global, in GW, CY2018 – CY2028E

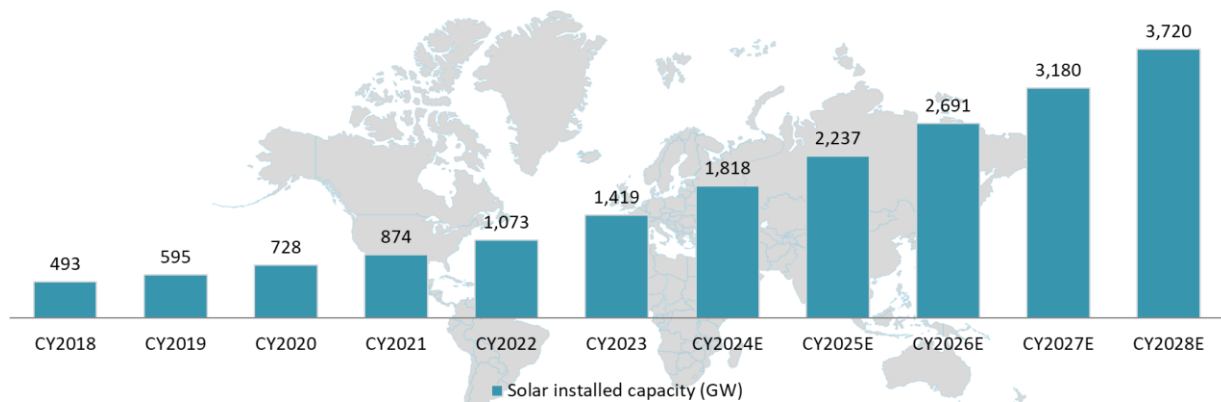


Solar capacity surged at a ~24% CAGR to exceed 1,419 GW. In CY2023, global annual renewable capacity additions rose by 56% to nearly 475 GW, the highest growth in two decades. Projections by the IEA estimate global RE capacity will surpass 7,300 GW by CY2028E. The share of renewables in global electricity generation is expected to increase from ~29% in CY2020 to ~72% by CY2050E, growing from 5,700 TWh to 51,000 TWh at a CAGR of 6.5% (source: Enerdata). In India, renewables accounted for ~24% of electricity generation in FY2024 (up to February 2024). The Indian government aims to meet 50% of the country's energy needs with renewables by CY2030, as stated during COP-26.

3.3 Global installed solar capacity

Solar power is projected to grow from 1,419 GW in CY2023 to 3,720 GW by CY2028E, achieving a CAGR of ~21%. By CY2024E, solar power is expected to surpass hydropower, followed by natural gas in CY2026E and coal in CY2027E, becoming the largest installed electricity capacity globally. Solar PV has maintained a strong growth trajectory despite challenges like Covid-related disruptions and supply-chain issues. The Russia-Ukraine conflict has further emphasized the importance of energy security, accelerating the adoption of clean and renewable energy technologies worldwide.

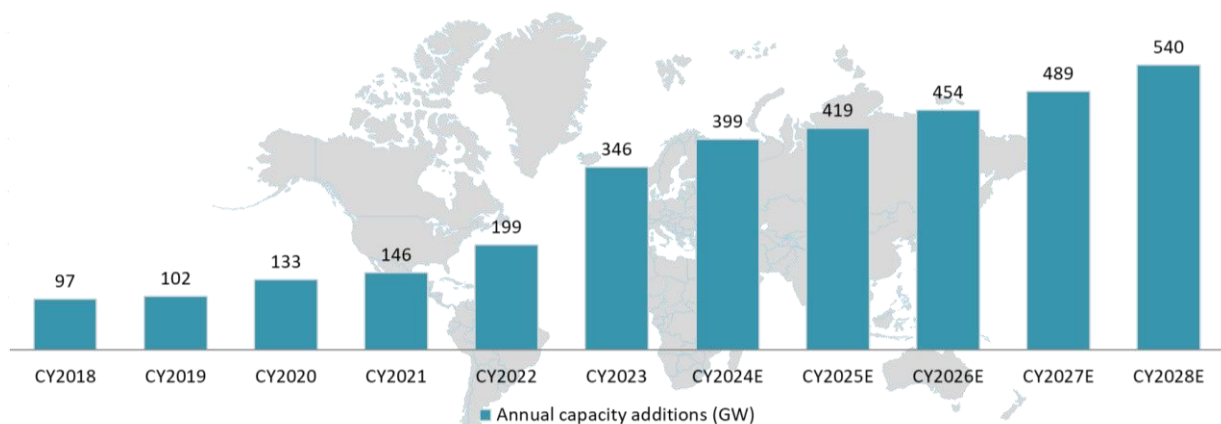
Exhibit 3.4: Solar installed capacity, Global, in GW, CY2018 - CY2028E



Note: Future capacity has been calculated based on CY2023 actual installed capacity + annual capacity additions projected by IEA till CY2028

Source: IRENA, IEA, Frost & Sullivan Analysis

Exhibit 3.5: Annual solar capacity additions, Global, in GW, CY2018 - CY2028E



Note: Future capacity has been calculated based on CY2023 actual installed capacity + annual capacity additions projected by IEA till CY2028

Source: IRENA, IEA, Frost & Sullivan Analysis

In CY2023, global solar capacity additions reached a record 346 GW, up from 199 GW in CY2022, marking a 74% increase. Annual solar capacity additions are projected to grow to 540 GW by CY2028E. Major economies like China, the US, and India are leading this expansion, with plans to double their renewable energy capacity in the next five years. Policies such as the REPowerEU plan and the Inflation Reduction Act in the US support long-term solar investments. Additional policies, including feed-in tariffs and tax incentives, are enhancing the cost-competitiveness of solar energy. This trend is expected to continue, with rising investments in solar PV as it becomes a preferred power source globally.

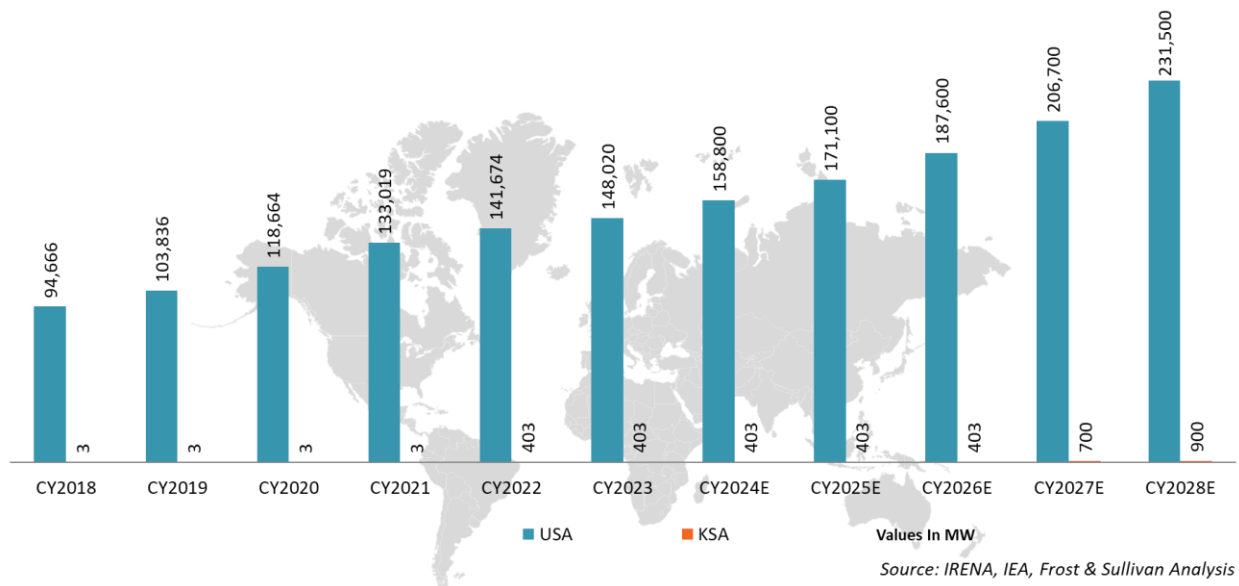
3.4 Global solar and wind energy capacity in USA and KSA

A. Wind Energy

From CY2018 to CY2023, the total wind capacity has grown at a CAGR of 9.4%. This indicates a growing reliance on wind energy as a sustainable power source. This trend is expected to continue, with projected growth rates of 9.4% from CY2023 to CY2028.

- **United States:** Grew at a CAGR of 9.4% from CY2018 to CY2023, with the same growth rate expected through CY2028E.
- **Saudi Arabia:** Noted a dramatic 167% CAGR from CY2018 to CY2023, with a more moderated forecast CAGR of 17% from CY2023 to CY2028E.

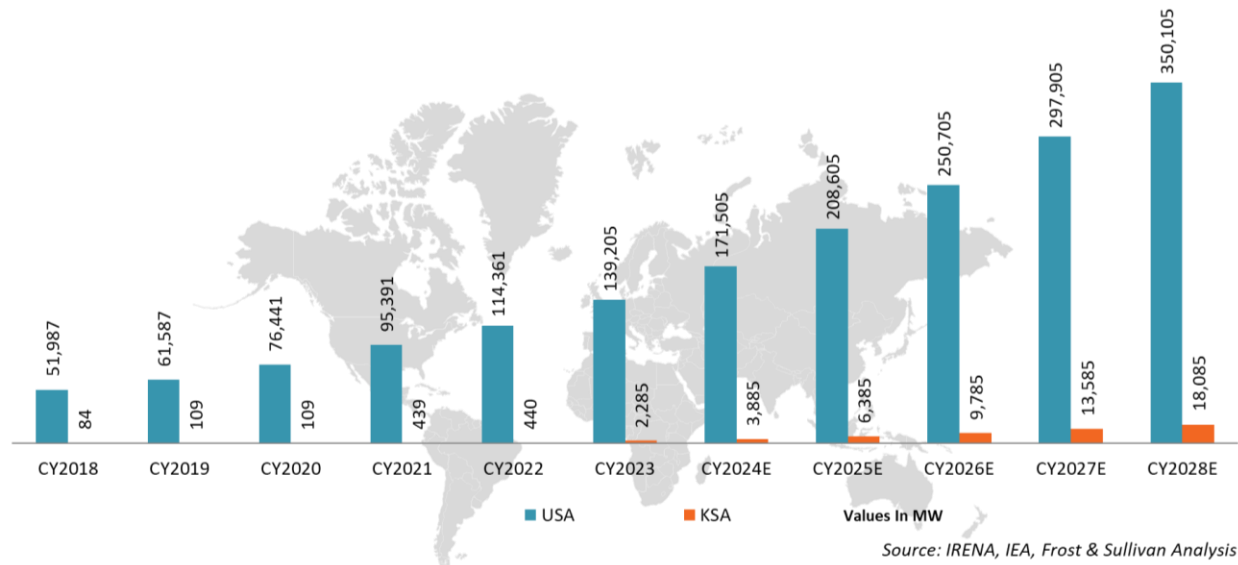
Exhibit 3.6: Wind energy capacity in USA and KSA, in MW, CY2018 - CY2028E



B. Solar Energy

From CY2018 to CY2023, solar capacity in the USA and Saudi Arabia grew at a CAGR of ~22%. Projections indicate continued growth at a CAGR of ~27% from CY2023 to CY2028E. Saudi Arabia led with a CAGR of ~93% during CY2018 to CY2023 and is expected to maintain a CAGR of ~68% through CY2028E. The United States had a CAGR of ~22%, anticipated to rise to ~26%.

Exhibit 3.7: Solar capacity in USA and KSA, in MW, CY2018 - CY2028E



3.5 Drivers of Renewables energy globally

The global landscape for energy production is undergoing a significant shift. Driven by environmental concerns, economic factors, and technological advancements, renewable energy sources are experiencing a surge in growth.

A. Climate Change Concerns and Sustainability Goals:

- **Global Warming Threat:** Human activity, particularly fossil fuel combustion, is identified as the main cause of global warming. The urgency to address climate change and its impacts, such as extreme weather, rising sea levels, and ecological disruption, drives the adoption of renewable energy.
- **International Agreements:** The Paris Agreement, adopted in 2015, aims to limit global warming to well below 2 degrees Celsius, ideally 1.5 degrees Celsius, compared to pre-industrial levels. This agreement has led countries to set renewable energy targets and implement supportive policies.
- **Shifting Public Perception:** Increased public awareness of climate change has led to higher demand for renewable energy and pressure on governments and businesses to adopt sustainable practices.

B. Economic Competitiveness and Cost Reduction:

- **Technological Advancements:** Technological innovation has significantly driven down the costs of renewable energy technologies like solar panels, wind turbines, and geothermal systems. This ongoing cost reduction has made renewable energy more competitive with traditional fossil fuels, particularly when considering long-term operational costs and environmental externalities.
- **Government Subsidies and Incentives:** Many governments around the world offer financial incentives for renewable energy projects. These incentives include feed-in tariffs, tax credits, loan guarantees, and grants. These subsidies help bridge the cost gap between renewable and traditional energy sources, making renewable projects more attractive for investors and developers.
- **Market Diversification and Economies of Scale:** The renewable energy sector has witnessed significant growth, leading to economies of scale. This translates to lower manufacturing costs for

renewable energy equipment and improved efficiency in project development. This further enhances the economic competitiveness of renewable energy across various applications.

C. Energy Security and Independence:

- **Geopolitical Tensions and Fuel Price Volatility:** The global energy market is susceptible to geopolitical tensions and disruptions. Dependence on fossil fuels imported from specific regions can leave countries vulnerable to price fluctuations and supply chain interruptions. Renewable energy sources, particularly those that can be harnessed locally (solar, wind, geothermal), offer greater energy security and independence, reducing reliance on volatile fossil fuel markets.
- **Decentralized Generation:** Renewable energy sources like solar panels and small wind turbines can be deployed on a distributed basis, closer to where the electricity is consumed. This decentralized approach reduces reliance on centralized power grids, which can be vulnerable to disruptions, and allows for a more resilient energy infrastructure.

D. Technological Innovation and Advancements:

- **Efficiency Improvements and Storage Solutions:** Ongoing research and development are continuously improving the efficiency of renewable energy technologies. Additionally, advancements in energy storage solutions like batteries are essential for managing the intermittency of some renewable sources (solar, wind). Improved storage allows for smoother integration of renewables into the grid and helps overcome limitations associated with variable power generation.
- **Smart Grid Integration and Smart Technologies:** Integrating renewable energy sources effectively requires a modernized grid infrastructure. Smart grid technologies enable better communication between energy producers and consumers, facilitating a more efficient and flexible energy system. Additionally, smart technologies like smart meters and demand-side management tools allow for optimized energy usage and grid management.

E. Corporate Sustainability Initiatives and Consumer Demand:

- **Corporate Social Responsibility (CSR):** Many corporations are increasingly adopting sustainability goals and incorporating renewable energy into their operations. This is driven by a combination of factors: reducing their environmental footprint, appealing to environmentally conscious consumers, and potentially lowering energy costs in the long term. As corporations demand more renewable energy, it creates a larger market and further drives up investment in the sector.
- **Consumer Preferences and Green Products:** Consumers are increasingly making purchasing decisions based on sustainability considerations. This shift in consumer behavior creates a market demand for products and services powered by renewable energy. Additionally, the rise of "green" products and services further incentivizes businesses to adopt renewable energy solutions.

3.6 Key Policies Driving Renewable Energy Growth by Country

A. United States (USA)

The USA has a range of policies to promote renewable energy adoption. Key federal tax credits include the Investment Tax Credit (ITC), which provides a tax credit for a portion of solar project costs, and the Production Tax Credit (PTC), which supports wind energy by offering financial incentives for electricity production from renewable sources. Many states have Renewable Portfolio Standards (RPS) that require

utilities to obtain a certain percentage of their electricity from renewable sources by specific deadlines, fostering long-term demand for renewable energy. Additionally, the Department of Energy (DoE) offers loan guarantees to mitigate financial risks associated with large-scale renewable energy projects, encouraging lenders to finance such ventures.

B. Kingdom of Saudi Arabia (KSA)

The Kingdom of Saudi Arabia (KSA) is transitioning towards renewable energy as part of its Vision 2030 plan, which aims to diversify the economy away from oil dependence. Vision 2030 targets 50% of electricity generation from renewable sources by 2030, including 40 GW of solar capacity. The National Renewable Energy Program (NREP) supports this goal with financial incentives such as feed-in tariffs and competitive auctions for project selection. Saudi Aramco is investing in renewable energy projects both domestically and internationally, reflecting a commitment to diversification and sustainability. The 2020 Solar Small-Scale Regulatory Framework governs grid-connected PV systems from 1 kW to 2 MW with a net-billing scheme and a 5 MW aggregate capacity limit per off-taker. The 2022 Self-Consumption Regulatory Framework, issued by the Water and Electricity Regulatory Authority (WERA), covers various renewable technologies and establishes regulatory requirements for both grid-connected and off-grid systems, enhancing consumer protection and efficiency without a specified capacity limit.

4. OVERVIEW OF INDIAN POWER AND SOLAR SECTOR

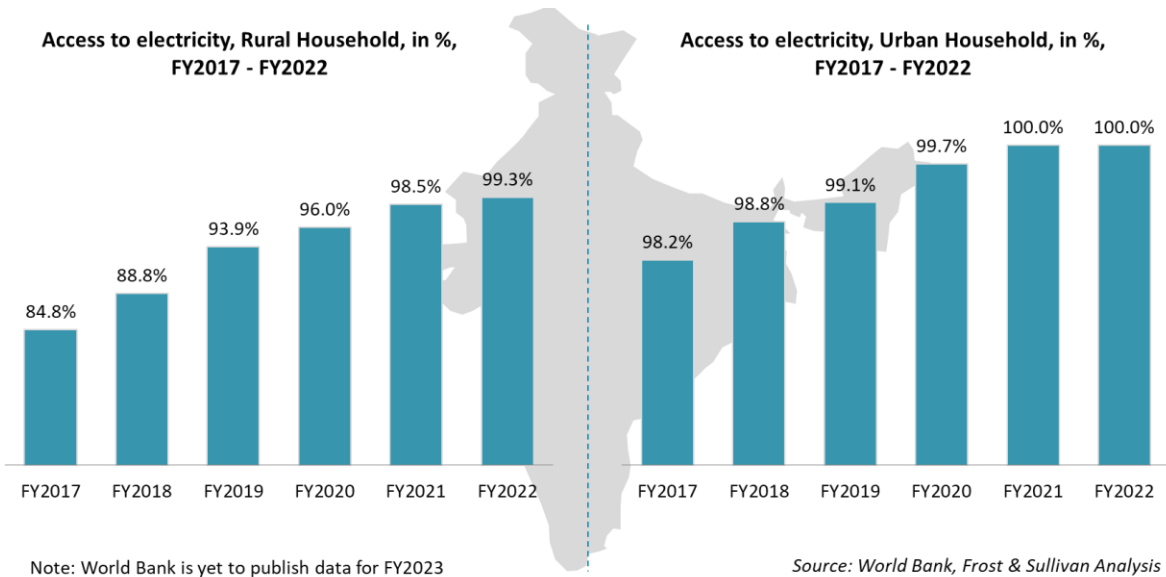
4.1 India is the third largest power producer and consumer globally

By the end of FY2024, India had 442 GW of installed generation capacity, making it the third-largest electricity producer and consumer globally. This capacity is projected to reach 622 GW by FY2028E. India's power generation capacity has increased over 100-fold since independence, driven by rising electricity demand. The country is transitioning from coal to renewable energy, aiming for 500 GW of renewable capacity by CY2030E, including 300 GW from solar. In FY2024, USD 885 million (INR 73,270 million) was allocated to solar projects, including grid-connected and off-grid systems, and the PM-KUSUM program for solar pumps. India also plans to replace 81 coal plants with renewable energy sources by 2026. These efforts reflect a significant shift towards cleaner energy and aim to achieve net-zero carbon emissions.

4.2 Growth in Household electrification in India

Power is crucial for economic growth and welfare. India has moved from a power shortage to a surplus through initiatives such as a single national grid, strengthened distribution networks, and universal household electrification. The Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA) and the Deen Dayal Upadhyay Gram Jyoti Yojana (DDUGJY), launched in October 2017, targeted universal electrification. By the end of FY2022, these programs had electrified 100% of urban households and 99.3% of rural households. To address remaining households, the Revamped Distribution Sector Scheme (RDSS) provides INR 3,038 billion in outlay and INR 976 billion in gross budgetary support from FY2022 to FY2026. RDSS focuses on sub-transmission and distribution network improvements and supports the electrification of Particularly Vulnerable Tribal Groups (PVTG) under PM-JANMAN, INR 8.1 billion has been allocated under RDSS to electrify ~5 lakh households in Uttar Pradesh, Rajasthan, and Andhra Pradesh. Additionally, PM-JANMAN has sanctioned on-grid electrification for 87,863 households across 7,113 habitations.

Exhibit 4.1: Access to electricity, in % of household, Rural and Urban India, FY2017 – FY2022



4.3 Growth in installed Power generation capacity in India

As of FY2024, India's installed power generation capacity stands at a robust 442 GW. The government's ambitious plan to add 309 GW by FY2030E, bringing the total to 751 GW, is a testament to its commitment to energy independence and sustainability. A remarkable 65% of this additional capacity is slated to come from solar power, signalling a significant shift away from traditional fossil fuels. India's solar energy landscape has witnessed a meteoric rise. Solar capacity has nearly tripled from 28 GW in FY2019 to 82 GW in FY2024. This impressive growth is set to continue, with projections reaching 243 GW by FY2029E and a staggering 280 GW by FY2030E. This ambitious solar expansion will have a profound impact on India's energy mix. By FY2028E, solar's share is expected to surpass 37%, while coal's share will decline to approximately 39%. This transition not only underscores India's commitment to clean energy but also highlights the increasing role of renewables in meeting the nation's growing energy demands.

Exhibit 4.2: All India installed power generation capacity by fuel sources, GW, FY2018 – FY2030E

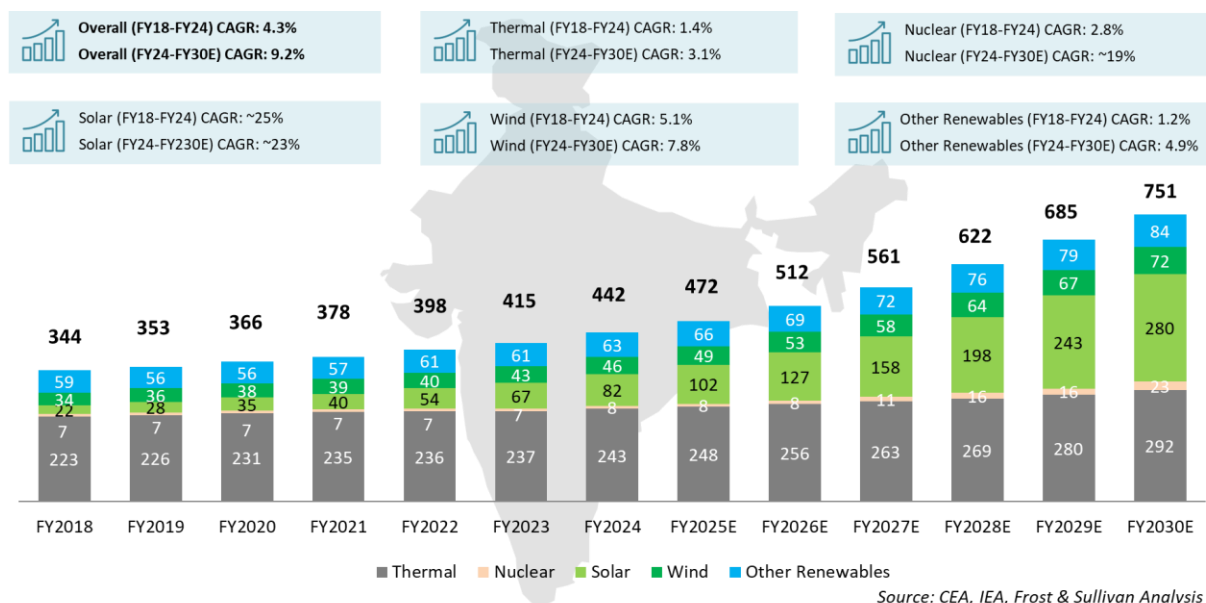
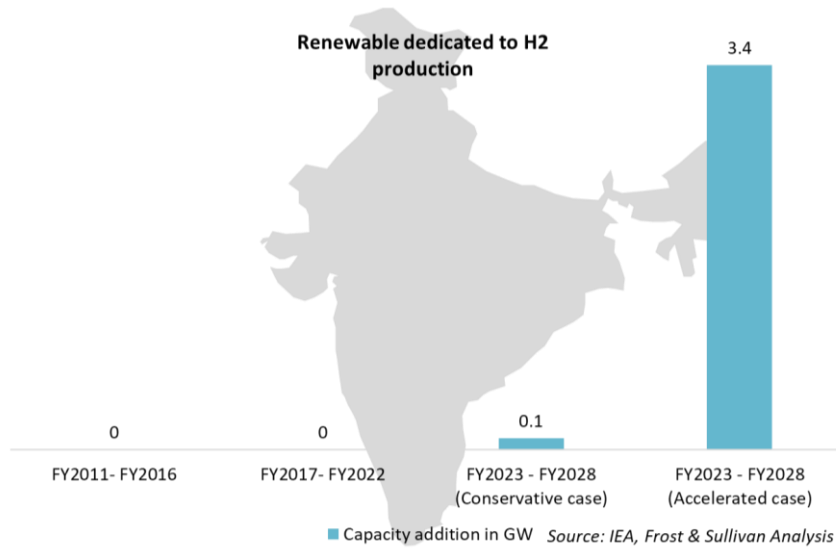


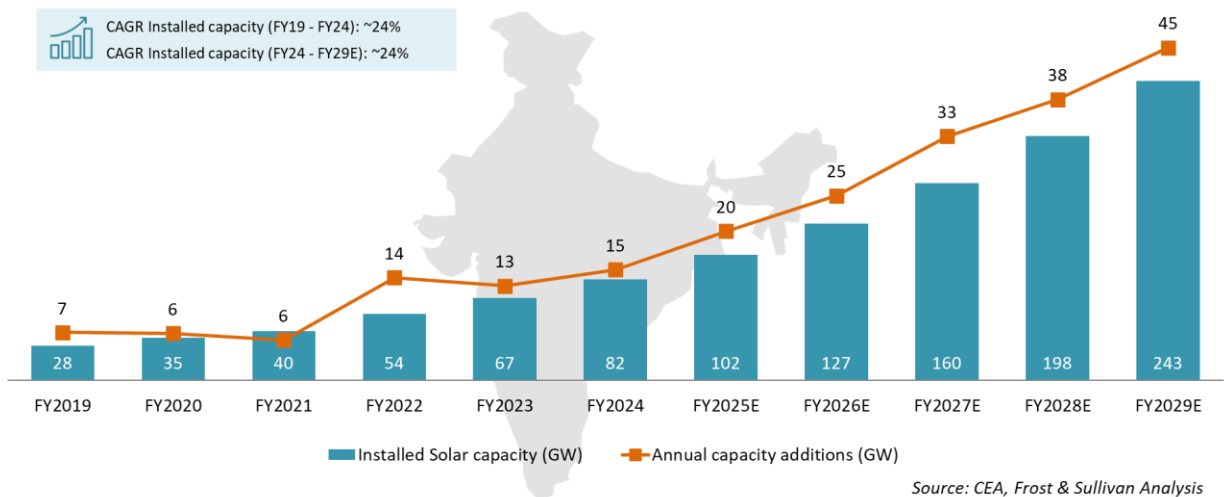
Exhibit 4.3: Renewable dedicated to H2 production, GW, FY2011 – FY2028E



From CY2000 to CY2040, the USA's energy landscape has seen significant changes. In CY2000, coal was the leading source with 312 GW, but its capacity fell sharply to 39 GW by CY2040 due to regulatory and economic shifts towards cleaner energy. Gas capacity grew from 251 GW to 504 GW, driven by domestic natural gas availability and advancements in technology.

Hydro capacity remained stable, increasing from 99 GW to 115 GW, reflecting its mature development. Oil-based capacity declined from 83 GW to 15 GW as the sector moved away from high-cost and environmentally impactful oil.

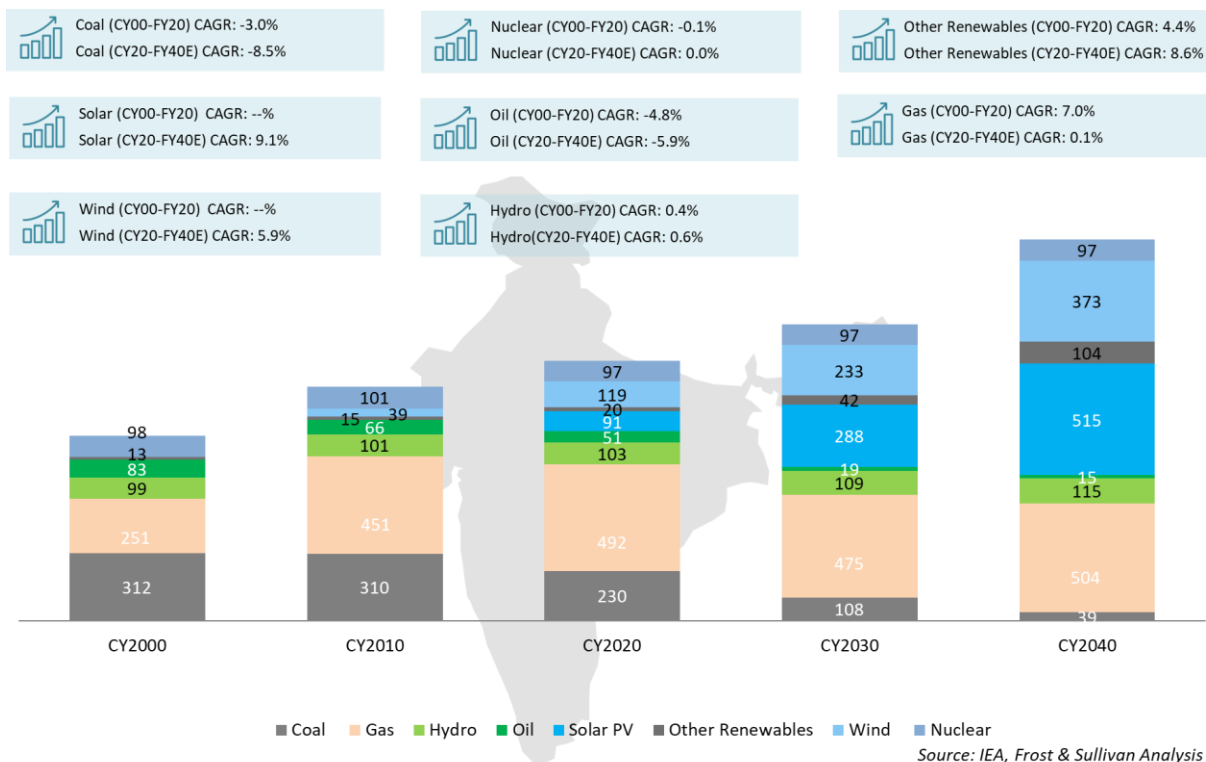
Exhibit 4.4: Growth in Solar installed capacity, India, GW, FY2019 – FY2029E



Solar PV saw exponential growth, rising from 0 GW to 515 GW, fueled by falling costs and strong incentives. Other renewables, including biomass and geothermal, grew from 13 GW to 104 GW. Wind capacity also expanded significantly, from 0 GW to 373 GW, thanks to technological advances and favorable policies. Nuclear capacity remained stable, fluctuating slightly around the 97-101 GW range from CY2000 to CY2040. This stability reflects both the challenges of new nuclear development and the longevity of existing nuclear plants, which continue to provide a substantial share of the country's carbon-

free electricity. These capacity additions reflect the USA's strategic shift towards a more sustainable and diverse energy mix, driven by technological advancements, economic considerations, and regulatory frameworks aimed at reducing greenhouse gas emissions and enhancing energy security.

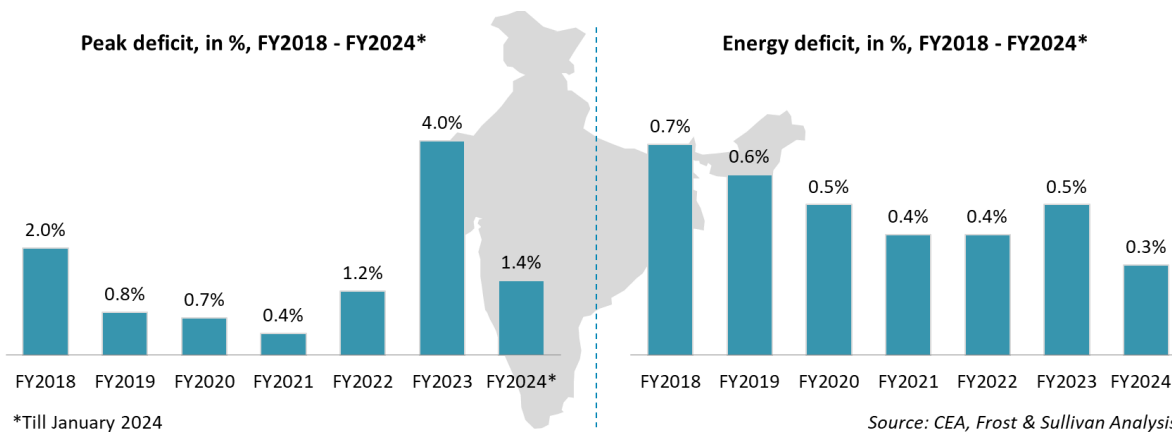
Exhibit 4.5: USA installed power generation capacity by fuel sources, GW, FY2000 – FY2040E



4.4 Overview of Power demand-supply scenario in India

India's peak power deficit improved from ~17% in FY2008 to 0.4% in FY2021 but rose to 1.2% in FY2022 and 4.0% in FY2023 due to a surge in electricity demand and insufficient capacity additions. As of January FY2024, the peak deficit has reduced to 1.4%.

Exhibit 4.6: Peak deficit and Energy deficit in India, in %, FY2018 – FY2024



To address future deficits, the government plans to add 88 GW of baseload thermal power to meet peak demands of 295 GW by FY2028E and 366 GW by FY2032E. Additionally, converting renewable energy plants to round-the-clock (RTC) plants is expected to help manage deficits. Energy deficit on the other

hand has shown a more consistent trend and remained within 0.4% - 0.7% between FY2018 – FY2023. The energy requirement of the country in FY2023 was 1,513 billion units and the country’s power generating stations and grid were able to supply 1,506 billion units. The energy deficit has further gone down to 0.3% in the first 10 months of FY2024.

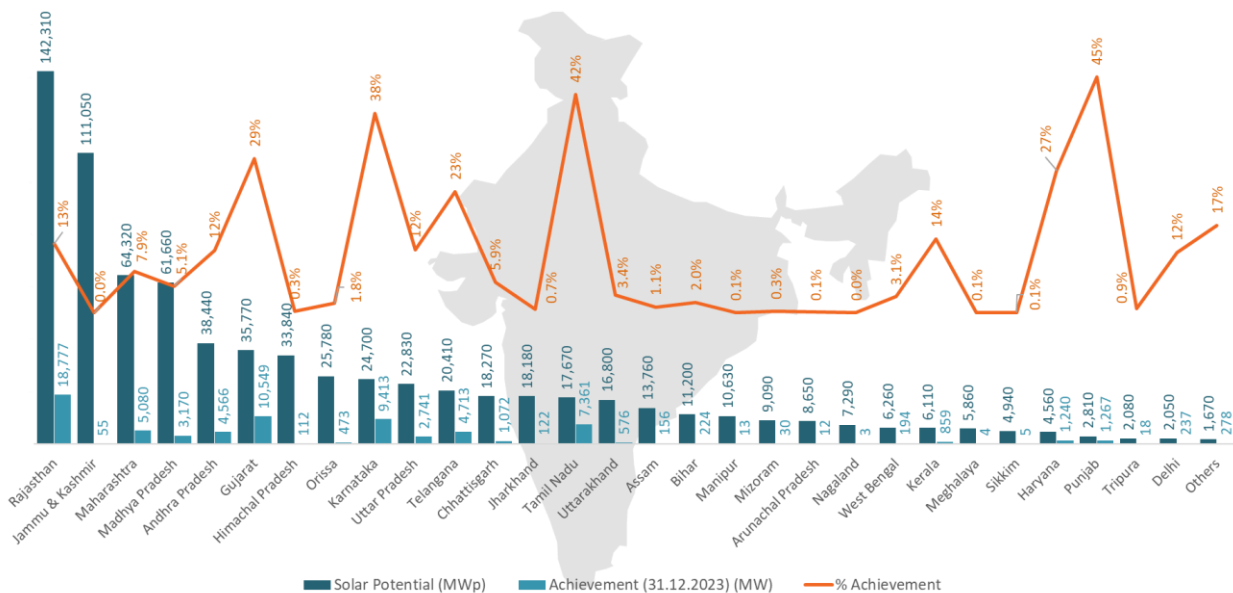
4.5 Factors that will drive electricity demand in India

India’s electricity demand is set to rise significantly due to urbanization and industrialization. By CY2040, an additional 270 million people are expected to join the urban population, increasing residential floor space to over 50 billion square meters. This will drive higher electricity use for appliances and amenities. Industrial growth, fueled by initiatives like ‘Make in India,’ the PLI scheme, and Aatmanirbhar Bharat Abhiyaan, will boost energy consumption, with the industrial sector’s share of energy use projected to rise from 36% to 41% by CY2040E. The expansion of EV charging infrastructure, with a target of 10,000 public stations by CY2025 and 2 million by CY2030, will add 4-5 billion units of electricity demand. Additionally, the National Hydrogen Mission aims to produce 5 MMT of green hydrogen by CY2030, requiring INR 8 trillion investment and 125 GW of renewable energy.

4.6 India’s Solar power generation potential

India has substantial solar energy potential with approximately 5,000 trillion kWh of solar energy incident annually, offering 4-7 kWh per square meter per day. The National Institute of Solar Energy estimates a potential of about 748 GWp, assuming 3.0% of wasteland is covered with Solar PV modules. As of December 2023, India has utilized around 10% of this potential, with a total installed capacity of 73 GW. Key states contributing to solar capacity include Rajasthan, Gujarat, Karnataka, Tamil Nadu, and Maharashtra, accounting for 70% of the total capacity added. In terms of potential utilization, Punjab leads at ~45%, followed by Tamil Nadu (~42%), Karnataka (~38%), Gujarat (~30%), and Haryana (~27%).

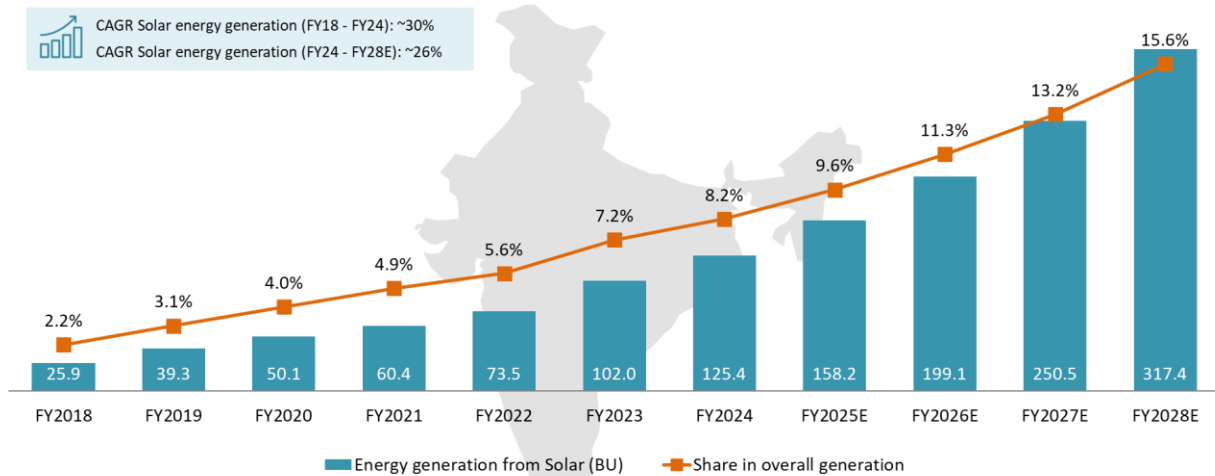
Exhibit 4.7: State-wise Solar energy potential and achievement at the end of December 2023



4.7 Electricity generation from Solar energy

Electricity generation from Solar energy has grown fourfold between FY2018 and FY2023 to cross the 100 BU milestone.

Exhibit 4.8: Growth in Solar energy generation, India, Billion Units (BU), FY2018 – FY2028E



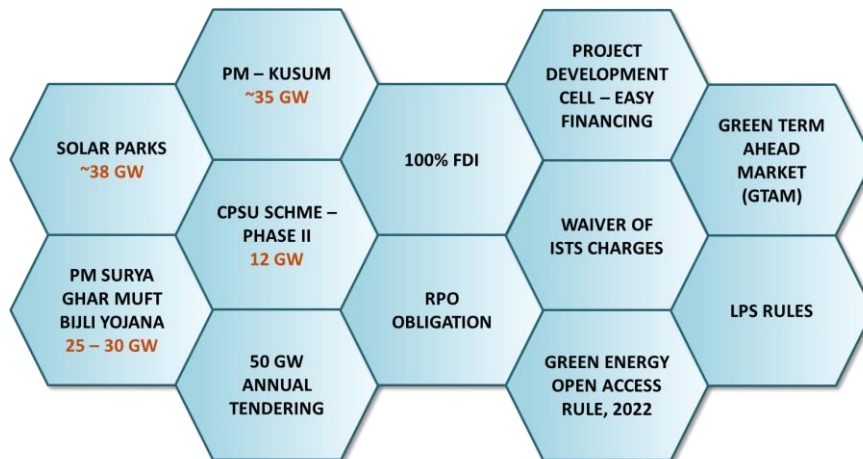
Source: CEA, Frost & Sullivan Analysis

The share of Solar in the country’s overall generation has increased from 2.2% to 7.2% during this period. As the country is gearing for capacity addition at an accelerated pace, Solar energy generation is expected to cross 300 BU by FY2028E – accounting for more than 15% share in overall generation.

4.8 Policy initiatives to drive the Solar sector in India

In recent years, the Indian government has implemented various measures to boost the solar power sector. On the demand side, schemes have been introduced to support the goal of achieving 300 GW of installed solar capacity by CY2030. On the supply side, policies have been enacted to attract investment in domestic solar manufacturing and protect local manufacturers from competition with Chinese and Southeast Asian companies. A brief description of some of the notable demand side measures has been provided below:

Exhibit 4.9: Demand side measures for the promotion of Solar energy in the country

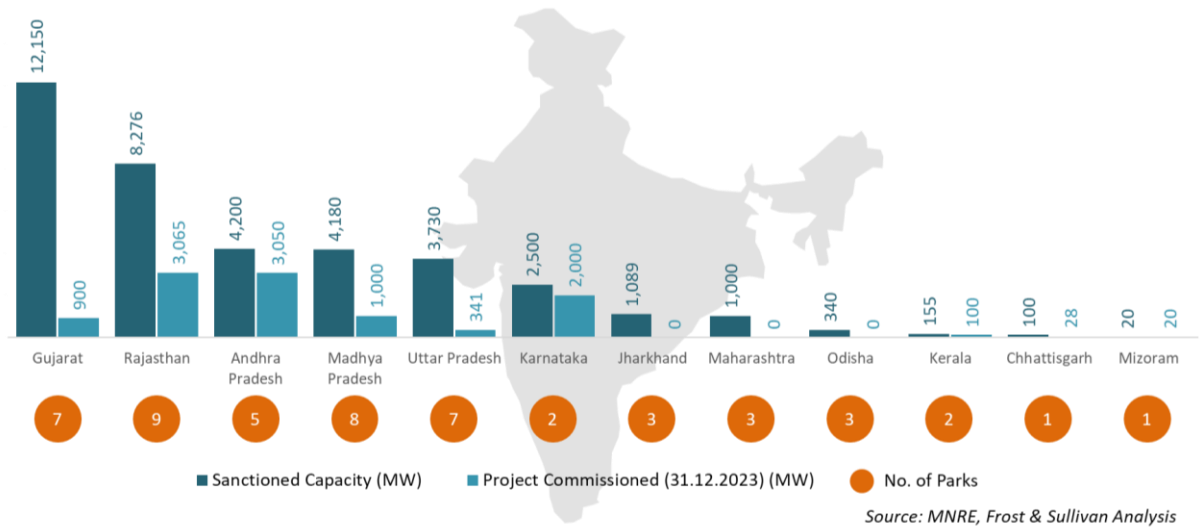


Source: Frost & Sullivan Research & Analysis

A. Solar Parks – ~38 GW

This scheme underscores India's commitment to solar energy, aiming to establish 51 Solar Parks each of 500 MW and above by 2025-26, with a cumulative capacity of ~38 GW.

Exhibit 4.10: State-wise Solar Park sanctioned capacity and commissioned capacity, MW, December 2023



These parks will serve as pivotal hubs for solar energy generation, stimulating investments and fostering an environment conducive to solar power development, thereby enhancing affordability and accessibility. Till the end of December 2023, approx. ~11 GW of solar projects have been commissioned under this scheme.

B. PM Surya Ghar Muft Bijli Yojana: 25-30 GW

With an allocation of over INR 750 billion, the scheme provides capital subsidies to install rooftop solar panels and offers up to 300 units of free electricity per month to about 10 million households. Its goal is to reduce household electricity costs, promote sustainable energy practices, and decrease reliance on traditional energy sources. The scheme requires the use of Domestic Content Requirement (DCR) solar modules. The government has proposed to provide the below subsidies for the implementation of this programme:

- For up to 2 kW - INR 30,000 per kW
- For additional capacity up to 3 kW - INR 18,000 per kW
- Total subsidy for systems larger than 3 kW - Maximum INR 78,000

As per Frost & Sullivan analysis, this scheme is expected to generate 25–30 GW of rooftop solar installation opportunities over the next 2-3 years.

C. PM-KUSUM Scheme – ~35 GW

The Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) aims to reduce diesel use in farming, enhance water and energy security, increase farmer income, and reduce pollution. It targets adding ~35 GW of solar power by March 2026 with a central financial support of INR 344 billion. The three components of the scheme are:

- **Component A:** Setting up of 10,000 MW of decentralized ground/stilt mounted solar power plants on barren/fallow/pasture/marshy/cultivable land of farmers. Such plants can be installed by individual farmer, solar power developer, cooperatives, panchayats, and farmers producer organizations.
- **Component B:** Installation of 1.4 million stand-alone Solar Water Pumps in off-grid areas.

- **Component C:** Solarization of 3.5 million grid connected agriculture pumps through (i) Individual Pump Solarization and (ii) Feeder Level Solarization.

Exhibit 4.11: Targets and Achievements under PM-KUSUM, June 2024

COMPONENTS	SANCTIONED	INSTALLED (30.06.2024)
COMPONENT A (MW)	8,112	256.78
COMPONENT B (NOS.)	1,354,315	397,437
COMPONENT C (NOS.)	IPS – 161,640 FLS – 3,383,966	IPS – 2,644 FLS- 10,918

Source: MNRE, Frost & Sullivan Analysis

Solar water pumps use solar energy to pump water, offering a clean, efficient alternative to diesel-powered systems. They reduce carbon footprints, require minimal maintenance, and are offered by companies like Premier Energies, which manufactures the solar modules while sourcing pumps externally.

D. CPSU Scheme – Phase II – 12 GW

The CPSU Scheme Phase-II, also known as the Government Producer Scheme, is a significant initiative from the Indian government to promote domestic solar power generation and enhance energy security. The key features of this scheme are:

- **Financial Assistance:** The scheme offers Viability Gap Funding (VGF) of up to INR 7 million per MW to incentivize participation and address project cost viability concerns.
- **Capacity Target:** The scheme initially aimed to develop a total of 12,000 MW of grid-connected solar power capacity through plants set up by the eligible entities. While the deadline for the project commissioning has already passed, the scheme continues to be operational for unallocated projects.
- **Implementation:** The scheme is implemented through a competitive bidding process managed by the Solar Energy Corporation of India (SECI). Eligible entities can submit proposals for setting up solar power plants, and SECI selects the most competitive proposals based on pre-defined criteria.

With government initiatives like the PM-KUSUM, PM-Surya Ghar Muft Bijli Yojana, and the CPSU scheme in play, there is an emphasis on utilising DCR solar modules within the domestic solar market. Along with these demand-side measures; the Indian government has also initiated a number of initiatives to strengthen the domestic Solar manufacturing industry. A brief description of some of the notable supply-side measures have been provided below:

E. Production Linked Incentive (PLI)

The Indian Govt. has implemented Production Linked Incentive (PLI) Scheme for the national programme on high efficiency Solar PV modules, for achieving manufacturing capacity of Giga Watt (GW) scale with an outlay of INR 240 billion. The scheme offers incentives to the selected Solar PV module manufacturers on manufacture and sale of high efficiency Solar PV modules. The scheme is applicable for the first five years from the actual commissioning date or from the scheduled commissioning date, whichever is earlier. The objectives of the scheme include the following:

- To build up Solar PV manufacturing capacity of high-efficiency modules.

- To bring cutting-edge technology to India for manufacturing of high efficiency modules. The scheme will be technology agnostic, however the technologies that would yield better module performance will be incentivized.
- To promote setting up of integrated plants for better quality control and competitiveness.
- To develop an ecosystem for sourcing of local materials involved in the solar manufacturing industry.
- Employment generation and technological self-sufficiency.

F. 50 GW Annual Tendering

India's renewable energy push is receiving a major boost with the "MNRE - 50 GW bidding every year" initiative. This ambitious policy aims to significantly increase solar power generation capacity by setting a fixed annual target of 50 GW for bidding rounds. This predictable schedule fosters investor confidence and potentially leads to lower solar power prices through competition. The policy is expected to accelerate solar capacity growth, enhancing energy security, and creating new jobs. With 80% of the annual target focused on solar, this initiative represents a major leap forward in India's journey towards a cleaner and more secure energy future fueled by the sun.

G. 100% Foreign Direct Investment (FDI)

The Government of India's Foreign Direct Investment (FDI) policy allows up to 100% FDI in renewable energy projects, including solar power generation and distribution. Under the Automatic Route, the non-resident investor or the Indian company does not require any approval from Government of India for the investment.

H. RPO Obligation

The declaration of trajectory for Renewable Purchase Obligation (RPO) up to the year FY2030 is a key policy implemented by the Indian government to promote renewable energy, specifically focusing on solar power. The declaration defines a gradual increase in the RPO percentage for each state over the years until FY2030 and imposes penalty in case of non-compliance. This provides clarity and certainty for investors and developers in the renewable energy sector, allowing them to plan their investments with confidence. By creating a guaranteed market, the RPO encourages developers to invest in solar and other renewable projects, leading to an increase in generation capacity. Diversifying the energy mix by increasing the share of renewables reduces dependence on imported fossil fuels and enhances energy security.

I. Project Development Cell

The Project Development Cell (PDC) aids investors in entering the Indian solar power market. It provides information on solar policies, investment opportunities, and regulatory processes, and supports land acquisition and grid connectivity. The PDC also conducts investor outreach through conferences and roadshows, facilitates project financing, and connects investors with developers and consultants. It advocates for the solar sector and addresses investor concerns with government bodies.

J. Waiver of ISTS charges

In March 2023, the Central Electricity Regulatory Commission (CERC) amended the CERC (Sharing of Inter-State Transmission Charges and Losses) Regulations, 2020. This amendment waives ISTS charges for

renewable energy and pumped hydroelectric projects that begin commercial operations by June 30, 2025. The waiver also applies to any solar, wind, or other sources eligible for waiver of inter-state transmission charges, which are scheduled to be commissioned on or before June 30, 2025.

K. Green Energy Open Access Rules, 2022

Green Energy Open Access Rules, 2022 (Green Open Access Rules) is a policy aimed at facilitating the purchase of renewable energy by large consumers directly from generators, bypassing the traditional distribution network.

Key Provisions of the rules are:

- **Minimum Consumption Threshold:** Only large consumers with a minimum contract demand or sanctioned load (typically 100 kW or more) can avail of Green Open Access.
- **Streamlined Process:** The rules aim to simplify the process for obtaining approvals and entering into agreements for direct purchase of renewable energy.
- **Green Certificates:** Consumers who purchase renewable energy through Green Open Access are eligible for green certificates, which can be used to meet their Renewable Purchase Obligation (RPO).

Benefits for Solar Power are:

- **Increased Demand:** By creating a new market segment for large consumers, the policy can significantly increase demand for solar power.
- **Economic Advantages:** Large consumers might benefit from potentially lower prices through direct purchase and avoid some distribution charges.

L. Green Term Ahead Market (GTAM)

The Green Term Ahead Market (G-TAM) is a platform that allows bulk buyers of electricity to purchase renewable energy (RE) on a short-term basis. The G-TAM allows buyers such as corporates and discoms with a contracted load of 1 MW or more to purchase RE from sellers such as merchant RE projects or discoms with surplus RE. The G-TAM features contracts such as Green-Intraday, Green-Day-ahead Contingency (DAC), Green-Daily and Green-Weekly. The GTAM enables transactions between buyers and sellers through bilateral trading. There are four types of short-term contracts that are covered under the GTAM – Intra-day contracts, Day-ahead contracts, Daily contracts, and Weekly contracts.

M. LPS Rules (Late Payment Surcharge)

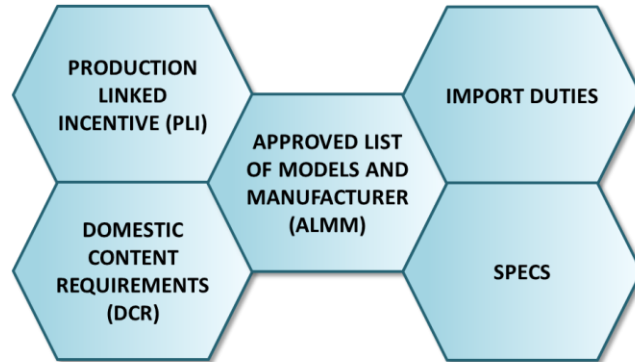
The Electricity (Late Payment Surcharge and Related Matters) Rules, 2022 (LPS Rules) aim to tackle delayed payments by Discoms (distribution companies) to generators and transmission companies. Additionally, the rules establish a clear timeline for settling outstanding dues, promoting transparency in billing and payments. This not only improves cash flow for all stakeholders but also minimizes disputes and creates a more predictable environment for investment, ultimately benefiting solar power producers by ensuring timely payments and potentially attracting further investment in the sector.

The PLI Scheme is being implemented in two tranches as follows:

- **Tranche-I:** Under this tranche, Indian Renewable Energy Development Agency Limited (IREDA), the implementing agency on behalf of MNRE for the PLI Scheme, issued Letters of Award (LOA) in November and December 2021 to three successful bidders for setting up of 8,737 MW capacity of fully integrated Solar PV Module manufacturing units with an outlay of INR 45 billion.

- **Tranche-II:** MNRE, on 30th September 2022, issued guidelines for implementation of Tranche-II with an outlay of INR 195 billion. In this tranche, Solar Energy Corporation of India (SECI), the implementing agency on behalf of MNRE, issued Letters of Award (LOA) to 11 bidders in April 2023 for setting up 39,600 MW of fully / partially integrated solar PV module manufacturing units.

Exhibit 4.12: Supply side measures to strengthen domestic Solar manufacturing industry



Source: Frost & Sullivan Research & Analysis

N. Domestic Content Requirement (DCR)

The Domestic Content Requirement (DCR) policy in India mandates that a certain percentage of components, including solar cells and modules, used in government-funded solar projects must be sourced from domestic manufacturers. This percentage is set to increase from 40% to 55% over the coming years, with incremental increases each year: 45% for projects starting in CY2025, 50% in CY2026, and 55% thereafter.

The DCR policy aims to stimulate domestic manufacturing, create jobs, and reduce dependence on imports by guaranteeing a market for locally produced solar components. It also helps domestic manufacturers by reducing competition from cheaper imported components, allowing them to establish themselves and benefit from economies of scale and technological advancements. Additionally, the policy encourages investment in research and development (R&D), fostering technological innovation and enhancing the global competitiveness of Indian manufacturers.

The policy applies to grid-connected solar power plants, rooftop solar installations on government buildings, and off-grid solar solutions. In August of the previous year, the Ministry waived DCR requirements for projects awarded before June 20, 2023. To further ensure adherence to DCR, the Indian government plans to set up a data repository to monitor compliance and curb imports.

O. Approved List of Models and Manufacturers (ALMM)

The ALMM program establishes a pre-approved list of reliable solar photovoltaic (PV) modules and cell manufacturers. This program ensures quality and efficiency of solar installations in India by requiring developers and investors to source their equipment from ALMM-listed vendors. By promoting high-quality domestic and imported products, ALMM fosters trust and encourages the adoption of reliable solar solutions throughout the country. The ALMM policy was introduced in April 2022 and after being under suspension for FY2024, the policy is again in effect from April 1, 2024. As per the latest list published by MNRE, the ALMM list still does not mention any foreign manufacturer. The ALMM program, by ensuring that solar photovoltaic (PV) modules and cell manufacturers meet high-quality standards,

indirectly benefits fixed tilt solar structural component manufacturers. Since the program requires developers and investors to source equipment from ALMM-listed vendors, it promotes the use of reliable and efficient solar products. This focus on quality encourages the deployment of solar installations, including fixed tilt structures, which are commonly used in such projects. Additionally, with the exclusion of foreign manufacturers from the current ALMM list, there is likely to be an increased demand for domestically produced modules and, consequently, for locally manufactured fixed tilt structural components that support these installations.

P. Import Duties

Customs Duty Exemptions: Exemptions on basic customs duty (BCD) have been introduced for machinery and equipment used in the manufacturing of solar cells and modules, aimed at reducing costs for manufacturers. Additionally, the BCD exemptions for goods used in the production of silicon wafers, EVA sheets, and photovoltaic ribbons have been extended until March 31, 2026. Similar exemptions have also been granted for parts and raw materials required for the manufacturing of lithium-ion cells and batteries, with the extension running until the same date, March 31, 2026.

New Customs Duties: A 10% basic customs duty (BCD) on solar glass and a 5% BCD on tinned copper interconnects for solar cells and modules will come into effect from October 1. Additionally, the customs duty exemption on active energy controllers for renewable power inverters is set to expire on September 30. In support of renewable energy efforts, an allocation of INR 6,250 crore has been made for the PM Suryaghar Muft Bijli Yojana, which aims to install rooftop solar systems and provide free electricity up to 300 units for 1 crore households.

4.9 International policies aiding export of Indian solar PV

The Indian solar Photovoltaic (PV) industry is experiencing a significant growth spurt, and international policy changes are playing a key role in propelling this momentum. Following is a breakdown of how specific international policies from the US and China are impacting Indian solar PV component exports:

A. United States Inflation Reduction Act (IRA):

- **Policy Overview:** The IRA, a landmark piece of US legislation enacted in August 2022, aims to combat climate change and boost domestic clean energy manufacturing. It includes several provisions that can incentivize the import of solar PV components from countries like India.
- **Impact on Indian Exports:**
 - **Tax Credits:** The IRA extends and expands tax credits for renewable energy projects, including solar installations. This increased demand for solar in the US market creates a significant opportunity for Indian solar component manufacturers.
 - **Importer Neutrality:** The IRA removes existing tariffs on solar cells and modules from certain Southeast Asian countries. However, it maintains a technology-neutral approach, meaning Indian manufacturers can compete based on price and quality.
 - **Focus on Domestic Manufacturing:** While the IRA incentivizes domestic manufacturing within the US, it doesn't explicitly exclude imports. Indian manufacturers can leverage their cost competitiveness and established production capacity to cater to the growing US solar market.

- **Commentary on Solar tracking and mounting products:** The specific impact on Indian exports of solar tracking and mounting products (e.g., mounting systems, racking) is less clear at this stage. The IRA primarily focuses on solar cells and modules. However, the overall growth of the US solar market due to the IRA could indirectly lead to increased demand for solar tracking and mounting products as well.

B. China + 1 Strategy:

- **Policy Overview:** This is not a specific policy but rather a broader strategic shift by some countries, particularly in Southeast Asia, to diversify their supply chains away from a heavy reliance on China. This creates an opportunity for Indian manufacturers to fill the gap.
- **Impact on Indian Exports:** The China + 1 strategy presents a significant opportunity for Indian solar PV component manufacturers. As companies look to diversify their sourcing, India, with its established manufacturing base and competitive production costs, emerges as a viable alternative.

4.10 Indian Wind Power Sector

India boasts a robust domestic wind power industry that has consistently driven sector expansion. This growth has fostered a strong ecosystem, honed project operation capabilities, and established a robust manufacturing base with a capacity of approximately 15,000 MW annually. As a testament to this success, India currently ranks fourth globally in terms of installed wind energy capacity.

The government actively promotes wind power projects nationwide by attracting private sector investment through various fiscal and financial incentives. Examples include accelerated depreciation benefits and concessional customs duty exemptions on specific wind turbine components. Notably, the Generation Based Incentive (GBI) Scheme was previously available for wind projects commissioned before March 31st, 2017.

A. Potential for wind energy in India by states (in GW)

To identify suitable locations for wind farms, the Indian government has established a network of over 900 wind-monitoring stations and published wind potential maps at various elevations through the National Institute of Wind Energy (NIWE). Current assessments show a gross wind power potential of 696 GW at 120 meters and 1,164 GW at 150 meters above ground. This potential is concentrated in eight particularly windy states.

Exhibit 4.11: Potential for wind energy in India

STATE	WIND POTENTIAL AT 120M (GW)	WIND POTENTIAL AT 150M (GW)
Andhra Pradesh	75	123
Gujarat	143	181
Karnataka	124	169
Madhya Pradesh	15	55
Maharashtra	98	174
Rajasthan	128	284
Tamil Nadu	69	95

Telangana	25	55
Total 8 windy states	677	1,137
Others	19	27
Total	696	1,164

B. Tapping the wind energy – Challenges and opportunities

Wind energy has emerged as a critical pillar in India's ambitious clean energy transition. Harnessing the power of the wind holds immense potential to address the nation's growing energy demands while mitigating climate change impacts. However, despite its leadership in renewable energy and a robust domestic wind power industry, India's wind energy sector has encountered headwinds in recent years, hindering its full potential.

Challenges and Obstacles

- **Land Acquisition Hurdles:** Securing large tracts of land for wind farms, especially in densely populated areas, can be time-consuming and costly due to complex approval processes and right-of-way clearances.
- **Transmission Infrastructure Bottlenecks:** Existing power transmission infrastructure often cannot handle large-scale wind power integration, leading to curtailment and reduced investor confidence.
- **Financial Stress of DISCOMs:** Financial difficulties among distribution companies lead to delayed payments to wind power generators, causing cash flow problems and deterring investment.
- **Competition from Falling Solar Costs:** Declining solar PV costs make solar energy more attractive, putting wind energy at a competitive disadvantage, especially in high-solar regions.
- **Uncertainty in Policy Framework:** Frequent policy changes create uncertainty for investors, hindering effective project planning and financing. A stable policy environment is needed for sustainable growth in wind energy.

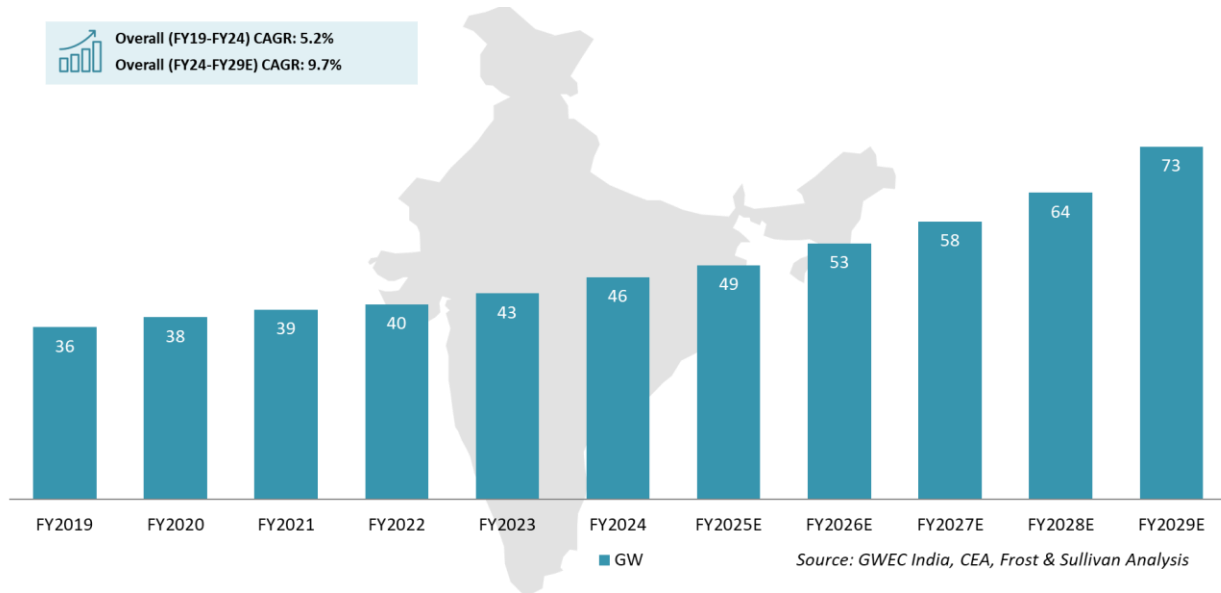
Opportunities: Harnessing the Wind's Power

- **Untapped Wind Power Potential:** India has over 695 GW of untapped wind power potential at 120 meters, offering a significant opportunity for clean energy.
- **Technological Advancements:** Improvements in wind turbine technology and storage solutions enhance efficiency and reduce costs, increasing competitiveness with other renewables.
- **Cost Reduction Strategies:** Optimizing logistics, supply chains, and financing models can improve the viability and competitiveness of wind energy projects.
- **Hybrid Power Solutions:** Combining wind and solar energy in hybrid projects can optimize power generation and enhance grid stability.
- **Job Creation and Economic Growth:** The wind energy sector can generate substantial employment and drive economic growth, especially in rural areas where wind farms are located.

C. India's Wind energy installed capacity

Recognizing the untapped potential of wind power, the Indian government has taken decisive action over the past 1.5 years to revitalize the sector and ensure it plays a more prominent role in the country’s energy mix. Key measures include the introduction of specific carve-outs for Wind Renewable Purchase Obligations (RPOs) and a significant overhaul of the auction mechanism for wind projects, making it more attractive and feasible for developers. Additionally, the government has committed to issuing 10 GW of exclusive tenders annually for wind projects to achieve India’s renewable energy goals. These initiatives are expected to generate substantial momentum, driving the addition of at least 25 GW of new wind capacity by FY2029E. This renewed focus on wind power highlights the sector’s vital role in diversifying India’s energy portfolio and reinforcing the country’s commitment to sustainable energy. As wind energy regains its footing, it is poised to make a significant contribution to India’s transition to a cleaner, more resilient energy landscape, complementing the rapid growth of solar and other renewables.

Exhibit 4.12: Wind energy installed power generation capacity in India, FY2019 – FY2029E



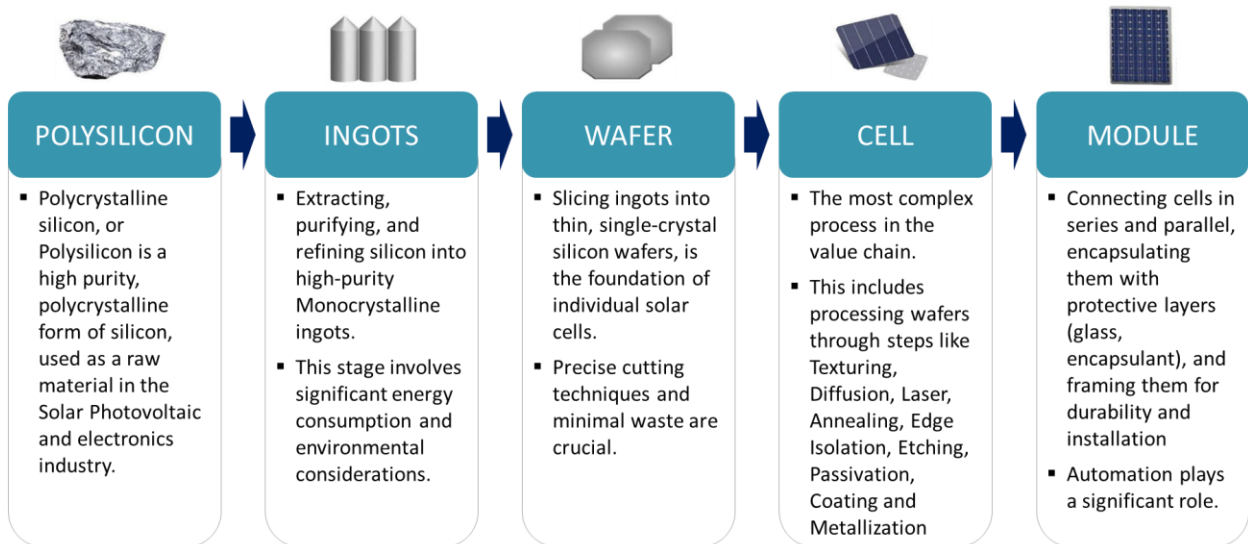
5. EVOLUTION OF SOLAR TRACKER TECHNOLOGY

5.1 Solar cell and module manufacturing processes

The solar PV module manufacturing value chain involves five key processes that convert raw polysilicon into finished solar panels. India's solar industry has made significant progress, with a solar module manufacturing capacity exceeding 60 GW as of FY2024, indicating substantial self-sufficiency.

Solar cell manufacturing, still in its early stages, currently has a capacity of around 8.1 GW, showing promising development. In India, solar module assembly uses advanced automation and efficient techniques to connect and protect solar cells, with some companies fully automating their production lines. Conversely, solar cell manufacturing is more complex and technical, requiring specialized equipment and a skilled workforce. The process involves texturing silicon wafers, creating p-n junctions, and careful monitoring to ensure quality. Due to the high initial investment and the need for a specialized workforce, cell production is less scaled but presents opportunities for technological advancements and strategic development. Overall, while module assembly is well-established, cell manufacturing in India is evolving, with potential for growth and technological innovation.

Exhibit 5.1: Solar Module Manufacturing Process



5.2 Leading manufacturers of Solar cells and modules in India

India's solar manufacturing landscape involves a well-established solar module manufacturing ecosystem and a limited number of solar cell manufacturing companies.

India recently has also taken steps towards self-sufficiency in solar cell manufacturing with the commencement of commercial production of ingots and wafers by the Adani Group. This represents India's first large-scale domestic production of these crucial components. However, it's important to acknowledge that India's presence in this segment remains limited. Adani's initiative could pave the way for other players, but domestic ingot and wafer manufacturing is still in its initial stages highlighting the ongoing dependence on established international producers for a critical part of the solar cell supply chain. Key players in the solar cell and module manufacturing industry in India include Premier Energies, Mundra Solar, Waaree Energies, Renew-Sys, Vikram Solar, Goldi Solar, Jupiter Solar, and Websol. Premier Energies and Mundra Solar boast significant integrated capacities and diverse technology offerings, with Premier Energies specializing in poly-crystalline and mono-crystalline technologies, while Mundra Solar focuses on multi-crystalline, mono PERC, and bifacial modules. Waaree Energies stands out with the largest annual installed module capacity and Renew-Sys is noted for its advanced technology in mono/multi-PERC and bi-facial modules.

Vikram Solar and Goldi Solar have substantial annual installed module capacities, focusing on advanced technologies like mono PERC and multi-crystalline PV cells. Jupiter Solar and Websol, though smaller in scale, offer integrated capacities and specialize in both mono-crystalline and poly-crystalline technologies, with Websol also utilizing advanced techniques like PECVD and TOPCon. These companies collectively drive innovation and capacity in India's solar manufacturing sector

India's Solar Module installed manufacturing capacity reached approximately 72 GW at the end of FY2024. However, the country has an installed capacity of around 8.1 GW for solar cells at the end of FY2024. The domestic companies increasingly focusing on backward integration and setting up integrated manufacturing facilities. Premier Energies emerged as a major player in the Indian Solar PV manufacturing sector, having an integrated Cell and Module manufacturing capacity of 2.0 GW.

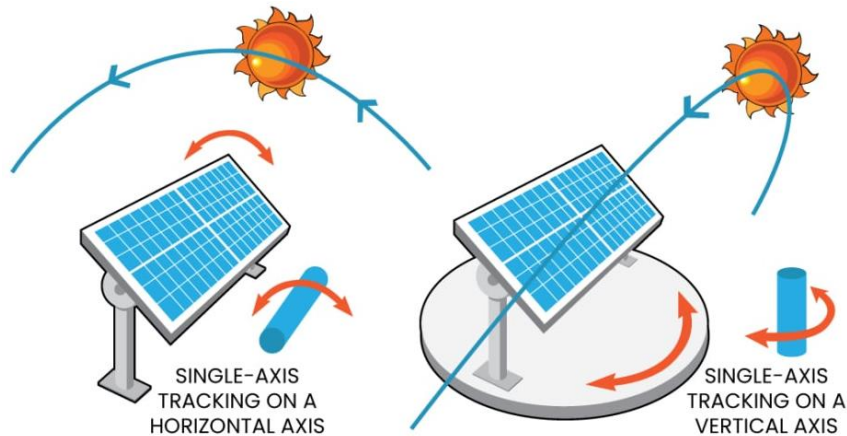
5.3 Introduction to Solar Tracker Technology

In the pursuit of maximizing solar energy capture, photovoltaic (PV) technology has taken a significant leap forward with the introduction of solar trackers. The trackers dynamically adjust the position of solar panels throughout the day, mimicking the sun's apparent movement across the sky. This strategic reorientation significantly boosts energy production compared to fixed-tilt mounting systems, where panels remain static at a predetermined angle. Solar trackers represent a crucial innovation, offering a powerful tool to optimize solar energy capture and increase overall electricity generation from PV systems.

A. Single-axis trackers

Single-axis solar trackers employ a robust mechanism to optimize solar energy capture. A dedicated tracking mechanism, such as a rack and pinion system or a screwdriver, physically adjusts the tilt of the photovoltaic (PV) panels throughout the day. Sophisticated sensors, including solar trackers or light position sensors, continuously monitor the sun's position.

Exhibit 5.2: Pictorial representation of Single-axis trackers



The control system acts as the central processing unit, interpreting sensor data and calculating the optimal panel tilt angle to maximize sunlight capture. This calculation can be based on pre-programmed algorithms or real-time sun-tracking data. The control system then transmits precise commands to the tracking mechanism, ensuring the panels maintain a near-perpendicular angle to the sun's rays as it traverses the east-west arc. This dynamic optimization significantly minimizes the angle of incidence, maximizing sunlight capture and leading to a substantial increase in energy production compared to fixed-tilt mounting systems.

B. Dual-axis trackers

Dual-axis solar trackers represent the benchmark of optimization in solar energy capture technology. Unlike their single-axis counterparts, these sophisticated systems boast the ability to adjust the panels on both the east-west and north-south axes.

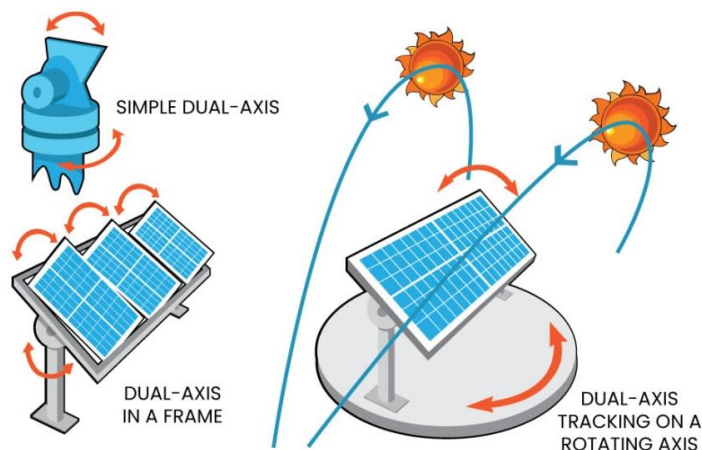
This comprehensive movement allows for unparalleled precision in maintaining a near-perpendicular angle to the sun's rays throughout the day, regardless of the season or time of day.

Dual-axis trackers use a sophisticated mechanism, often involving screwdrivers or hydraulic systems, to adjust solar panels on both horizontal and vertical axes. Light position sensors continuously monitor the

sun's location. The control system processes this data in real-time to determine optimal tilt angles, ensuring panels are always positioned to maximize sunlight exposure.

This dual-axis adjustment enhances energy production by 5%-10% more than single-axis trackers by maintaining optimal panel orientation throughout the day. However, this increased efficiency comes with higher initial costs and potentially more frequent maintenance.

Exhibit 5.3: Pictorial representation of Dual-axis trackers



C. Primary use case: Solar tracker applications

Utility-Scale Solar Farms: Maximizing energy generation on vast spans

Large-scale solar farms, often spread across vast expanses of land, are a cornerstone of the renewable energy revolution. Their primary objective is maximizing electricity production for grid integration. By dynamically adjusting the panels throughout the day to maintain a near-perpendicular angle to the sun, trackers can significantly increase energy output compared to fixed-tilt systems. This translates to:

- **Enhanced Project Viability:** Increased energy production improves the project's financial viability by generating more electricity for sale to the grid, leading to a faster return on investment.
- **Land Use Optimization:** Trackers allow for denser packing of panels on the available land due to their ability to optimize energy production from each panel. This maximizes energy output while minimizing land use, a crucial consideration for large-scale projects.
- **Grid Integration Benefits:** Increased and more consistent energy production from tracker-equipped solar farms can enhance grid integration by providing reliable renewable energy during peak demand periods.

Commercial and Industrial Rooftop Systems: Making the Most of Limited Space

Commercial and industrial rooftops often present unique challenges for solar installations. Space constraints are a major concern, limiting the number of panels that can be deployed. Solar trackers offer a compelling solution in these scenarios. By optimizing panel tilt for maximum sunlight capture throughout the day, trackers can significantly increase energy production even on rooftops with limited area. This translates to:

- **Increased Electricity Savings:** The ability to generate more electricity from a limited number of panels helps businesses offset their electricity bills to a greater extent, leading to substantial cost savings.

- **Improved Sustainability Profile:** Businesses seeking to enhance their environmental credentials can utilize solar trackers to generate more clean energy onsite, reducing their reliance on traditional energy sources.
- **Greater System Flexibility:** In some cases, solar trackers can be programmed to adjust panel tilt for seasonal variations in sun angles or to avoid shading from nearby structures, further optimizing energy production on rooftops.

Remote Off-Grid Applications: Powering communities in isolation

In remote locations where grid access is limited or non-existent, standalone solar PV systems are often the primary source of electricity. Here, maximizing energy production is crucial for powering homes, businesses, and vital infrastructure. Solar trackers play a transformative role in these off-grid applications including:

- **Enhanced energy security:** Increased electricity generation from trackers ensures greater self-sufficiency for remote communities, reducing their dependence on other unreliable fuel sources.
- **Improved system reliability:** Trackers can help overcome seasonal variations in sunlight availability in some regions, ensuring a more consistent and reliable supply of solar energy throughout the year.
- **Reduced reliance on generators:** Increased solar energy production through tracking can decrease dependence on diesel generators, which are often noisy, polluting, and expensive to operate, especially in remote locations.

Concentrated Solar Power (CSP) plants: Precise tracking for enhanced efficiency

Concentrated Solar Power (CSP) plants utilize mirrors to focus sunlight onto a receiver, generating heat for electricity production. While not all CSP configurations utilize trackers, some employ them to precisely adjust the mirror orientation throughout the day. This provides several key benefits including:

- **Maximized heat generation:** Precise tracking ensures that the concentrated sunlight is directed at the receiver throughout the day, maximizing heat generation and overall plant efficiency.
- **Increased energy output:** By capturing more concentrated sunlight, tracking systems can contribute to a significant increase in the overall electricity generation capacity of the CSP plant.
- **Operational flexibility:** In some cases, trackers can be programmed to adjust mirror orientation based on weather conditions, optimizing heat capture even during periods of cloud cover.

Agricultural Applications: Dual-purpose systems for sustainable farming

- Integrating solar trackers with agriculture optimizes land use by combining energy production with farming. This approach offers several benefits:
- **Land Use Synergy:** Maximizes land use by allowing simultaneous solar energy and crop production, useful in land-scarce areas.
- **Improved Crop Yields:** Partial shade from panels can boost yields for shade-tolerant crops and enhance air circulation, reducing disease risk.
- **Water Management:** Shade reduces water evaporation, improving irrigation efficiency.

- Overall, this system supports sustainable land management by balancing energy production with agricultural benefits.

5.4 Solar Tracker penetration and market size

A. Global

The global solar PV annual capacity additions have seen high growth from CY2018 to CY2023 with a CAGR of 29%. It is projected to grow further, from 346 GW in CY2023 to 540 GW in CY2028E, at a CAGR of 9%, with China being expected to add the highest portion at roughly 56% of the annual capacity addition in CY2028E. Unlike China, which may be experiencing market saturation, the US market appears to be in its early stages of growth, with a CAGR of 25% for the period of CY2018 to CY2023 and annual capacity additions growing to 25 GW in CY2023- almost three times of the additions in CY2018, suggesting ample room for further expansion. While still being a major player, China's growth appears to be stabilizing after a period of rapid expansion. This could be due to factors like market saturation in certain regions or a shift towards optimizing existing installations. However, China still holds the largest annual capacity addition, projected to reach 301 GW by CY2028E.

Exhibit 5.4: Annual solar PV capacity additions, in GW, (excluding India) CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Global	97	102	133	146	199	346	399	419	454	489	540
China	45	30	49	52	87	217	232	242	258	274	301
USA	8.2	9.6	15	19	19	25	32	37	42	47	52
KSA	0.1	0	0	0.3	0	1.8	1.6	2.5	3.4	3.8	4.5

Source: IREANA, IEA, Frost & Sullivan Analysis

Exhibit 5.5 (a): Annual solar tracker capacity additions, in GW, (excluding India) CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Global	22	28	43	54	84	163	208	239	277	318	378
China	4.5	3.6	7.4	8.8	17	54	65	78	96	107	132
USA	4.9	6.5	11	16	17	24	31	36	41	47	52
KSA	0.1	0	0	0.3	0	1.8	1.6	2.5	3.4	3.8	4.5

Source: Stakeholder consultation, Frost & Sullivan Analysis

The global solar tracker market is also experiencing a period of high growth with a compound annual growth rate (CAGR) of 49% between CY2018 and CY2023 and it is projected to grow at a CAGR of approx. 18% between CY2023 and CY2028E, in GW, with annual capacity addition projected to reach 378 GW by CY2028E.

Exhibit 5.5 (b): Penetration of tracker system across regions of interest (excluding India), in %, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Global	23%	27%	32%	37%	42%	47%	52%	57%	61%	65%	70%
China	10%	12%	15%	17%	20%	25%	28%	32%	37%	39%	44%
USA	60%	68%	75%	84%	90%	95%	97%	98%	98%	99%	100%
KSA	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Stakeholder consultation, Frost & Sullivan Analysis

This represents a significant increase from the 22 GW annual installed capacity in CY2018, reflecting a maturing industry and a growing preference for solar trackers as a technology to optimise energy capture. Growth has been driven by a fall in tracker prices, efficiency gains over time and intense competition in the downstream market forcing developers to optimise the operational design of projects. The U.S. solar tracker market has seen remarkable growth, with capacity expanding more than tenfold from CY2018 to CY2023 and expected to reach 52 GW by CY2028. This surge highlights the growing recognition of solar trackers’ benefits, which enhance energy capture by aligning panels with the sun's path. Key factors driving this expansion include favorable policies such as tax credits and renewable portfolio standards, which incentivize investment in solar technology. Additionally, in regions with land constraints, solar trackers optimize energy output on a smaller footprint, making them increasingly attractive. Technological innovations further boost their appeal by improving design and performance.

In contrast, the Kingdom of Saudi Arabia (KSA) showcases a unique market dynamic with 100% penetration of solar trackers, a result of government mandates requiring their use for all utility-scale projects. This strong policy support reflects a commitment to maximizing solar efficiency. Globally, while established markets like KSA and North America experience robust growth due to mature infrastructure and incentives, China has seen slower adoption of solar trackers in recent years.

Exhibit 5.5 (c): Solar tracker system market, Global, in USD Mn, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Global	24,051	27,305	41,474	47,940	69,595	130,356	158,614	181,172	196,129	222,349	255,309
China	4,433	3,296	6,597	7,288	13,321	39,711	43,575	51,918	59,453	68,654	74,011
USA	7,767	9,573	16,059	21,061	20,963	27,939	36,039	40,835	45,167	49,181	52,605
KSA	62	29	0	341	1.0	1,646	1,335	2,113	2,661	2,999	3,234

Source: Stakeholder consultation, Frost & Sullivan Analysis

B. India

India is the third largest market in terms of annual solar PV capacity additions, when compared to China, USA, Kingdom of Saudi Arabia, and its solar tracker market is experiencing a remarkable growth trajectory. With the increasing emphasis on solar capacity expansion in India and expected moderation in raw material prices, the installed capacity of solar projects in the country rose from 13 GW in Fiscal 2023 to 15 GW in Fiscal 2024. The Government of India has implemented several regulatory measures to support the growth of the solar sector, including domestic content requirements, performance-linked incentive schemes, and the imposition of basic customs duties. These steps are designed to further promote the addition of solar capacity. Since gaining acceptance in 2016, tracker installations have surged due to declining prices, improved commercial viability, and growing investor awareness. The need to maximize power output in a competitive market has further fueled demand for this technology. While India's starting point for tracker adoption was relatively low, the future looks bright. This rapid growth can be attributed to factors including:

- **Policy tailwinds:** Supportive government policies, like the Jawaharlal Nehru National Solar Mission (JNNSM), are encouraging investment in solar energy, including solar trackers.
- **Cost competitiveness:** The global decline in solar tracker prices has made them a more attractive option for developers in India.

- Expanding economy and rising energy demand:** Mirroring trends in other emerging economies, India's growing economy and increasing energy needs create a strong market for solar energy solutions, with trackers playing a key role.

By FY2029E, India's solar tracker market penetration is expected to reach nearly 62%, with an annual installed capacity of 28 GW. This signifies a remarkable shift towards this technology, solidifying its position as a crucial player in India's clean energy future.

India, with its cost-competitive advantage and growing domestic manufacturing base, is well-positioned to become a major player in the global solar tracker market. The Indian solar tracker market stands at USD 3,463 million as of FY2024, more than three times its value of USD 1,001 million in FY2019, with a Compound Annual Growth Rate (CAGR) of 28% for the period FY2019-FY2024E. This trend suggests the continued diversification and expansion of the market in the coming years, as is seen in the projected market. The country is expected to have a market of USD 13,660 million by FY2029E, growing at an estimated CAGR of 32% for FY2024-FY2029E.

Exhibit 5.6 (a): Solar tracker system penetration in India, in GW, penetration in %, FY2019 – FY2029E

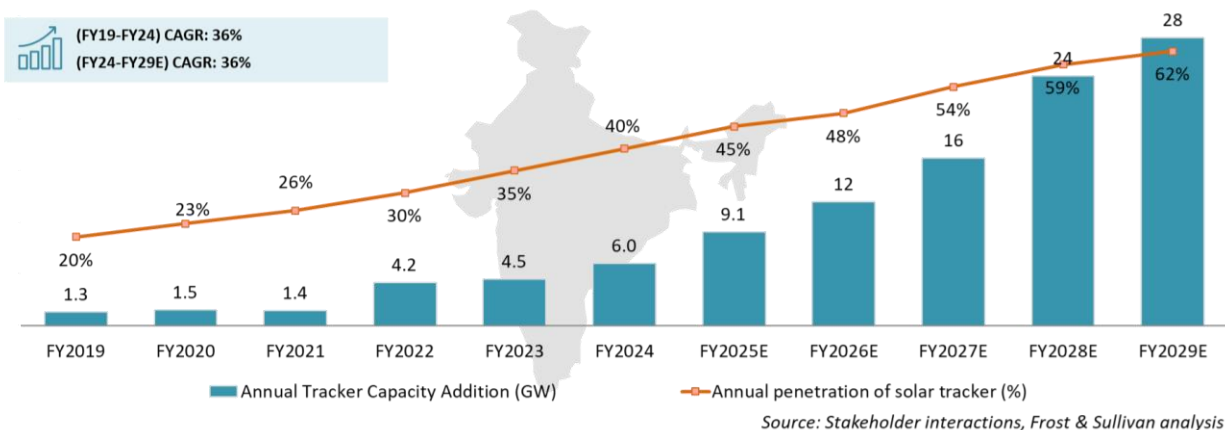
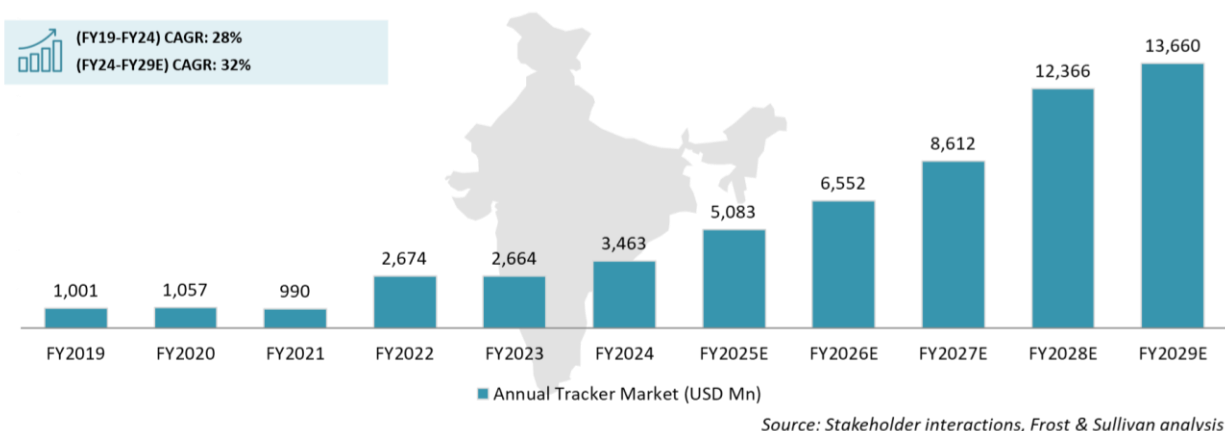


Exhibit 5.6 (b): Solar tracker system market in India, in USD million, FY2019 – FY2029E



Note: It is important to note that this analysis of global solar tracker market penetration trends is drawing insights from annual data for the period CY2018 – CY2028. For India, numbers are presented in FY terms. It is essential to acknowledge that these figures represent new installations and do not encompass the potential for retrofitting existing fixed-tilt systems.

5.5 Leading Solar Tracker technology suppliers

A. Nextracker LLC.



Company Overview	<ul style="list-style-type: none"> Nextracker LLC, headquartered in Fremont, California, and established in 2013, is a leading global solar tracker company. PMEA Solar Tech Solutions Limited have a long-standing relationship with Nextracker LLC., the world's largest solar tracker provider consistently maintaining its leadership in the global solar tracker market for the past seven years, with a market share ranging from 26% to 33%. This sustained performance underscores Nextracker LLCs position as the largest and most reliable provider of solar tracking solutions, reflecting its pivotal role in advancing solar energy deployment worldwide. 	
Operating Regions	<ul style="list-style-type: none"> U.S.A KSA UAE India Australia 	<ul style="list-style-type: none"> Chile Brazil Mexico China Europe
Market Share	<ul style="list-style-type: none"> 28-30% (by global shipments) 	
Offerings	<ul style="list-style-type: none"> Solar Trackers (NX Horizon, NX Horizon Low Carbon-35% less carbon footprint, NX Horizon XTR-All Terrain, NX Horizon Hail Pro- Hail risk mitigation) Software (TrueCapture- Yield optimisation and software control, NX Navigator- Tracker health monitor and weather risk mitigation) Skill Development (PowerworX- instructions for solar workers) Service (NX Global Services) 	
Production capacity	<ul style="list-style-type: none"> 50 GW/year 	
Financial indicators	<ul style="list-style-type: none"> Revenue 	<ul style="list-style-type: none"> USD 2,281 Million
Key Clients	<ul style="list-style-type: none"> NTPC Renewable Energy Limited Serentica Renewables ACWA Power 	<ul style="list-style-type: none"> IbVogt Vale S.A.

B. Array Technologies



Company Overview	<ul style="list-style-type: none"> Array Technologies was established in 1996 and its headquarters is in Albuquerque, New Mexico, U.S.A. With its key strength in utility-scale solar trackers, they have expanded its manufacturing capacities and engineering resources to cover three continents. They recently acquired one of Europe's leading tracker manufacturers, STI Norland in line with this. 	
Operating Regions	<ul style="list-style-type: none"> U.S.A UK Italy Brazil South Africa 	<ul style="list-style-type: none"> Mexico Japan Argentina Australia Chile

	<ul style="list-style-type: none"> Spain Australia Egypt Turkey Canada 	<ul style="list-style-type: none"> Romania Peru Portugal South Africa Botswana
Market Share	<ul style="list-style-type: none"> 21-24% (by global shipments) 	
Offerings	<ul style="list-style-type: none"> Solar Trackers (DuraTrack, STI H250, OmniTrack, SmarTrack) Services and Training 	
Production capacity	<ul style="list-style-type: none"> 50 GW/year 	
Financial indicators	<ul style="list-style-type: none"> Revenue 	<ul style="list-style-type: none"> USD 1,576.6 million
Key Clients	<ul style="list-style-type: none"> EDF Renewables Pacific Partners Primergy Solar 	<ul style="list-style-type: none"> sPower Lightsource BP

C. PV Hardware



Company Overview	<ul style="list-style-type: none"> With its headquarters in Cheste, Valencia, PV Hardware started in 2011 and has been providing its products and services majorly across Europe, U.S.A, Africa and Australia. Apart from in house manufacturing and solar trackers, they also provide services such as structural calculations and on-ground installations. 	
Operating Regions	<ul style="list-style-type: none"> Europe U.S.A Australia Egypt Kuwait 	<ul style="list-style-type: none"> KSA South Africa Turkey Jordan
Market Share	<ul style="list-style-type: none"> 8-11% (by global shipments) 	
Offerings	<ul style="list-style-type: none"> Solar Trackers (AxoneDuo Infinity, Monoline 2P) Fixed-tilt racking (SolarFix) PV Cleaners Smart controllers (DBox5) 	<ul style="list-style-type: none"> Software (ProInsights SCADA) Logistics Mounting services and training to third-party Structural calculations (Wind-tunnel tests, Pull Out Test- POT)
Production capacity	<ul style="list-style-type: none"> 30 GW/year 	
Financial indicators	<ul style="list-style-type: none"> Revenue 	<ul style="list-style-type: none"> NA
Key Clients	<ul style="list-style-type: none"> ACWA Power NEOM Madras 	<ul style="list-style-type: none"> DEWA Vena Energy

D. GameChange Solar



Company Overview	<ul style="list-style-type: none"> GameChange Solar was established in 2012 with its headquarters in Norwalk, Connecticut, USA. GameChange is the third largest global provider of solar tracker solutions for utility-scale and ground-mounted distributed generation solar projects. The company has delivered over 35 GW of solar tracker and fixed tilt systems. 	
Operating Regions	<ul style="list-style-type: none"> U.S.A South Africa Zimbabwe India Australia Spain 	<ul style="list-style-type: none"> Chile Saudi Arabia Egypt Brazil Mexico Canada
Market Share	<ul style="list-style-type: none"> 5-7% (by global shipments) 	
Offerings	<ul style="list-style-type: none"> Solar Tracker (Genius Tracker 1P, 2P, 1P-2Row), MV Transformer (GeniusBOS), Fixed Tilt Systems (MaxSpan, MaxDensity), Fixed Tilt solar racking system (Ultrafix), Ballasted Ground Systems (Pour in Place, Precast), Project Management Solutions 	
Production capacity	<ul style="list-style-type: none"> 55 GW/year 	
Financial indicators	<ul style="list-style-type: none"> Revenue 	<ul style="list-style-type: none"> NA
Key Projects & Clients	<ul style="list-style-type: none"> AMEA Power Bison Energy 	<ul style="list-style-type: none"> ACCIONA Energía Sabancı Renewables

E. Arctech



Company Overview	<ul style="list-style-type: none"> Arctech, established in 2009 in Jiangsu, China, went public on China’s STAR market in 2020. The company provides fixed-tilt structures, solar trackers, and BIPV solutions. It has set up global R&D centres and collaborates with academic institutes. As of 2023, Arctech has supplied over 68 GW of tracking and racking across 40 countries. 	
Operating Regions	<ul style="list-style-type: none"> China Japan India U.S.A Australia UAE KSA 	<ul style="list-style-type: none"> Namibia Burkina Faso Mexico Chile Brazil Vietnam Argentina
Market Share	<ul style="list-style-type: none"> 6-8% (by global shipments) 	
Offerings	<ul style="list-style-type: none"> Solar Trackers (SkyLine, SkyLine II, SkyWings, SkySmart II, Snow Protection System), Fixed Structures (Single Pole, Dual Pole, Continuously Adjustable, Actuator Adjustable R Tube, Adjustable), Building Integrated PV products/practices (BIPV Smart RooftopII), Solar Carport (SkyHarbor Single Row and Double Row) 	

Production capacity	• 30 GW/year	
Financial indicators	• Revenue	• USD 882.3 Million
Key Clients	• Badeel • ACWA Power	• China Machinery Engineering Corporation (CMEC)

6. FIXED TILT SOLAR TECHNOLOGY ADOPTION WORLDWIDE

6.1 Global analysis of fixed tilt markets

The global solar market is experiencing a significant shift towards tracker systems, with fixed-tilt installations steadily declining. While globally fixed tilt held a 77% share in CY2018, this is projected to drop to just 30% by CY2028E. This trend is particularly pronounced in the US, where fixed-tilt dominance has completely vanished (5% in CY2023).

Interestingly, KSA seems to have a unique dynamic, exhibiting a complete shift away from fixed-tilt (0% market share). This suggests the influence of factors beyond global trends, potentially including government policies or project-specific requirements.

Exhibit 6.1 (a): Analysis of fixed tilt penetration, Global, in %, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Global	77%	73%	68%	63%	58%	53%	48%	43%	39%	35%	30%
China	90%	88%	85%	83%	80%	75%	72%	68%	63%	61%	56%
USA	40%	32%	25%	16%	10%	5%	3%	2%	2%	1%	0%
KSA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Source: Stakeholder consultation, Frost & Sullivan Analysis

Exhibit 6.1 (b): Analysis of fixed tilt installed capacity, Global, in GW, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Global	75	75	90	92	115	183	192	180	177	171	162
China	41	26	42	43	70	163	167	165	163	167	168
USA	3.3	3.1	3.7	3.0	1.9	1.2	1.0	0.7	0.8	0.5	0
KSA	0	0	0	0	0	0	0	0	0	0	0

Source: Stakeholder consultation, Frost & Sullivan Analysis

Exhibit 6.1 (c): Market size of fixed tilt technology, Global, in USD Million, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Global	68,335	63,075	75,164	69,613	81,925	125,133	124,226	115,500	107,194	100,380	89,874
China	33,254	20,139	31,157	29,654	44,436	99,309	93,372	91,878	84,386	89,443	78,462
USA	4,142	3,604	4,282	3,209	1,863	1,176	892	667	738	397	0
KSA	0	0	0	0	0	0	0	0	0	0	0

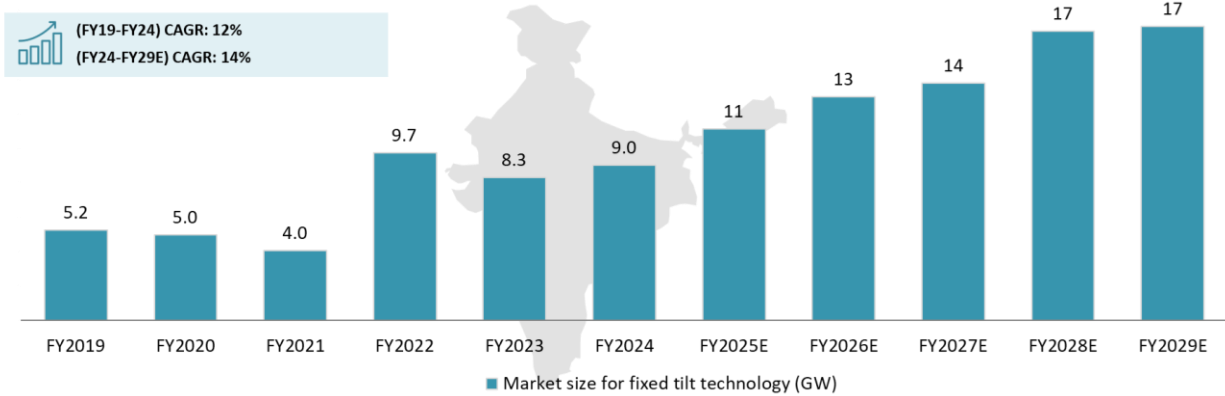
Source: Stakeholder consultation, Frost & Sullivan Analysis

The global fixed-tilt market stood at USD 68,335 million in CY2018 and is expected to reach a high of USD 125,133 million in CY2024E, followed by a decline to reach USD 89,874 million in CY2028E. The market exhibited a CAGR of 13% for CY2018-CY2023 and is projected to decline at a CAGR of -6.4% for the period of CY2023 to CY2028E.

6.2 Analysis of India’s fixed-tilt market

In certain regions of India, fixed-tilt solar systems are preferred over single-axis trackers due to their cost efficiencies. Fixed tilt panels, with fewer moving parts, are simpler to install and require less maintenance, leading to lower overall costs. There is a growing push from renewable energy players to innovate and improve efficiency for tracker components to trade-off the high cost of operations and maintenance for a solar power plant with higher revenue generation due to efficient solar tracking components. In certain parts of India, fixed-tilts are preferred over single-axis trackers primarily because of the economics of scale.

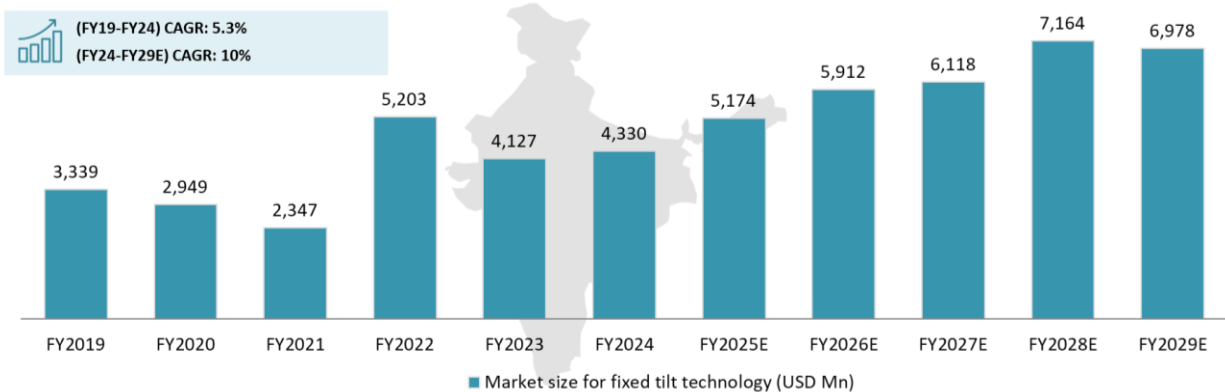
Exhibit 6.2(a): Market size of fixed tilt technology, India, in GW, FY2019 – FY2029E



Source: Stakeholder interactions, Frost & Sullivan analysis

Fixed tilt have fewer moving parts, are easier to install and require less maintenance, resulting in cost-effectiveness. This makes fixed-tilt systems more accessible for a range of applications. The fixed angle allows for accurate forecasts of energy output, resulting in efficient planning and resource allocation. Their space-efficient design makes them suitable for installations where there is limited real estate. They also minimize shading between panels, optimizing energy capture across the solar array. The cost advantages and efficiencies gained from using fixed tilt systems make them a more viable and attractive option for large scale solar projects.

Exhibit 6.2 (b): Market size of fixed tilt technology, India, in USD Million, FY2019 – FY2029E



Source: Stakeholder interactions, Frost & Sullivan analysis

The global solar market is experiencing a significant shift towards tracker systems, with fixed-tilt installations steadily declining, i.e., from 77% market share in 2018, and projected to drop to 30% by 2028. Despite the decrease in global market share, India stands out as a bright spot as, with the market value

projected to experience a significant upward trajectory i.e., growing from 9 GW in FY2024 and project to reach to 17 GW in FY2029. Despite these advantages, emerging economies like India are rapidly embracing solar trackers. By FY2029E, fixed tilt is expected to constitute 41% of the market, while the overall market for trackers is projected to grow significantly. India's solar market value, which was USD 3,339 million in FY2019, is anticipated to reach USD 6,978 million by FY2029E. The market is maturing, with both fixed-tilt and tracking systems expanding, but the growth rate for trackers is outpacing that of fixed-tilt systems, resulting in a decreasing relative share for fixed-tilt systems.

7. OVERVIEW OF SOLAR TRACKING AND MOUNTING PRODUCTS MANUFACTURING PROCESSES

7.1 Introduction to Solar Tracker Manufacturing Technologies

Solar trackers improve energy capture by adjusting their position throughout the day, relying on stamped and rolled metal products for their structure. Stamped metal forms the bearing housing assembly for rotation, while rolled steel provides the module mounting rails. These components ensure robust support, precise dimensions, and structural integrity. Stamped parts like rails and brackets add reinforcement and attachment points.

These metal products offer versatility and customization. Stamping allows for various shapes and sizes to accommodate different applications and panel types, and can be adapted to different metals for weight, strength, and corrosion resistance. This adaptability ensures compatibility with diverse designs and simplifies assembly with precise shapes and pre-drilled holes. Additionally, both stamping and rolling are cost-effective, producing large quantities of components at low unit costs while minimizing waste and reducing long-term operational costs through durability and low maintenance.

7.2 Leveraging the Advantages: Sourcing Solar Tracker Components from Indian Manufacturers

The global solar energy landscape is witnessing a surge, with India emerging as a key player. This growth is fueled by a confluence of factors, including ambitious renewable energy targets, abundant sunshine hours, and a thriving domestic manufacturing ecosystem. For companies involved in solar tracker production, strategically sourcing crucial components from Indian manufacturers presents a compelling opportunity to enhance competitiveness and unlock significant advantages.

1. Cost Competitiveness

- **Favorable labour rates:** India boasts a skilled workforce with competitive labour rates compared to established manufacturing hubs. This translates into significant cost savings for solar tracker manufacturers when sourcing MMA from Indian suppliers. The cost benefits can be particularly pronounced for labour-intensive processes like stamping and welding involved in MMA production.
- **Economical material acquisition:** India possesses a robust metal industry, offering domestic availability of steel and aluminium at competitive prices. This proximity to raw materials translates into lower material acquisition costs for Indian manufacturers of these solar tracker components, further contributing to overall cost advantages for solar tracker companies.
- **Duty optimization:** Strategic sourcing from India can help leverage existing free trade agreements or preferential duty structures. By partnering with Indian suppliers, solar tracker manufacturers can potentially minimize import duties and optimize their overall landed costs.

2. Enhanced Supply Chain resilience: Mitigating risks

- **Geographical Proximity:** Sourcing components from India shortens the supply chain for solar tracker manufacturers, particularly those located in Asia. This geographical proximity facilitates smoother logistics, faster response times for order fulfilment, and reduced reliance on long-distance transportation, which can be susceptible to disruptions.
- **Reduced vulnerability to global events:** Global events like geopolitical tensions or trade wars can significantly impact supply chains. Sourcing from India lessens dependence on geographically distant suppliers, mitigating potential disruptions and enhancing overall supply chain resilience for solar tracker manufacturers.
- **Improved inventory management:** The shorter lead times associated with sourcing from Indian manufacturers enable solar tracker companies to implement leaner inventory management strategies. This reduces the risk of stockouts and the associated financial burdens, leading to improved operational efficiency.

3. Fostering innovation: A collaborative approach

- **Skilled workforce and engineering expertise:** India boasts a large pool of skilled engineers and technicians with a strong foundation in metalworking and manufacturing. Partnering with Indian suppliers unlocks the potential for collaborative innovation in MMA design, leading to potentially more cost-effective or functionally optimized components.
- **Adaptability and flexibility:** Indian manufacturers are known for their adaptability and ability to cater to specific requirements. This flexibility allows solar tracker companies to work with Indian suppliers to develop customized components that meet their unique needs and project specifications.
- **Focus on sustainable practices:** The Indian government and a growing segment of Indian manufacturers are prioritizing sustainable manufacturing practices. Solar tracker companies sourcing from India can potentially benefit from this focus, aligning their own sustainability goals with those of their suppliers.

4. Leveraging government initiatives: A supportive ecosystem

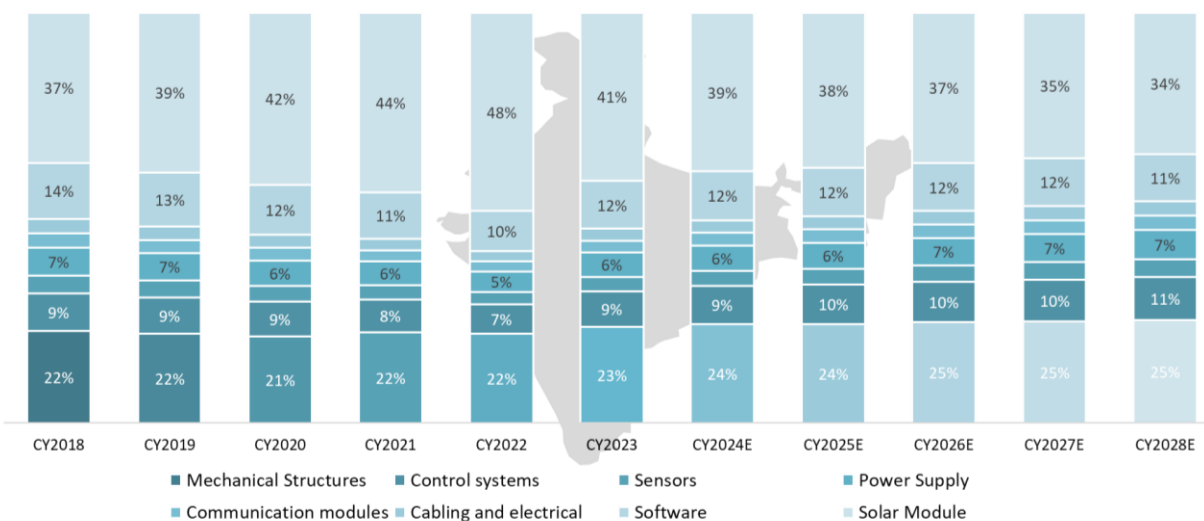
- **Production-Linked Incentive (PLI) Schemes:** The Indian government has implemented Production-Linked Incentive (PLI) schemes for various sectors, including solar equipment manufacturing. These schemes offer financial incentives to companies establishing or expanding their manufacturing facilities in India. Solar tracker manufacturers sourcing MMA from PLI-compliant Indian suppliers can potentially benefit indirectly from these initiatives.
- **Focus on "Make in India":** The Indian government's "Make in India" initiative aims to promote domestic manufacturing and self-reliance. By sourcing from Indian suppliers, solar tracker companies can align themselves with this national mission, potentially opening doors to future partnerships or collaborations.
- **Ease of doing business:** The Indian government has undertaken significant reforms to simplify the process of doing business in the country. These reforms can benefit solar tracker manufacturers by streamlining the sourcing process and fostering a more business-friendly environment.

7.3 Costing of solar tracking and mounting products

A. Cost breakup of solar plant with tracker

A cost breakdown per watt for a solar tracker reveals a complex interplay between several key components. Dominating the cost structure are solar modules (41%) responsible for converting sunlight into electricity and mechanical structures (23%) that enable the tracker's movement for optimal panel positioning throughout the day. Beyond hardware, software (12%) plays a critical role. This software functions as the system's control centre, utilizing advanced algorithms to maximize energy production by optimizing panel positioning. Control systems (8.8%) translate the software's instructions into the physical movements of the tracker, while a reliable power supply (5.9%) ensures continuous operation.

Exhibit 7.1: Cost breakup of components used in solar plants with the tracker, CY2018 – CY2028E



Source: Stakeholder interaction, Frost & Sullivan Analysis

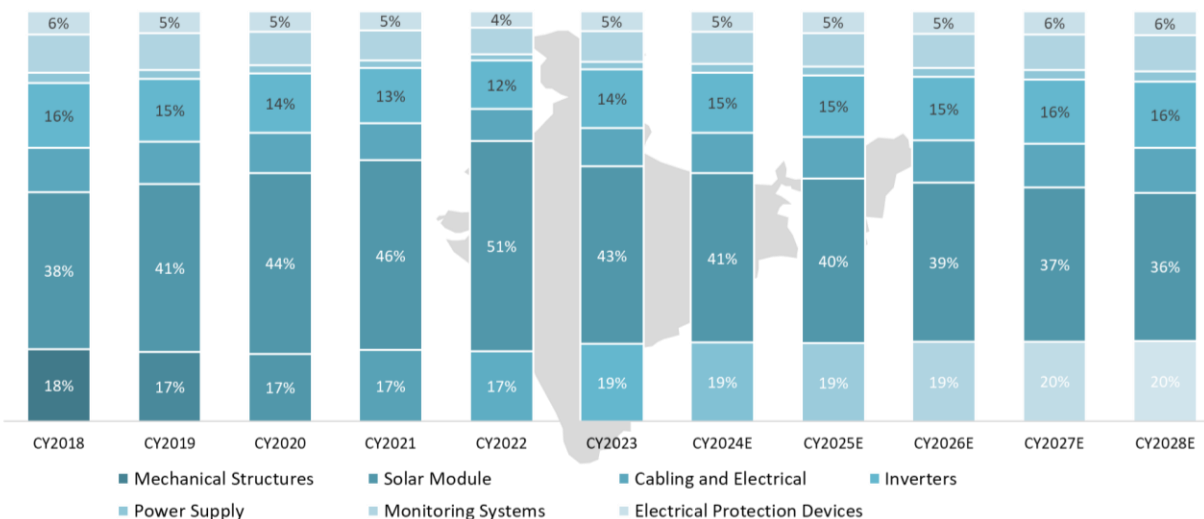
Sensors (3.5%), though a smaller cost component, play a crucial role by gathering data on wind speed and sun position, vital for both safety and efficiency. The remaining cost (5.8%) is attributed to cabling and electrical components (2.9%) that function as the system's nervous system, carrying power and signals, and communication modules (2.9%) that enable remote monitoring and troubleshooting.

B. Cost breakup of solar plant with fixed tilt

Unlike solar trackers with their complex moving parts, fixed-tilt systems present a simpler cost structure. Solar panels remain the most significant expense, claiming around 40% of the cost. After all, they're the workhorses, directly converting sunlight into electricity. However, fixed-tilt systems rely heavily on robust mechanical structures.

Amounting to roughly 20% of the total cost, they securely hold the panels at the optimal angle year-round. This ensures maximum sun exposure and energy generation. Material quality and engineering are crucial for these structures to withstand harsh weather conditions. Although cabling and electrical components (10%) are a smaller cost component, their role in efficiently transmitting power from panels to the inverter and maintaining proper signal flow for system monitoring is vital. Inverters (15%), electrical protection devices (5%), power supply and monitoring systems together amounting to roughly 10%, round out the cost breakdown.

Exhibit 7.2: Cost breakup of components used in fixed tilt solar plants, CY2018 – CY2028E

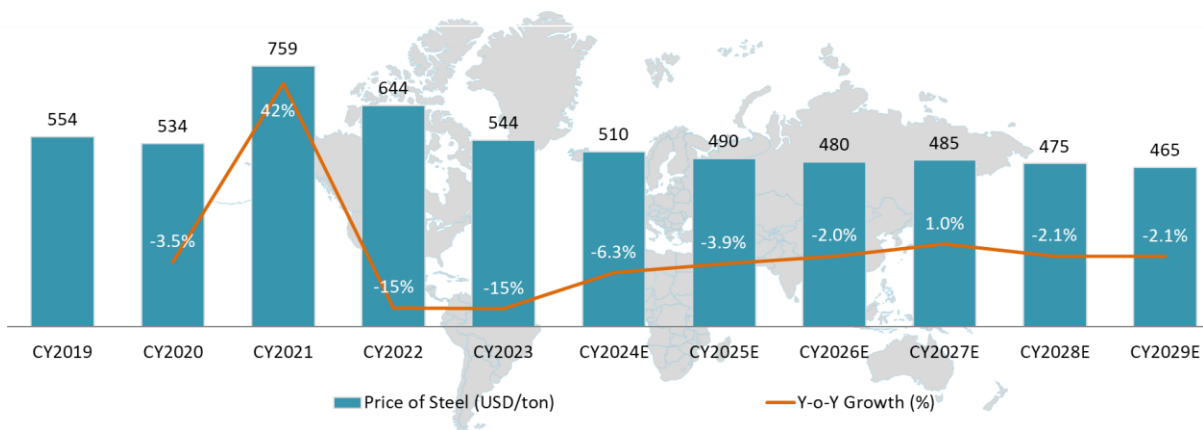


Source: Stakeholder interaction, Frost & Sullivan Analysis

7.4 Global Future Pricing Trend of Steel

The global steel market has been stabilizing after significant price fluctuations in recent years. Prices are expected to fall to USD 465 per ton by CY2029E, down from USD 554 per ton in CY2019. China, the leading steel producer with a 54% share of global production, saw prices peak at USD 759 per ton in CY2021 due to COVID-19-related supply chain disruptions and policy changes. Although prices surged again to USD 644 per ton in CY2022 due to strong demand and the Russia-Ukraine conflict, the market has since declined. Lower domestic demand in China, combined with increased exports and a global economic slowdown, has driven prices down, with this trend expected to continue until CY2029E.

Exhibit 7.3: Global hot rolled steel prices, in USD per ton, CY2019 - CY2029E



Source: Trading Economics, Frost & Sullivan Analysis

Market Correction: The global metal market, including zinc, aluminium, and magnesium, experiences cycles of highs and lows. A fall in prices of these raw materials post-CY2023 can potentially reduce the cost of the coatings themselves.

Technological Advancements: The steel industry is constantly innovating. New, more efficient methods for applying G90 and ZAM coatings in the coming years will potentially lead to lower production costs.

Increased Competition: The pre-galvanized steel market can expect to see a rise in competition from new players or alternative materials. This increased competition will drive down prices for both the base steel and the coatings.

8. GLOBAL MARKET: SOLAR TRACKING AND MOUNTING PRODUCTS FOR TRACKER AND STRUCTURAL COMPONENTS FOR FIXED TILT

8.1 Introduction to the global component market used in solar plant

The global solar power industry has experienced phenomenal growth, driven by a focus on clean energy. This market encompasses companies that provide the essential support structure for solar farms, ensuring optimal panel positioning for maximum sunlight capture throughout the day.

This market caters to diverse needs with a range of components. Fixed-tilt structures, the most common option, utilize prefabricated piles, beams, and rails for a cost-effective solution. Adjustable-tilt structures offer greater flexibility in regions with seasonal sunlight variations. Single-axis trackers represent a more advanced option, allowing panels to follow the sun's east-west movement. Double-axis trackers are the most sophisticated solution, constantly adjusting on both horizontal and vertical axes to maximize solar capture efficiency. Each component, from piles to torque tubes (a key element in single-axis trackers), plays a vital role in the structural integrity and performance of a solar farm.

8.2 Leading suppliers of solar tracking and mounting products globally

Exhibit 8.1: Global Solar tracking and mounting products manufacturers

COMPANY NAME	LOCATION	FOCUS	CAPACITY	PRODUCTS
Clenergy Technologies	Melbourne, Australia (Founded) Xiamen, China (Manufacturing HQ)	Manufacturing, EPC, Developer	8 GW/annum	Products: <ul style="list-style-type: none"> • Ground Mount system, Tracker system, Rooftop, Carports, Balcony Solar Systems • Inverters, Energy Storage Systems • Accreditation Services • After-Sales support
Schletter Group	Krichdorf, Germany (Founded) China (Manufacturing)	Manufacturing, Developer	>55 GWp installations	Products: <ul style="list-style-type: none"> • Fixed-tilt system, Tracker system, Rooftop, Carports, Agri-PV vertical systems, accessories • Assessment and Training, Supervision and Reporting, Advice and Support
Hangzhou Huading New Energy Co. Ltd.	Hangzhou, China	Manufacturing, EPC	6 GW/annum	Products: <ul style="list-style-type: none"> • Ground and Roof Mounting System, Tracker System, Carport, BIPV, Balcony Solar Bracket
OMCO Solar	Ohio, USA	Manufacturing	10 GW+ /annum	Products:

				<ul style="list-style-type: none"> • Tubes, Fixed-Tilt and Tracker Mounting structures, Purlins • Prototyping Services, Technical Training and Support
APA Solar Racking	Ohio, USA	Manufacturing	NA	Products: <ul style="list-style-type: none"> • Fixed-Tilt and Tracking Mounting Systems • Foundation Systems • Installation support and Training
Caracal Engineering	Johannesburg, South Africa	Manufacturing, Construction, Testing	NA	Products: <ul style="list-style-type: none"> • Ground-Mount and Rooftop Mounting Systems, Single-axis tracker System, Carports
Sunlock	Melbourne, Australia	Manufacturing, Inspections	NA	Products: <ul style="list-style-type: none"> • Rooftop and Ground-Mount Systems, Components

8.3 Solar tracking and mounting products of interest

A. Module Mounting Assembly (stamped and fabricated products)

Module Mounting Assembly (MMA): Module Mounting Assembly includes BHA, CMU, URA and MMR assemblies which are the rails on which the panel is mounted.

Bearing Housing Assembly (BHA): The BHA is a pivotal component in the solar tracker's anatomy. It is the heart of the system, housing the bearings that enable the tracker's smooth rotation and precise tracking of the sun's path. Crafted from high-strength, low-carbon steel, the BHA demands high durability to withstand the constant movement and weight loads of the tracker

Module Mounting Rail (MMR/URA): The Module Mounting Rail (MMR)/ Universal Rail Assembly (URA) plays a critical role in the solar tracker's anatomy. Imagine it as the skeletal structure that supports the solar panels, ensuring they are positioned at the optimal angle to capture sunlight throughout the day. MMRs are from cold-rolled steel, chosen for its balance of strength and ease of forming.

Control Mount Unit (CMU): The Control Mount plays a critical role in the solar tracker's nervous system. It is the secure enclosure that houses the electrical controls, the brain of the tracker operation. This vital component protects the electrical components from the elements and ensures their reliable operation. Control mounts are crafted from sheet metal, and their manufacturing process relies primarily on stamping techniques.

B. Rolled Products

Torque Tube: Torque tubes are a structural element that connect multiple solar panels and provide the necessary rigidity and structural integrity to the solar array, ensuring that the panels stay in optimal orientation. Accordingly, panels are located on the front side of URA/MMR while the back side would be secured with the torque tube.

Torque Tube Assembly: This refers to the complete torque tube system, including the tube itself, bearings, and connecting components. It forms the core of the tracker's rotational mechanism.

W-Beam: A structural element, often used in solar trackers as a support structure for the module mounting rails. It provides additional rigidity and stability to the tracker.

Open Section: A type of structural member with a hollow open cross-section, often used in solar trackers for components like the torque tube or support beams. It offers a balance of strength and weight reduction.

8.4 Estimated size of the global solar tracking and mounting products market

The global solar tracking and mounting products and fixed-tilt structural components market has grown significantly from CY2018 to CY2028E. The fixed-tilt market increased from USD 12,010 million in CY2018 to an estimated USD 17,682 million by CY2028E. After a high growth rate of 39% CAGR from CY2018 to CY2023, the market is expected to slow to a 15% CAGR from CY2023 to CY2028E. China leads this market, growing from USD 5,845 million in CY2018 to USD 15,436 million by CY2028E. The USA's market will decline as solar trackers replace fixed-tilt systems, and Saudi Arabia has fully transitioned to trackers.

In contrast, the solar tracking and mounting product market surged from USD 5,397 million in CY2018 to USD 30,493 million in CY2023, with a 113% CAGR. It is projected to grow at a 42% CAGR, reaching USD 64,092 million by CY2028E. This sector is expected to more than double from USD 15,140 million in CY2022 to USD 38,301 million in CY2024, driven by increased demand and investment in tracker technologies.

Exhibit 8.2: Structural components market, fixed-tilt, Global, in USD million, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Global	12,010	10,735	12,429	12,125	14,088	23,674	23,898	22,081	20,811	19,606	17,682
China	5,845	3,428	5,152	5,165	7,641	18,788	17,962	17,565	16,383	17,470	15,436
USA	728	613	708	559	320	223	172	128	143	78	0
KSA	0	0	0	0	0	0	0	0	0	0	0

Source: Stakeholder interactions, Frost & Sullivan Analysis

In China, solar tracking and mounting products market is set to grow from USD 995 million in CY2018 to an estimated USD 18,580 million by CY2028E, fueled by widespread adoption and robust local manufacturing. From CY2022 to CY2024E, the market is expected to surge from USD 2,898 million to USD 10,522 million. In the USA, the market expanded from USD 1,743 million in CY2018 to USD 6,536 million in CY2023 and is projected to reach USD 13,206 million by CY2028E, doubling from USD 4,560 million in CY2022 to USD 8,702 million in CY2024E due to increased solar PV capacity.

In Saudi Arabia, the market grew from USD 14 million in CY2018 to USD 385 million in CY2023, with an expected rise to USD 812 million by CY2028E. Globally, major solar tracker components such as MMA and Rolled Products are experiencing significant growth, with a minimum CAGR of 15% from CY2023 to CY2028E. The Torque Tube market, for example, expanded from USD 408 million in CY2018 to USD 5,493 million by CY2028E, growing at a CAGR of ~16% from CY2023 to CY2028E. In China, the Torque Tube market grew from USD 151 million in CY2018 to USD 1,713 million in CY2023, with a CAGR of 63%, and is projected to reach USD 3,058 million by CY2028E at a CAGR of 12%. The USA market for Torque Tube is expected to grow from USD 148 million in CY2018 to USD 1,382 million by CY2028E.

Exhibit 8.3: Solar tracking and mounting products market, tracker, Global, in USD million, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Global	5,397	5,938	8,736	10,587	15,140	30,493	38,301	43,686	48,201	55,167	64,092
China	995	717	1,390	1,609	2,898	9,289	10,522	12,519	14,611	17,034	18,580
USA	1,743	2,082	3,382	4,651	4,560	6,536	8,702	9,846	11,100	12,202	13,206
KSA	14	6.2	0	75	0.2	385	322	510	654	744	812

Source: Stakeholder interactions, Frost & Sullivan Analysis

Exhibit 8.4: Torque Tube market, Global, in USD million, CY2018 – CY2028E

Country / Region	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025E	CY2026E	CY2027E	CY2028E
Global	408	509	705	941	1,324	2,417	3,115	3,526	4,108	4,682	5,494
China	50	39	75	102	203	649	762	896	1,110	1,238	1,529
USA	148	181	293	394	428	676	895	1,009	1,134	1,260	1,382
KSA	1.4	0.6	0	7.7	0	50	42	64	85	93	108

Source: Stakeholder interactions, Frost & Sullivan Analysis

PMEA Solar Tech Solutions Limited was one of the early entrants in the production of torque tubes in India. Companies like Karamtara Engineering had already established their presence in this manufacturing segment. PMEASolar Tech Solutions Limited’s entry into the market further increased the competition and added to the domestic production capabilities for solar mounting structures, including torque tubes. In addition, following the introduction of tariffs by the U.S. government on imports of Chinese steel, domestic sourcing of steel also helps PMEASolar Tech Solutions Limited to respond rapidly and efficiently to changing tariffs and other trade policies, and government incentives and requirements in the United States.

9. SOLAR PLANT COMPONENT MARKET IN INDIA

9.1 Introduction to the structural component market in India

In India's rapidly expanding solar power sector, solar tracking and mounting products are essential for optimizing panel positioning and maximizing sunlight capture. Key types include rooftop mounts, which secure panels to buildings, and ground mounts, which support large solar farms with options for fixed-tilt or single-axis tracking systems. Carport and shed mounts offer both shade and energy generation, while floating mounts enable solar panels on water bodies. Material choice is critical, balancing cost, durability, and availability. Galvanized steel is favored for its strength, lightweight nature, and corrosion resistance, with durability 1.5 to 2.5 times greater than standard steel. Aluminum provides a rustproof but more costly alternative, while high-tensile steel is suited for large projects due to its strength-to-weight ratio. Concrete is often used for foundations in ground-mounted systems.

India’s "Make in India" initiative supports domestic manufacturing of solar components, enhancing quality control and reducing costs. As solar ambitions grow, advancements are expected in materials, automation, and technologies such as self-cleaning systems. Solar tracking and mounting products account for about 20% of the total cost of a solar project, highlighting their significance in the sector’s development

9.2 Leading manufacturers of these components in India

India's solar power sector is undergoing significant expansion, fueled by ambitious renewable energy goals and its abundant sunlight resources. However, a critical but often unseen element underpins these solar panel arrays: the ecosystem for solar tracking and mounting products used for tracker systems and the structural components used for fixed-tilt systems. These companies provide the essential foundation for solar plants, ensuring optimal panel positioning to maximize sunlight capture throughout the day.

Exhibit 9.1: Indian Solar tracking and mounting/ Structural component manufacturers

COMPANY NAME	FOCUS	CAPACITY/ SUPPLY	ABOUT AND PRODUCT INFORMATION
PMEA Solar Tech Solutions Limited	Tracker and Fixed tilt	MMA – 16 GW Rolled Products – 6 GW	Solar tracking and mounting products for: <ul style="list-style-type: none"> • Tracker Strategy: <ul style="list-style-type: none"> • Fixed-tilt structural components Special Processes and Machinery: <ul style="list-style-type: none"> • Sheet Metal Fabrication, Robotic and Seam Welding, Conveyorized Powder Coating, Stamping • Dedicated press line for MMA Rails and extra heavy MMA products • Spot Welding SPMs, Bending SPMs, Drilling SPMs, Bend Saw
Purshotam Profiles Pvt. Ltd.	Tracker and Fixed tilt	15 GW/ annum	The Company is a registered/recognized vendor for many reputed Solar EPC players/ developers that supply Solar Module Mounting Structures, Tracker Structures, cable trays, and walkways. Products: <ul style="list-style-type: none"> • Module Mounting Structure • Tubes
Metalkraft Forming Industries Pvt Ltd	Tracker and Fixed tilt	54,000 MT/ annum	Metalkraft Forming Industries Pvt Ltd produces components for both fixed-tilt and tracker systems for solar PV mounting. They provide various mounting systems, including ground-mounted, rooftop, and carport solutions. Their product range includes mounting structures and associated components that cater to different types of solar installations. Products/ Applications: <ul style="list-style-type: none"> • Roof Top Structures • Ground Mounted Structures • Carport Structures
Hi-Tech Pipes Limited	Tracker and Fixed tilt	580,000 MT/ annum	Hi-Tech Pipes Limited provides products for both fixed tilt and tracker applications. Their steel pipes and structural products are used in the solar power industry for mounting structures, supporting both fixed tilt and tracking solar panel systems

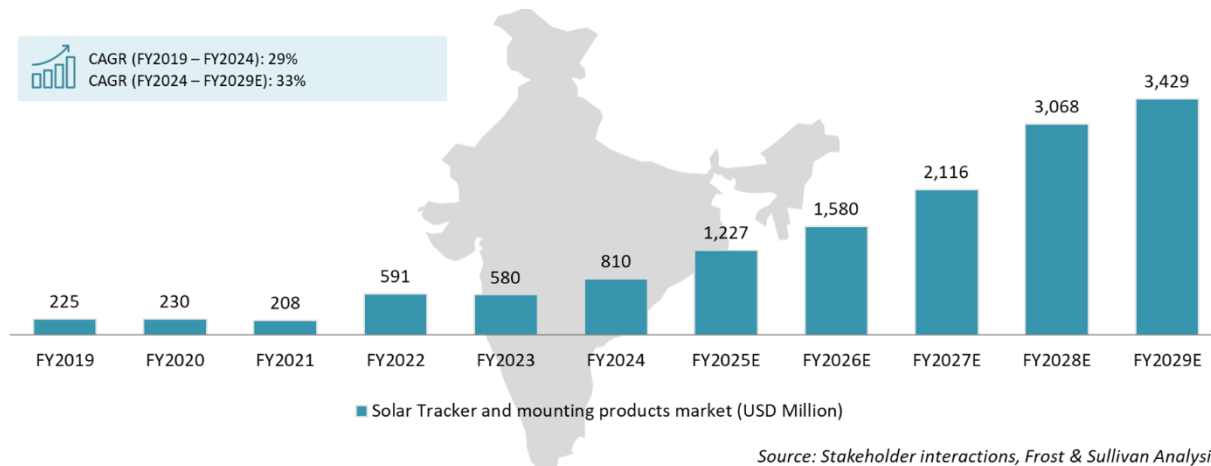
			Products: <ul style="list-style-type: none"> • Pipes, coils, hollow sections and strips • Torque tube • Solar mounting sections
Goodluck India	Tracker and Fixed tilt	420,000 MT/annum	<p>Goodluck India's products such as ERW, galvanized, MS, square and rectangular, and pre-galvanized pipes are used in both fixed tilt and tracker solar installations, with specific applications depending on the structural requirements and environmental conditions of the installation. Their offerings include:</p> <ul style="list-style-type: none"> • Mounting Structures- Ground Mount, Carport • Solar Tracker Parts (Torque tubes, Fabricated components-Transition shafts, Bearing heads, Clamps) • Tubes, pipes, flanges, hollow sections, coils, sheets
Karamtara Engineering Pvt. Ltd.	Tracker and Fixed tilt	Solar Mounting plant – 50,000 MT/ annum, H-beam/Piers/piles – 100,000 MT/ annum, Torque tubes – 100,000 MT/annum	<p>Karamtara Engineering Pvt. Ltd. is involved in the manufacturing of products for both fixed tilt and tracker applications in the solar industry. They produce a variety of steel structures and components that are used for solar PV mounting systems, including both fixed tilt and solar tracker systems. Their offerings include:</p> <ul style="list-style-type: none"> • Ground and Rooftop Module Mounting Structures, H-Beams/Piers/ steel piles, Torque beams & Torque tubes, Fasteners (Bolts, Nuts, Washers)
APL Apollo	Tracker and Fixed tilt	28,00,000 tons/ annum	<p>APL Apollo's products, including ERW, galvanized, pre-galvanized, and square/rectangular tubes, are used in both fixed tilt and tracker solar installations for structural support and mounting.</p> <ul style="list-style-type: none"> • ERW Pipes (Electric Resistance Welded Pipes) for both fixed tilt and tracker applications • Galvanized Pipes/ Pre Gal-Pipes • Square and Rectangular Tubes used in the structural support of trackers, helping to handle the stresses associated with the moving parts

9.3 Estimated size of the solar tracking and mounting products market in India

A. Solar tracker and mounting products market size

India's market for solar tracking and mounting products used in tracker systems exhibits a distinct trend. The market initially demonstrated an upward trend from USD 225 million in FY2019 to USD 810 million in FY2024 growing at a CAGR of 29%. This positive trend is expected to continue, with projections estimating the market to reach USD 3,429 million by FY2029E growing at a CAGR of 33%. Additionally, the share of these solar tracking and mounting products as a percentage of the overall solar tracker market has risen from 22% in FY2019 to 23% in FY2024 and is projected to reach 25% by FY2029E, further strengthening the sector's significance.

Exhibit 9.2: Solar tracking and mounting products market, India, in USD million, FY2019 – FY2029E



This growth indicates India's increasing investment and demand for tracker systems in its energy infrastructure. Trackers optimize energy production by following the sun's path, and their use appears to be gaining traction in the Indian market.

The market is experiencing growth, potentially driven by several qualitative factors. Trackers can significantly boost energy production compared to fixed-tilt systems, making them attractive in regions with lower sunlight or limited land. Advancements in tracker technology reduce costs and improve durability, while automation and tracking accuracy further optimise energy capture. Additionally, government support for trackers and a focus on renewable energy goals encourages wider adoption as the solar industry prioritizes maximizing output and grid integration. These factors combined contribute to the rise in demand for solar tracking and mounting products used in solar plants.

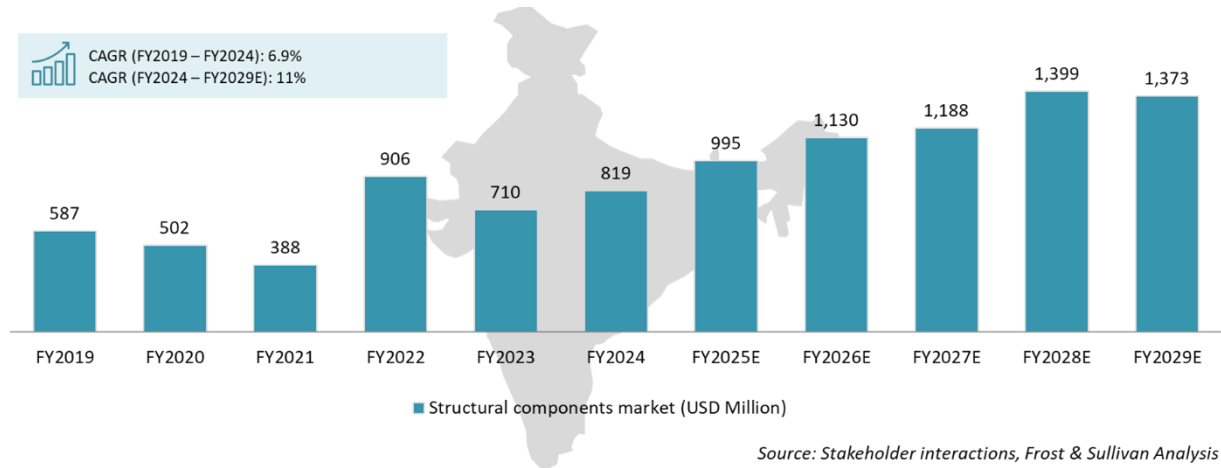
B. Structural component market size for fixed tilt

India's market for fixed-tilt solar structural components, which grew from USD 587 million in FY2019 to USD 819 million by FY2024, is projected to reach USD 1,373 million by FY2029E. Despite this growth, adoption is expected to decline as tracker systems gain popularity. However, the fixed-tilt structural component market's share of the overall fixed-tilt market is increasing, rising from 18% in FY2019 to 19% in FY2024, and is anticipated to reach 20% by FY2029E.

Trackers offer dynamic adjustments to follow the sun, significantly increasing energy capture compared to fixed-tilt systems. This enhances power generation, particularly in regions with variable sunlight. Advancements in tracker technology, such as reduced component costs and improved durability, make them a financially viable and reliable option, despite higher initial investments. Government policies and renewable energy targets also influence this shift. Supportive initiatives and subsidies for trackers

encourage their adoption over fixed-tilt systems. As India aims to meet its clean energy goals, trackers' enhanced efficiency and grid integration benefits make them a strategic choice for maximizing solar energy output.

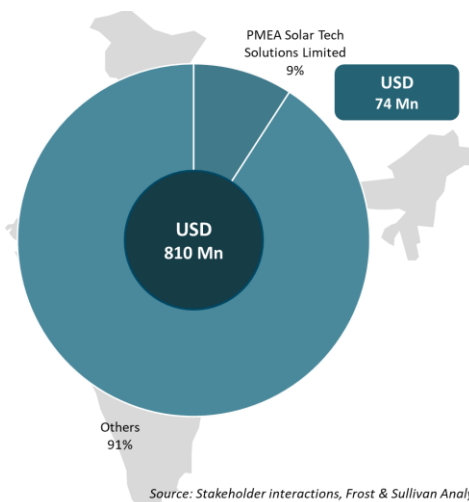
Exhibit 9.3: Structural components market, fixed tilt, India, in USD million, FY2019 – FY2029E



9.4 Market share estimates

Between October 2019 and April 2024, PM Electro Auto Pvt. Ltd. completed over 200 shipments to Nextracker LLC, positioning itself as the fourth-largest supplier to the company. PMEA Solar Tech Solutions Limited achieved revenue from Operations of INR 15,002 million in FY2024, reflecting its strong market position.

Exhibit 9.4: Solar tracking and mounting products, domestic market share of PMEA Solar Tech Solutions Limited, in %, FY2024



As of 31st March 2024, PMEA Solar Tech Solutions Limited held an approximately 9% share of the overall domestic market for solar tracking and mounting products used in solar trackers, equating to a market share of approximately USD 74 million within a total solar tracking and mounting components market valued at approximately USD 810 million. Notably, as of FY2024, PMEA Solar Tech Solutions Limited has a significant presence in its current range of solar tracking and mounting products, including MMA and rolled products in India. PMEA Solar Tech Solutions Limited's customers include Nextracker LLC, the global

market leader in solar tracking systems and solutions consistently for the past seven years. As of March 31, 2024, PMEA Solar Tech Solutions Private Limited ranks among the leading manufacturers in the solar tracking and mounting products sector in India, with an annual installed capacity of 16 GW of MMA and 6 GW of rolled products.

In addition to the growing global demand for increased solar capacity installations and their presence in the export market, PMEA Solar Tech Solutions Limited is expected to gain from various international policies, notably tariffs and anti-dumping duties on solar tracker products imposed by major export markets such as the United States against China. This strategic approach is gaining traction within the solar industry as companies seek to reduce their reliance on China and diversify their supply chains. Countries such as India, Vietnam, Malaysia, and Thailand offer significant advantages, including lower labour costs, supportive governmental policies, and access to burgeoning markets. India, particularly, emerges as a promising manufacturing destination due to its competitive labour costs and a favourable political and regulatory environment conducive to manufacturing activities.

9.5 Growth drivers and market restraints

India's solar power sector is experiencing a meteoric rise, driven by ambitious renewable energy targets, abundant sunshine, and a growing focus on clean energy. However, behind every gleaming solar panel lies a critical, yet often unseen, ecosystem: the solar components that go into tracker and fixed tilt systems. These companies provide the essential skeleton for solar farms, ensuring optimal panel positioning for maximum energy capture throughout the day. Understanding the key forces shaping this market – both propelling and restraining its growth – is vital for informed decision-making by manufacturers and project developers alike.

A. The Key Drivers

- **Government Targets:** India's renewable energy goals drive demand for solar tracking and mounting products by incentivizing investments and enhancing the domestic supply chain through policies like production-linked incentives (PLIs) for solar modules.
- **Cost Competitiveness:** In a price-sensitive market, cost competitiveness is key. Innovations in material use and production efficiency reduce project costs, supported by the "Make in India" initiative, which boosts domestic manufacturing.
- **Technological Advancements:** Innovations in materials and coatings, such as lighter, high-strength materials and self-cleaning technologies, improve performance and durability, and reduce maintenance, keeping the market responsive and dynamic.

B. Navigating Challenges: The Restraints

- **Land Acquisition:** Securing large land parcels and navigating permitting processes can hinder solar project development in India. Streamlining land acquisition and approval procedures is essential for advancing the solar tracker and mounting / structural component market.
- **Financing Challenges:** High upfront costs and limited financing options pose significant barriers for solar projects. Improving access to competitive financing and risk mitigation tools is crucial for advancing the solar power sector and stabilizing the solar tracking and mounting products market.

9.6 Export of solar tracking and mounting products from India

India's manufacturing sector has the potential to become a major exporter of bearing housing assemblies. Several factors contribute to this promising prospect. Firstly, India offers a significant cost advantage due to factors like relatively lower labour costs, making Indian-made assemblies attractive to international buyers seeking competitive pricing. Secondly, India boasts a large pool of skilled engineers and technicians within its manufacturing sector. This readily available workforce can efficiently cater to the production demands of bearing housing assemblies.

9.7 Factors driving the growth of the exports business of solar tracking and mounting products from India

Ambitious climate goals and a growing focus on clean energy security are driving significant investments in renewable technologies, particularly solar power. This surge in demand creates fertile ground for export opportunities in countries with established solar manufacturing ecosystems. However, government policies play a crucial role in shaping the export competitiveness of these nations. The specific international policies that are propelling export growth in four key markets such as India, USA, China, and KSA (Kingdom of Saudi Arabia) include:

A. India

- **Production-Linked Incentives (PLIs):** India's government has implemented a game-changing policy – Production-Linked Incentives (PLIs) for solar module manufacturing. These PLIs offer financial assistance to domestic manufacturers based on their production capacity. This incentivizes companies to scale up production, fostering a robust domestic manufacturing base and enhancing India's export competitiveness in solar components.
- **Free Trade Agreements (FTAs):** India's recent Free Trade Agreements (FTAs) with countries including United Arab Emirates (UAE) offer significant benefits for solar component exporters. These FTAs often involve tariff reductions or elimination, making Indian exports more price-attractive in foreign markets.
- **Quality Improvements:** Indian manufacturers are focusing on enhancing the quality and reliability of their solar tracking and mounting products as many countries now accept Make-in-India products. This would make them more competitive in the international market, where buyers seek cost-effective yet high-quality products.
- **Sync with Domestic Demand:** India's rapidly growing domestic solar market is creating a strong foundation for its manufacturing capabilities. As domestic demand rises, Indian manufacturers can leverage this capacity and expertise to cater to international markets as well.
- **Global Renewable Energy Focus:** The worldwide push towards renewable energy is generating a surge in demand for solar components. Indian manufacturers can strategically position themselves to capitalize on this growing market opportunity.

B. USA

- **Cost Competitiveness + Quality Assurance:** Indian manufacturers can cater to a specific segment in the US market by offering cost-effective components that meet rigorous US quality standards. This is an attractive opportunity, as developers seek to balance project budgets with long-term durability.

- **Focus on Innovation:** Potential collaboration between Indian and US companies can foster innovation in component design or manufacturing processes. This could lead to the development of new, cost-efficient, and high-performance solar tracking and mounting products specifically targeted for the US market.

C. China

- **Strategic Niche Targeting:** Given China's established position as a solar manufacturing giant, Indian manufacturers might be strategically targeting specific niches within the Chinese market. This could involve focusing on high-quality, specialty components not readily available domestically or catering to specific regional needs within China.
- **Focus on Automation and Efficiency:** Understanding China's emphasis on efficiency and automation, Indian manufacturers are working on offering components designed for rapid assembly and streamlined integration with automated installation processes. This focus on production efficiency could be a unique selling point in the Chinese market.

D. KSA

- **National Renewable Energy Program (NREP):** KSA's NREP drives large-scale investments in solar power, creating high demand for solar components. Exporters with established capabilities can capitalize on this growing market.
- **Economic Diversification:** KSA's push for economic diversification includes developing a strong domestic renewable energy sector. Countries skilled in technology transfer and joint ventures can seize opportunities to enter the KSA market and support its renewable energy objectives.

9.8 Threats and challenges to PMEASolar Tech Solutions Limited and its products and services

A. Challenges specific to PMEASolar Tech Solutions Limited

- **High Revenue Concentration:** A significant portion of PMEASolar Tech Solutions Limited's revenue is dependent on a single customer, Nextracker LLC. This heavy reliance poses a risk if there are any changes in Nextracker LLC's business strategy or procurement practices.
- **Export and Regulatory Risks:** PMEASolar Tech Solutions Limited's strong focus on the U.S. market exposes the company to potential regulatory impacts, including trade policies, tariffs, and compliance with U.S. regulations, which could affect its export operations.
- **Raw Material Cost Fluctuations:** Managing the cost of raw materials, which can be volatile, remains a key challenge. These fluctuations can impact profit margins and overall cost management.
- **Technological Advancements:** Keeping pace with rapid technological developments in the solar industry is essential for staying competitive. Falling behind in technology could result in a loss of market share.
- **Supply Chain Reliability:** Ensuring a consistent and reliable supply of raw materials and components is crucial to maintaining production efficiency and avoiding disruptions that could impact project timelines.
- **Customized Solutions:** Meeting the diverse needs of solar project developers by offering tailored solutions is critical for maintaining a competitive edge in the market.

B. Challenges specific to the End user industry

- **Fluctuations in Solar Panel Prices:** Changes in solar panel prices can directly affect the overall cost and attractiveness of solar projects, influencing demand for solar tracking and mounting products.
- **Impact of Government Policies:** Government policies, including subsidies and regulations, play a significant role in the viability of solar projects. Any changes in these policies can impact the demand for solar tracker components.
- **Grid Integration Challenges:** Integrating large-scale solar power into existing power grids often involves technical and regulatory hurdles. These challenges can slow down the deployment of solar trackers and affect market demand.
- **Competition from Other Renewable Energy Sources:** The growing competitiveness of other renewable energy sources, such as wind power, can divert investments away from solar projects, potentially reducing the demand for solar tracker components.

10. OVERVIEW OF OTHER BUSINESS SEGMENTS

10.1 Overview of PMEASolar Tech Solutions Limited’s Product Offerings

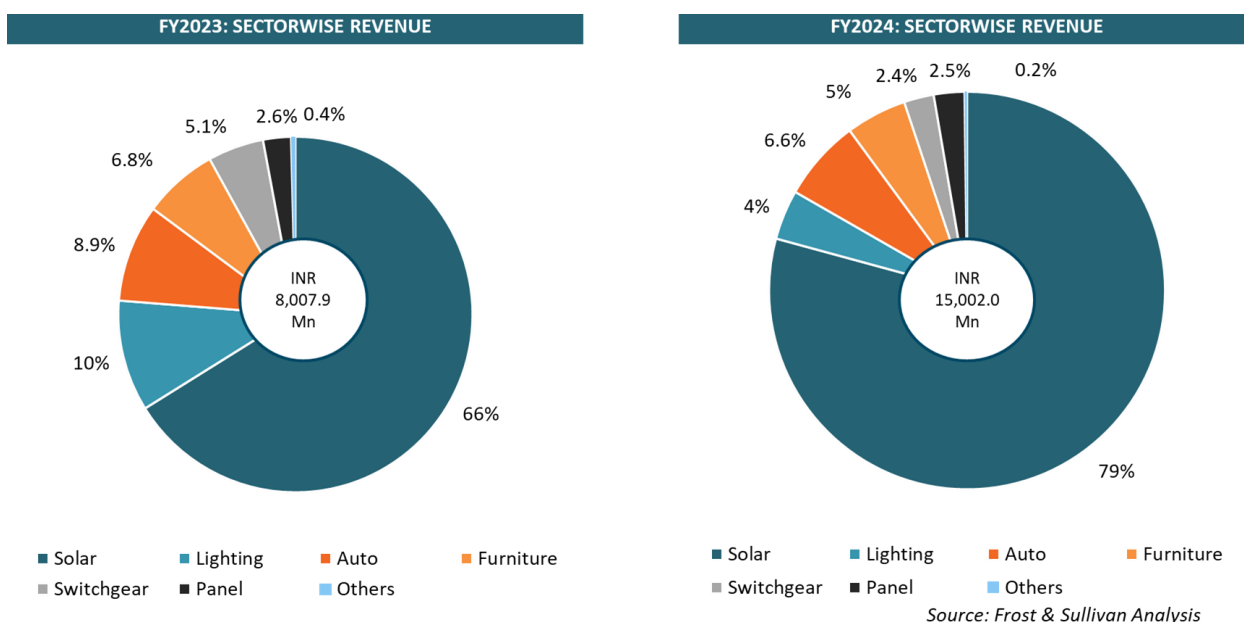
Since its inception, PMEASolar Tech Solutions Limited has provided solutions across diverse sectors and industries. The company has a presence in LED Lighting, Cleanroom Partition Panels, Furniture, Laboratory Furniture, Switchboard Components, Automobile Parts, and the Solar Industry. Its product offerings cater to a wide range of industries including retail, pharmaceutical, medical, architecture, and government sectors.

INDUSTRY SEGMENT	PRODUCT OFFERINGS
Lighting	<ul style="list-style-type: none"> • Lighting solutions for Retail, Pharma, Office, and Government Sector • Products designed for the Government sector to be supplied to Metro, Railway Stations, Airports, Parks including: <ul style="list-style-type: none"> ○ Streetlight ○ Baton Light ○ Pole Light ○ Post Top Light • Spotlight • Down Light • Track Light • Lighting Fixture • Linear Light • Floodlight
Panel Boards	<ul style="list-style-type: none"> • Cleanroom and Operation Theatre partitions • Modular Wall Panels • Ceiling systems including Walkable and Non-Walkable Cleanroom Ceilings • Cleanroom Doors and windows • Vision Panels
Switch Boards and Control Panels	<ul style="list-style-type: none"> • Medium Voltage (MV) switchgear panels <ul style="list-style-type: none"> ○ Feeder Pillars ○ APFC Panels • Low Voltage (LV) switchgear panels including: <ul style="list-style-type: none"> ○ Various capacity VFD Panels and Bus ducts

	<ul style="list-style-type: none"> ○ Power Control Centres ○ Motor Control Centres ○ DG Synchronizing Panels ○ LT Metering Panels 	<ul style="list-style-type: none"> ● Telecommunication panels & CPS ● Electrical DB ● Galvanized Feeder Pillars & Mini Pillars (CRP box)
Furniture	<ul style="list-style-type: none"> ● Furniture solutions for offices and home ● Laboratory furniture ● Sliding Almirah 	<ul style="list-style-type: none"> ● Safe, Storage systems and cabinets ● Iron Tables ● Cloth Dryers
Automobile, and other offerings	<ul style="list-style-type: none"> ● Automobile components & sub-assemblies ● SS Junction Box 	

The company derives a significant portion of its revenue from the Solar Industry, which has grown to represent 79% of its total revenue in FY2024.

Exhibit 10.1: PMEA Solar Tech Solutions Limited’s sector-wise revenue, in INR Million, FY2023 and FY2024



Additionally, it caters to the Lighting sector and provides solutions tailored for various applications across industries. PMEA Solar Tech Solutions Limited’s expertise in Cleanroom solutions spans manufacturing, consultancy, and installation services. Furthermore, the Company’s involvement in the Automobile sector facilitates adaptation to evolving business landscapes across the automotive value chain. The company’s offerings in Furniture and Laboratory Furniture are designed to meet the diverse requirements of its clientele.

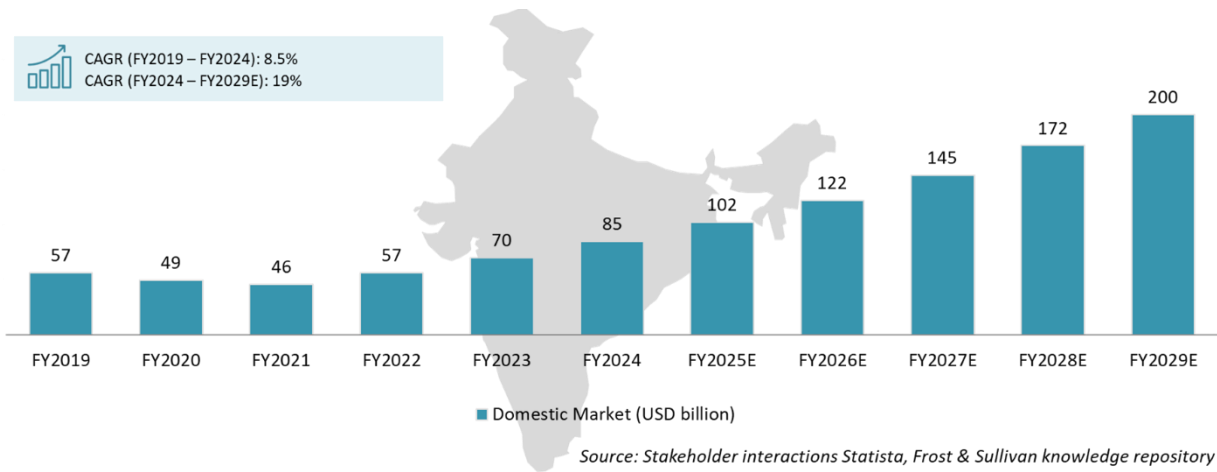
10.2 Overview of the Auto components market in India

India's automotive component industry is poised for substantial growth, projected to reach a market size of USD 200 billion by FY2029E. This growth is propelled by several factors, including the escalating demand for energy-efficient and environment-friendly vehicles leading to increased demand for lighter and more advanced components.

Furthermore, the booming electric vehicle (EV) market is generating a significant demand for specialized EV components. As India positions itself as a global automotive hub, attracting Foreign Direct Investments (FDI) and fostering technological advancements, the auto component sector is poised to play a critical

role. It is noteworthy that despite a moderate CAGR observed from FY2019 to FY2024, the focus on the affordability of components for the domestic market remains a key strength.

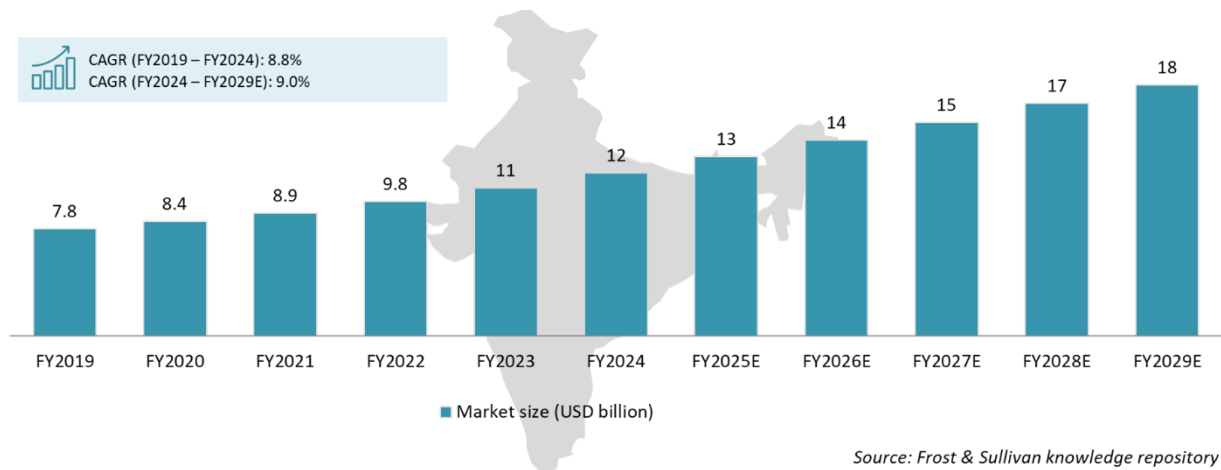
Exhibit 10.2: Indian auto components market, in USD billion, FY2019 to FY2029E



10.3 Overview of the Switchgear market in India

India's power sector is undergoing a major transformation, driven by urbanization, industrial expansion, and the increasing integration of renewable energy. This is fueling significant growth in the switchgear market, which was valued at USD 12 billion in FY2024 and is projected to reach USD 18 billion by FY2029E. The growth is supported by government initiatives in infrastructure development, smart grid implementation, and power network expansion. Low voltage (LV) switchgear currently dominates the market, serving residential, commercial, and industrial sectors. However, demand for medium voltage (MV) and high voltage (HV) switchgear is increasing, especially with the rise of renewable energy and industrial automation.

Exhibit 10.3: Indian switchgear market, in USD billion, FY2019 to FY2029E



For switchgear component manufacturers—those producing electrical panels, steel casings, stamping, and rolling products—this presents a significant opportunity. The rise in demand for LV switchgear, driven by urbanization and higher appliance usage, will increase the need for panel components. Additionally, the focus on automation, smart grids, and advanced switchgear solutions will open up markets for manufacturers that can offer innovative and efficient designs. The push for renewable energy further

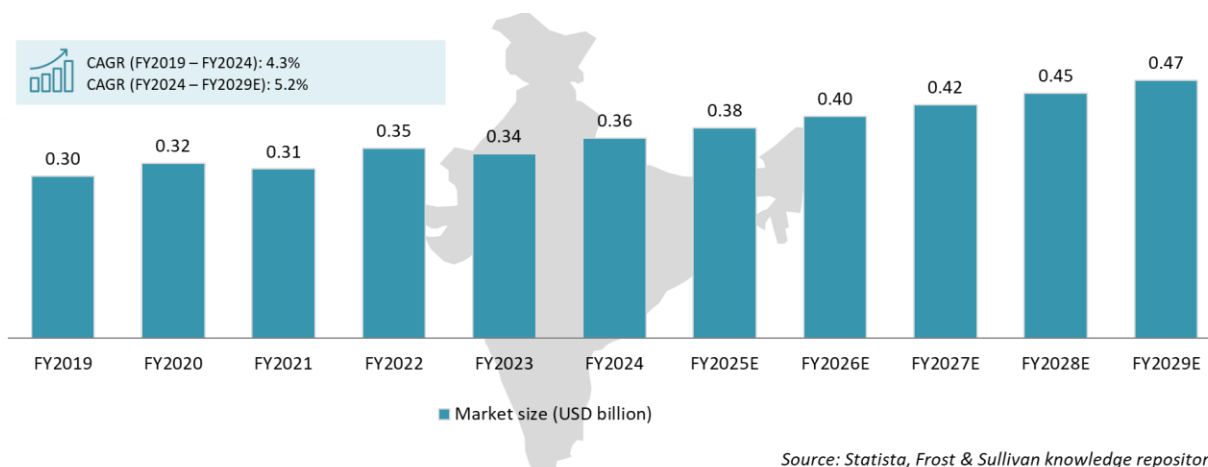
enhances the need for robust power infrastructure, providing an ongoing demand for high-quality switchgear components that can support fluctuating power loads. Domestic manufacturers stand to benefit from the "Make in India" initiative, which emphasizes local production of cost-effective, high-quality products, allowing them to capture a greater share of the market.

Looking forward, sustained infrastructure development and urbanization, combined with a focus on energy efficiency and green technologies, will continue to drive growth. As India integrates more renewable energy sources, reliable switchgear and its components will be crucial for managing power variations. This offers a substantial opportunity for component manufacturers to position themselves as key suppliers in the growing switchgear market by aligning with market trends and technological advancements.

10.4 Overview of the Lighting market in India

The Indian lighting industry is set for substantial growth, projected to reach USD 0.47 billion by FY2029E from USD 0.36 billion in FY2024, with a CAGR of 5.2%. This growth is driven by several factors. Energy efficiency is a major factor, with LED technology providing significant cost savings and rapidly replacing traditional bulbs across various applications, including automotive, general illumination, advertising, and specialized uses.

Exhibit 10.4: Indian lighting market, in USD billion, FY2019 – FY2029E



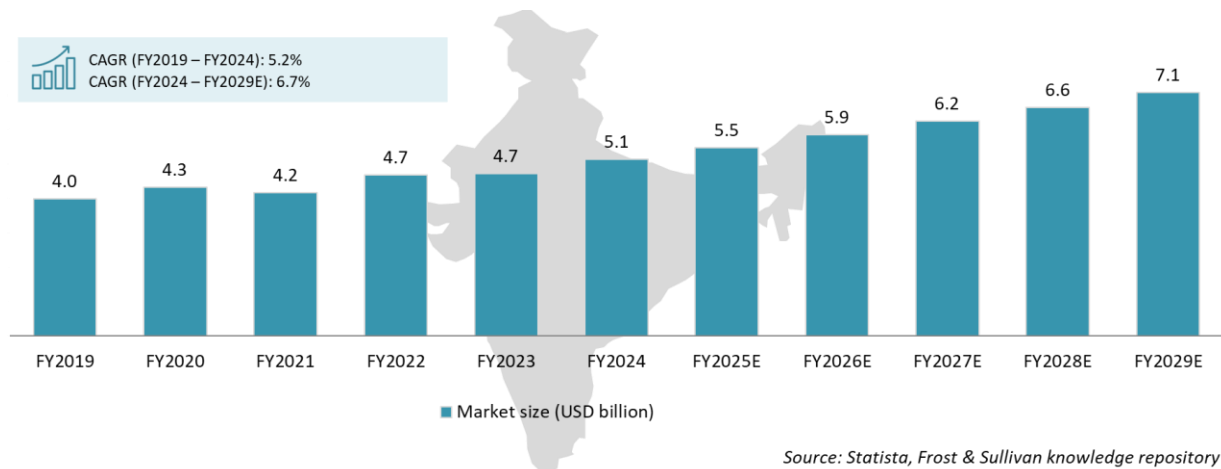
The influx of competitive Chinese LED manufacturers is pushing domestic players to innovate and offer cost-effective solutions. Urbanization also plays a crucial role, driving the demand for well-lit infrastructure such as highways, commercial complexes, and airports. Additionally, LEDs are becoming the preferred choice for energy-intensive commercial buildings like malls, offices, and hospitals, leading to reduced operating costs. Enhanced safety is another advantage, as LED lights offer superior illumination, which is particularly beneficial in parking lots by deterring theft and vandalism. The growth of the lighting market faces challenges, including disruptions in the real estate and construction industries and the lingering effects of the COVID-19 pandemic, which caused production delays, supply chain issues, and price fluctuations. Smaller companies have been particularly affected by the pandemic’s financial impacts. Despite these hurdles, India’s lighting market is poised for growth, driven by rising demand for energy-efficient LED technology and ongoing urbanization.

This growth boosts demand for precisely manufactured metal components used in lighting fixtures. Rolling mills and stamping companies are crucial in supplying these components. Sheet metal casings, produced by rolling mills, are essential for housing electrical components and diffusers in lighting fixtures. Reflectors, made from stamped metal sheets, are vital for directing light effectively. Additionally, rolling mills supply the sheet metal for heat sinks, which are stamped into shape to manage the heat generated by LEDs.

10.5 Overview of the Furniture market in India

The Indian furniture market is forecasted to emerge as a significant industry, generating USD 5.1 billion in revenue by FY2024. It is expected to sustain steady growth, with a projected CAGR of 6.7% from FY2024 to FY2029E. While the US furniture market currently leads globally in revenue, India's market exhibits promising growth prospects. This expansion is anticipated to stimulate demand for stamping and rolling products essential in furniture manufacturing, thereby presenting potential advantages for companies such as PMEA Solar Tech Solutions Limited that specialised in supplying these products to the furniture sector.

Exhibit 10.5: Indian furniture market, in USD billion, FY2019 – FY2029E



10.6 Overview of the EV market in India

The electric vehicle (EV) market in India is undergoing remarkable expansion, driven by a confluence of factors. Starting from 145,989 units sold in FY2019, the market experienced a substantial increase in FY2024, reaching an impressive 1.7 million units. This surge is attributable to several key drivers:

- **Government Incentives:** Initiatives like the FAME scheme offer subsidies and support for EV adoption, making them more affordable for consumers. Government support in this regard plays a crucial role in accelerating EV sales.
- **Rising Environmental Concerns:** Increasing awareness about environmental pollution and the need for sustainable solutions is compelling consumers to shift towards EVs.
- **Technological Advancements:** Continuous advancements in battery technology, charging infrastructure, and overall EV performance are increasingly rendering EVs a more viable and attractive option.

However, the market did experience a setback in FY2021 with an 18% decline in sales compared to FY2020. This is attributed to factors including temporary supply chain disruptions and policy revisions.

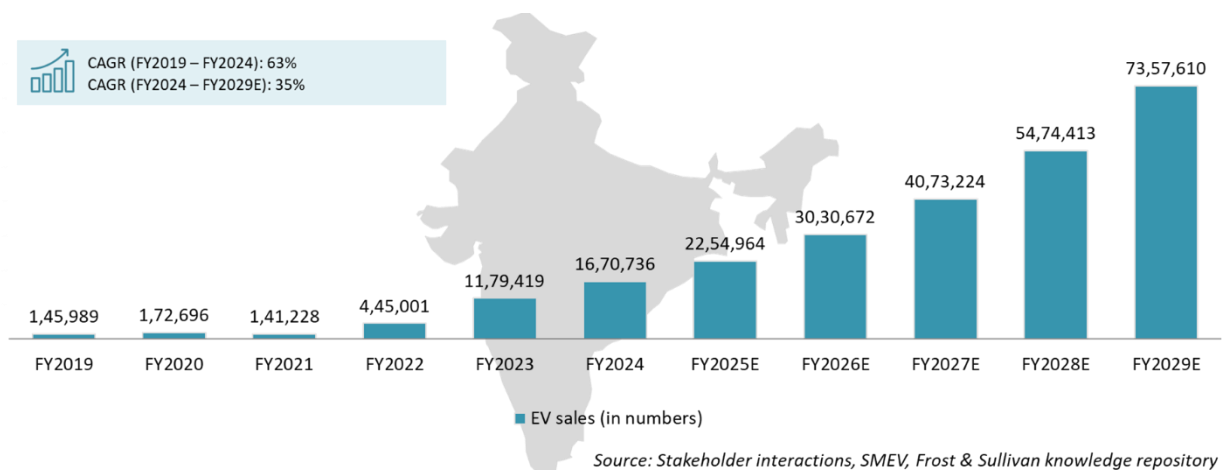
Despite this, the market quickly rebounded in FY2022 and has maintained a strong growth trajectory since. Looking ahead, the future of India's EV market appears bright. The growth in EV sales indicates a CAGR of 63% between FY2019 and FY2024 and a projected CAGR of 35% from FY2024 to FY2029E. This signifies a rapidly expanding market with immense potential.

The Indian government's ambitious target of substantially increasing EV penetration across all vehicle segments by 2030 further reinforces this optimistic outlook. This vision, combined with ongoing government backing, technological advancements and rising consumer demand, positions India as a potential leader in the global EV revolution.

However, to fully capitalize on this potential, it is essential to address certain critical challenges:

- **Battery Costs:** While costs are coming down, making EVs more affordable remains a key focus.
- **Charging Infrastructure:** Expanding and improving charging infrastructure across the country is essential to address range anxiety among potential buyers.
- **Consumer Awareness:** Continued efforts are needed to educate consumers about the benefits and economics of EVs.

Exhibit 10.6: Indian EV market, in volume (in numbers), FY2019 – FY2029E



The growing EV market presents a significant opportunity for companies like PMEA Solar Tech Solutions Limited that manufacture stamping products and rolled products. These precisely engineered metal components are crucial for various EV parts, including:

- **Chassis and Body Components:** EV chassis and body structures often utilize lightweight, high-strength steel produced by rolling mills. Stamping companies then transform this sheet metal into complex shapes for doors, hoods, and other body panels.
- **Battery Housings:** Durable and precisely formed metal enclosures, manufactured from rolled products and stamped into shape, are essential for protecting EV batteries.
- **Motor Components:** Electric motors within EVs rely on stamped laminations and other metal components for efficient operation.

As the EV market expands, the demand for these critical metal components will rise proportionally, translating into a significant growth opportunity for companies including PMEA Solar Tech Solutions Limited, who are well-positioned to cater to the needs of this burgeoning industry.

11. COMPETITIVE BENCHMARKING

11.1 Operational Benchmarking

A. PMEA Solar Tech Solutions Limited

Company Overview	<ul style="list-style-type: none"> PMEA Solar Tech Solutions Limited is a company focused on manufacturing and supplying solar trackers and fixed tilt components. These products are integral to the installation and operation of solar energy systems. Strategically located near Mundra port, their Mundra facility enjoys a prime location for efficient logistics and distribution resulting in reduced turnaround times and cost savings.
Product Offerings	<ul style="list-style-type: none"> The company makes solar tracking and mounting products and utilizes advanced processes and machinery. Their capabilities include sheet metal fabrication, robotic and seam welding, and conveyorized powder coating. They operate dedicated press lines for MMA Rails and extra heavy MMA products and employ spot welding, bending, and drilling SPMs (Special Purpose Machines), along with a bend saw
Key Clients	<ul style="list-style-type: none"> Nexttracker LLC Sterling and Wilson

B. Purshotam Profiles Pvt. Ltd.

Company Overview	<ul style="list-style-type: none"> Purshottam Profiles is a company involved in the manufacturing of steel structures and profiles. The company specializes in producing a range of steel components, including solar tracker structures and fixed tilt mounting systems, which are used in solar power installations. Their focus is on delivering durable and efficient steel solutions for various industrial applications.
Product Offerings	<ul style="list-style-type: none"> The company is a recognized vendor for leading solar EPC players and developers, supplying solar module mounting structures, tracker structures, cable trays, and walkways. Their products include module mounting structures and tubes.
Key Clients	<ul style="list-style-type: none"> NTPC Renew Sterling and Wilson Tata Power Solar Waaree Eden Renewables

C. Metalkraft Forming Industries Pvt Ltd

Company Overview	<ul style="list-style-type: none"> Metalkraft Forming Industries Pvt Ltd manufactures metal components and assemblies, serving various sectors including the solar industry. The company produces solar tracker structures and fixed tilt mounting systems, which are utilized in solar installations across India.
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Product Offerings	<ul style="list-style-type: none"> • Metalkraft Forming Industries Pvt Ltd manufactures components for both fixed-tilt and tracker solar PV mounting systems. They offer a variety of mounting solutions, including rooftop structures, ground-mounted systems, and carport structures, tailored to support different types of solar installations.
Key Clients	<ul style="list-style-type: none"> • NA

D. Hi-Tech Pipes Limited

Company Overview	<ul style="list-style-type: none"> • Hi-Tech Pipes Limited manufactures a range of steel pipes used in various industrial applications. The company provides products that comply with industry standards for quality and performance.
Product Offerings	<ul style="list-style-type: none"> • Hi-Tech Pipes Limited supplies a range of products for both fixed tilt and tracker solar applications. Their offerings include pipes, coils, hollow sections, strips, torque tubes, and solar mounting sections, all designed to support and enhance the structural integrity of solar panel systems.
Key Clients	<ul style="list-style-type: none"> • Reliance Industries Ltd • Indian Oil • NTPC • HPCL • BHEL • GMR

E. Goodluck India

Company Overview	<ul style="list-style-type: none"> • Goodluck India produces steel pipes and tubes for diverse applications, including solar, infrastructure and construction.
Product Offerings	<ul style="list-style-type: none"> • Goodluck India provides a range of products for both fixed tilt and tracker solar installations, tailored to meet specific structural and environmental needs. Their offerings include mounting structures for ground mounts and carports, as well as solar tracker components such as torque tubes, transition shafts, bearing heads, and clamps. They also supply various tubes, pipes, flanges, hollow sections, coils, and sheets, including ERW, galvanized, MS, square, rectangular, and pre-galvanized pipes.
Key Clients	<ul style="list-style-type: none"> • Larsen & Toubro • Thermax • ISGEC Heavy engineering • Thyssen Krupp

F. Karamtara Engineering Pvt. Ltd.

Company Overview	<ul style="list-style-type: none"> • Karamtara Engineering produces steel pipes and tubes for use in construction, infrastructure, and industrial sectors. The company offers products like structural pipes, hollow sections, and line pipes.
Product Offerings	<ul style="list-style-type: none"> • Karamtara Engineering Pvt. Ltd. manufactures a range of steel structures and components for solar PV mounting systems, catering to both fixed tilt and tracker applications. Their product lineup includes ground and rooftop module mounting structures, H-beams, piers, steel piles, torque beams and tubes, as well as fasteners such as bolts, nuts, and washers.
Key Clients	<ul style="list-style-type: none"> • Power Grid Corporation • Larsen & Toubro • LANCO • Bajaj • BHEL • NTPC

G. APL Apollo

Company Overview	<ul style="list-style-type: none">• APL Apollo produces a wide range of steel pipes and tubes used in construction and infrastructure projects. The company is known for its extensive product portfolio and adherence to industry quality standards.
Product Offerings	<ul style="list-style-type: none">• APL Apollo offers a range of products used in both fixed tilt and tracker solar installations for structural support and mounting. Their offerings include ERW pipes (Electric Resistance Welded Pipes), galvanized and pre-galvanized pipes, and square and rectangular tubes. These products provide essential structural support, with the square and rectangular tubes specifically designed to handle the stresses associated with moving parts in tracker systems.
Key Clients	<ul style="list-style-type: none">• Larsen & Toubro• Godrej• DLF Limited• Shapoorji Pallonji Group• Tata Projects

11.2 Financial Benchmarking

Exhibit 11.1(a): Key financial indicators of key competitors, value in INR Million, FY2022 – FY2024

Financial Indicators	Years	PMEA Solar	APL Apollo	Goodluck India	Hi Tech Pipes	Karamtara Engineering	Purshotam Profiles	Metalkraft Forming
Revenue from Operations INR Million	FY2022	5,585.37	1,30,633.20	26,132.13	18,788.47	12,448.09	16,857.60	5,539.10
	FY2023	8,007.90	1,61,659.50	30,720.08	23,858.47	16,003.07	15,015.50	5,210.45
	FY2024	15,002.04	1,81,188.00	35,247.76	26,992.93	NA	NA	NA
Revenue from Operations Y-O-Y Growth in %	FY2022	NA	NA	NA	NA	NA	NA	NA
	FY2023	43.37%	23.75%	17.56%	26.98%	28.56%	-10.93%	-5.93%
	FY2024	87.34%	12.08%	14.74%	13.14%	NA	NA	NA
EBITDA INR Million	FY2022	589.30	9,452.60	1,829.95	1,005.18	1,296.97	586.20	321.06
	FY2023	887.20	10,215.50	2,043.71	1,032.11	1,536.02	450.00	313.66
	FY2024	2,093.88	11,921.70	2,822.41	1,148.59	NA	NA	NA
EBITDA Marging in %	FY2022	10.55%	7.24%	7.00%	5.35%	10.42%	3.48%	5.80%
	FY2023	11.08%	6.32%	6.65%	4.33%	9.60%	3.00%	6.02%
	FY2024	13.96%	6.58%	8.01%	4.26%	NA	NA	NA
PAT INR Million	FY2022	448.20	6,189.80	750.11	403.26	126.46	402.10	165.12
	FY2023	274.40	6,418.60	878.01	376.81	423.60	212.20	164.41
	FY2024	1,036.39	7,324.40	1,322.68	439.31	NA	NA	NA

Source: Annual Reports of Companies published in RoC, MCA; Frost & Sullivan Analysis

Exhibit 11.1(b): Key financial indicators of key competitors, value in INR Million, FY2022 – FY2024

Financial Indicators	Years	PMEA Solar	APL Apollo	Goodluck India	Hi Tech Pipes	Karamtara Engineering	Purshotam Profiles	Metalkraft Forming
PAT Margin in %	FY2022	7.58%	4.72%	2.87%	2.15%	1.01%	2.37%	2.98%
	FY2023	3.39%	3.96%	2.84%	1.58%	2.65%	1.41%	3.15%
	FY2024	6.81%	4.03%	3.74%	1.63%	NA	NA	NA
RoCE in %	FY2022	25.63%	30.44%	14.95%	14.75%	12.23%	43.09%	19.39%
	FY2023	17.25%	24.77%	15.33%	14.08%	15.87%	28.23%	20.06%
	FY2024	28.65%	24.89%	15.98%	10.70%	NA	NA	NA
RoE in %	FY2022	40.94%	25.12%	16.10%	15.59%	2.75%	50.10%	20.19%
	FY2023	20.13%	21.36%	14.16%	9.01%	8.46%	20.91%	17.29%
	FY2024	43.29%	20.32%	11.82%	7.62%	NA	NA	NA
Net working capital in INR Million	FY2022	1,058.73	1,294.70	6,079.96	3,471.58	3,476.38	847.90	1,137.41
	FY2023	2,494.20	203.10	7,432.16	3,181.21	3,965.04	468.90	920.33
	FY2024	4,391.57	-2,046.20	8,231.32	4,695.39	NA	NA	NA
Net working capital days	FY2022	82.64	2.42	101.29	70.31	108.63	-10.48	79.75
	FY2023	159.26	0.11	103.17	51.51	98.35	-32.10	68.60
	FY2024	133.10	-5.37	101.46	68.52	NA	NA	NA
Net debt to equity	FY2022	1.67	0.17	1.27	1.41	0.79	0.87	0.86
	FY2023	2.04	0.25	0.96	0.56	0.54	0.61	0.51
	FY2024	1.93	0.22	0.45	0.63	NA	NA	NA

Source: Annual Reports of Companies published in RoC, MCA; Frost & Sullivan Analysis