

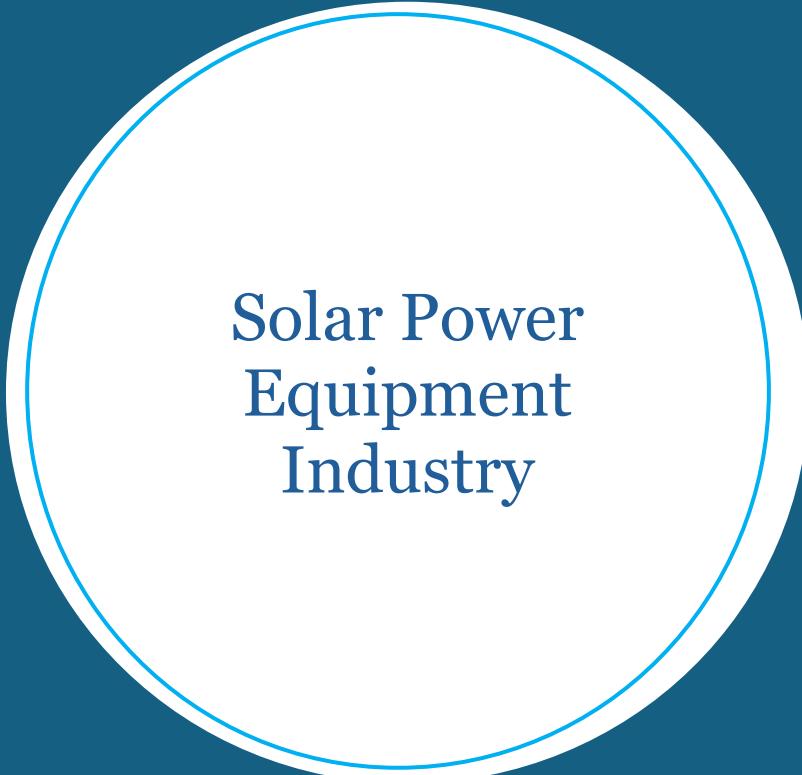
# Infomerics

## Analytics & Research

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**Solar Power  
Equipment  
Industry**

Dated: January 05,  
2026

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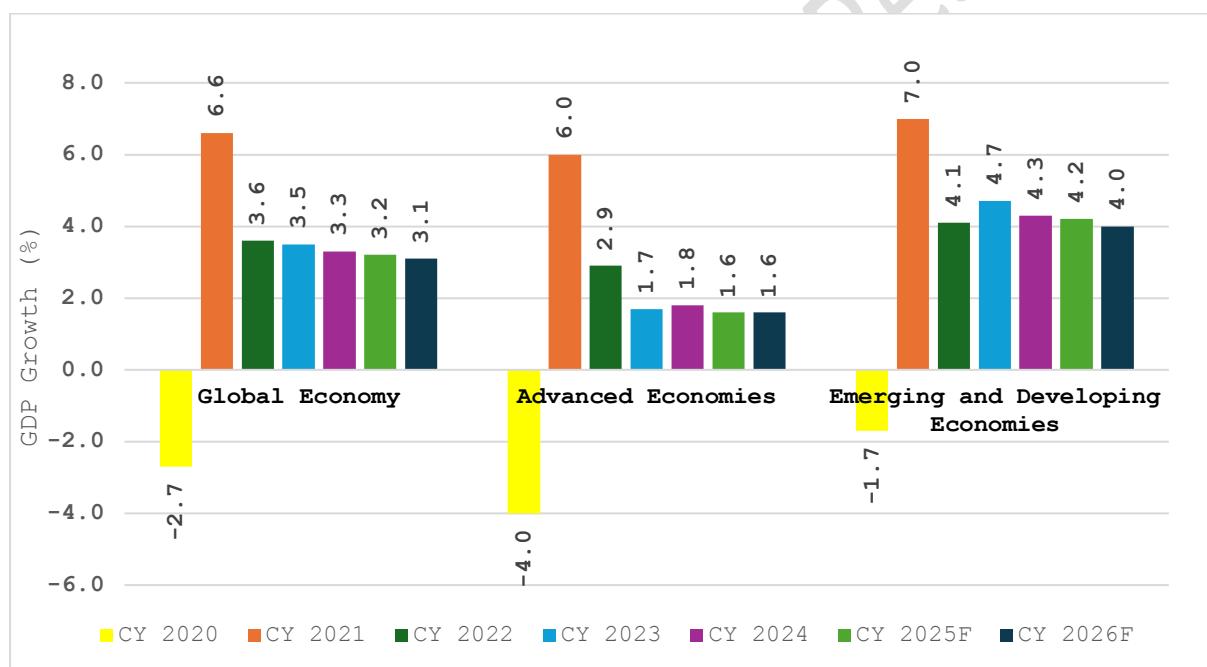
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## 1. Global Economic Outlook

The global output is expected to grow by 3.2% in CY 2025, down from 3.3% in CY 2024, and moderating to 3.1% in CY 2026. This deceleration reflects a combination of lingering trade tensions, policy uncertainties, and region-specific structural challenges.

Global inflation is expected to ease, with headline inflation forecast at 4.2% in CY 2025 and 3.7% in CY 2026, supported by tighter monetary policies in advanced economies, improving labour market conditions, and the gradual resolution of supply-side disruptions. Global trade growth is set to moderate to 3.6% in CY 2025 and further to 2.3% in CY 2026, reflecting the impact of elevated trade barriers and geopolitical instability.



F – Forecast, Source – IMF World Economic Outlook October 2025

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

Advanced Economies are projected to slow, with GDP growth at 1.6% in CY 2025 and CY 2026. The United States is expected to expand by 2.0% in CY 2025 and 2.1% in CY 2026, supported by resilient consumer spending despite fiscal and trade pressures. The Euro Area faces

subdued growth at 1.2% in CY 2025, with Germany at 0.2% and France at 0.7%, amid lingering trade disruptions and domestic challenges. Japan's growth is forecast at 1.1% in CY 2025, reflecting weak domestic demand, while the United Kingdom is projected to grow at 1.3%.

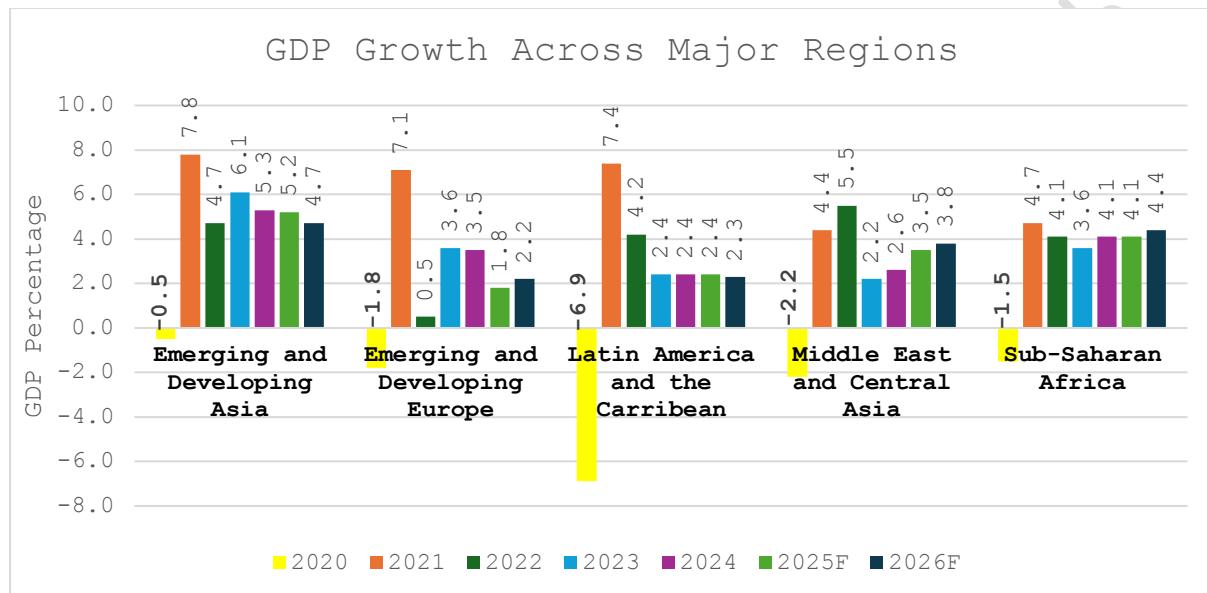
Emerging Markets and Developing Economies are expected to maintain moderate expansion, with GDP growth of 4.2% in CY 2025 and 4.0% in CY 2026. China's growth is projected at 4.8% in CY 2025, slightly higher than previously expected, constrained by real estate sector weakness and soft consumer demand. India is projected to grow at 6.6% in CY 2025 and 6.2% in CY 2026, driven by robust rural consumption, infrastructure investment, favourable demographics, and digitalisation. Other key economies, including Brazil (2.4%) and Russia (0.6%) in CY 2025, are expected to grow more slowly amid structural and geopolitical challenges.

Global commodity prices are anticipated to remain volatile. Oil prices are projected to decline by 12.9% in CY 2025, following a 1.8% decline in CY 2024, before recovering moderately in CY 2026. Non-fuel commodities are expected to increase by 7.4% in CY 2025, driven by agricultural and industrial demand.

Overall, the global economic outlook indicates slowing growth, easing inflation, and continued uncertainty due to geopolitical tensions and trade fragmentation. Nevertheless, India stands out as a relative growth leader among major economies, supported by macroeconomic stability, demographic advantages, and continued investment-led expansion.

### 1.1 GDP Growth across Major Regions

GDP growth across major global regions—including Europe, Latin America & the Caribbean, Middle East & Central Asia, and Sub-Saharan Africa—continues to display varied trajectories. While some regions are stabilizing post-pandemic, others remain challenged by structural and cyclical issues. The global outlook presents a mixed scenario, with emerging economies continuing to outperform advanced economies.



Source-IMF World Economic Outlook October 2025 update

In Emerging and Developing Asia, growth is projected to moderate from 5.3% in CY 2024 to 5.2% in CY 2025, before slightly declining to 4.7% in CY 2026. India is expected to grow at 6.6% in CY 2025, supported by resilient rural consumption and sustained infrastructure investments, up from 6.5% in CY2024. In contrast, China's growth is anticipated to decelerate to 4.8% in CY2025, amid persistent real estate concerns and subdued domestic demand.

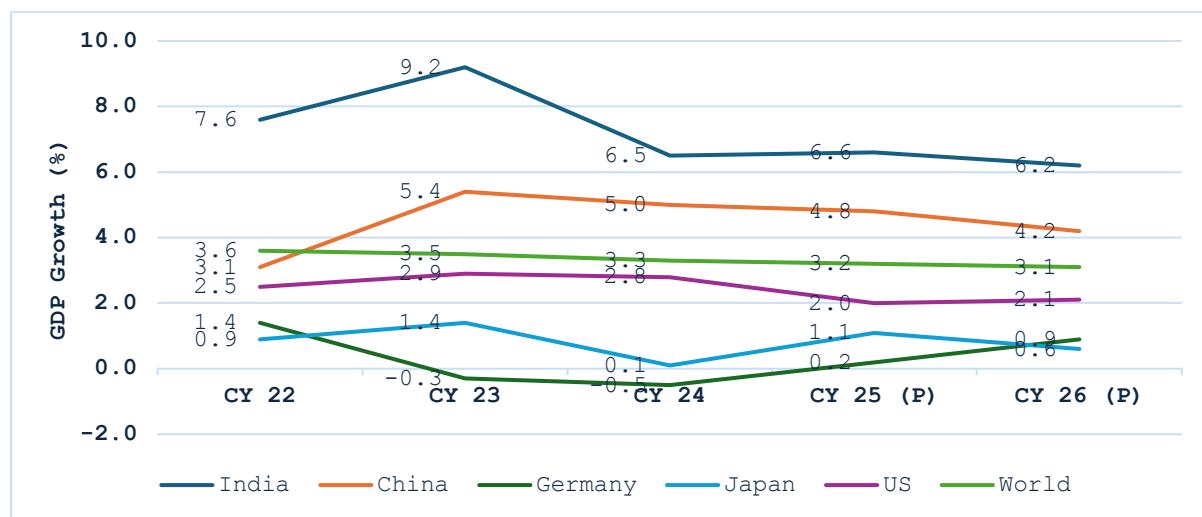
Sub-Saharan Africa is projected to grow at 4.1% in CY 2025, maintaining the same pace as CY 2024, with growth expected to accelerate slightly to 4.4% in CY 2026. This gradual improvement is being supported by better weather conditions and more efficient supply chain operations.

In the Middle East and Central Asia, the economy is forecasted to expand at 3.5% in CY 2025, up from 2.6% in CY 2024, and further strengthen to 3.8% in CY 2026, driven by stabilization in oil production and ongoing economic reforms.

For Latin America and the Caribbean, modest growth of 2.4% is forecast for CY 2025, unchanged from 2.4% in CY2024, with a slight moderation to 2.3% in CY2026, reflecting stable yet subdued economic momentum supported by stronger macroeconomic management across key economies.

Emerging and Developing Europe remains subdued, with growth estimated at 1.8% in CY 2025, down from 3.5% in CY 2024, expected to rise modestly to 2.2% in CY 2026. The region continues to face structural manufacturing challenges, particularly in major economies like Germany.

#### India and Top 4 Global Economies GDP Growth Forecast



Note: P = Projections, Source: IMF World Economic Outlook October 2025 update

Overall, while global growth is expected to remain steady at 3.2% in CY 2025, regional disparities persist, influenced by a combination of domestic challenges, external geopolitical tensions, and fluctuating commodity prices.

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## 2. India's Macroeconomic Scenario

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### **2.1 Gross Domestic Product (GDP)**

***India's real GDP has shown a glittering growth at 8.2% in the second quarter (Q2) of FY26*** compared to the growth rate of 5.6% during Q2 of FY25, whereas nominal GDP has witnessed a growth rate of 8.7% in Q2 of FY 2025-26.

In its latest Economic Outlook, the OECD noted that India remains one of the fastest-growing major economies, supported by strong investment activity and resilient services. OECD highlighted that India's GDP is projected to grow by 6.7% in fiscal year 2025-26, 6.2% in 2026-27 and 6.4% in 2027-28. Despite some likely impact of the US tariff on Indian exports, private consumption will be supported by rising real incomes as inflation remains soft and low consumption/indirect taxes (GST). Going forward, investment will be sustained by declining borrowing costs and strong public capital expenditure. Current low headline inflation is projected to gradually converge towards the 4% target. Notably, India's Headline Inflation drops to 0.25 % in October 2025.

**India's Economic Growth Momentum Remains Strong - Surpassed USD 4 Trillion.**

In June 2025, India became the fourth-largest economy in the world and retained its position as the fastest-growing major economy. The country is projected to become the world's third largest economy by 2030, with an estimated GDP of USD 7.3 trillion.

*Source: PIB, Press Release - India Becoming an Economic Powerhouse posted on June 16, 2025*

India achieved a significant milestone by overtaking Japan to become the *third most powerful nation in the Asia-Pacific region*, as per the Asia Power Index 2024. India's overall score rose to 39.1, reflecting a 2.8-point increase from the previous year, driven by growing influence across economic, military, and diplomatic dimensions.

*Source: PIB, Press Release - India becomes 3rd Most Powerful Nation in Asia, Surpasses Japan in Asia Power Index posted on September 24, 2024*

Key factors behind India's rise include its strong economic performance, expanding and youthful workforce, and increasing strategic engagement across the region. India's Economic Capability improved significantly, supported by its position as the world's third-largest economy in terms of purchasing power parity (PPP). Additionally, a notable increase in its Future Resources score highlights the demographic advantage that is expected to sustain its growth trajectory in the coming years.

## 2.2 Gross Value Added (GVA)

Real GVA in Q2 of FY 2025-26 is estimated at ₹44.77 lakh crore, against ₹41.41 lakh crore in Q2 of FY 2024-25, registering a growth rate of 8.1%. Nominal GVA in Q2 of FY 2025-26 is estimated at ₹77.69 lakh crore, against ₹71.45 lakh crore in Q2 of FY 2024-25, showing a growth rate of 8.7%.

### **Quarterly Estimates of GVA at Basic Prices for Q2 (July-September) 2025-26 (at 2011-12 Prices) (₹ Crore)**

Sector	GVA at Basic Price							
	2023-24		2024-25		2025-26		Percentage Change Over Previous Year	
	Q1	Q2	Q1	Q2	Q1	Q2	2024-25	2025-26
	₹	₹	₹	₹	₹	₹	₹	₹
<b>1. Primary Sector</b>	<b>6,24,534</b>	<b>5,22,188</b>	<b>6,38,065</b>	<b>5,40,666</b>	<b>6,55,701</b>	<b>5,57,501</b>	<b>2.2</b>	<b>3.5</b>
1.1 Agriculture, Livestock, Forestry & Fishing	5,40,008	4,56,998	5,47,919	4,75,765	5,68,374	4,92,623	1.5	4.1
1.2. Mining & Quarrying	84,526	65,190	90,146	64,901	87,327	64,878	6.6	-0.4
<b>2. Secondary Sector</b>	<b>10,89,237</b>	<b>11,27,299</b>	<b>11,82,833</b>	<b>11,72,416</b>	<b>12,65,896</b>	<b>12,67,823</b>	<b>8.6</b>	<b>4.0</b>
2.1. Manufacturing	6,56,922	7,05,592	7,06,798	7,20,846	7,61,394	7,86,670	7.6	2.2
2.2. Electricity, Gas, Water Supply & Other Utility Services	96,203	1,00,019	1,05,981	1,02,970	1,06,470	1,07,519	10.2	3.0
2.3. Construction	3,36,112	3,21,688	3,70,054	3,48,601	3,98,032	3,73,634	10.1	8.4
<b>3. Tertiary Sector</b>	<b>21,78,681</b>	<b>22,63,703</b>	<b>23,26,433</b>	<b>24,27,523</b>	<b>25,42,237</b>	<b>26,51,589</b>	<b>6.8</b>	<b>7.2</b>
3.1 Trade, Hotels, Transport, Communication & Services related to Broadcasting	6,53,847	7,13,765	6,89,172	7,57,326	7,48,348	8,13,369	5.4	6.1
3.2 Financial, Real Estate & Professional Services	10,55,657	10,47,187	11,25,793	11,22,890	12,32,476	12,37,877	6.6	7.2
3.3 Public Administration, Defence & Other Services*	4,69,176	5,02,752	5,11,468	5,47,308	5,61,413	6,00,343	9.0	8.9
<b>GVA at Basic Prices</b>	<b>38,92,452</b>	<b>39,13,191</b>	<b>41,47,331</b>	<b>41,40,606</b>	<b>44,63,834</b>	<b>44,76,914</b>	<b>6.5</b>	<b>5.8</b>
Net Taxes	2,77,663	3,41,615	2,94,333	3,52,981	3,24,789	3,86,426	6.0	3.3
<b>GDP®</b>	<b>41,70,114</b>	<b>42,54,806</b>	<b>44,41,664</b>	<b>44,93,587</b>	<b>47,88,623</b>	<b>48,63,340</b>	<b>6.5</b>	<b>5.6</b>
							7.8	8.2

\* Public Administration, Defence & Other Services category includes the Other Services sector i.e. Education, Health, Recreation, and other personal services @GDP (Production/Income Approach) = GVA at Basic Price + Net Taxes on Products

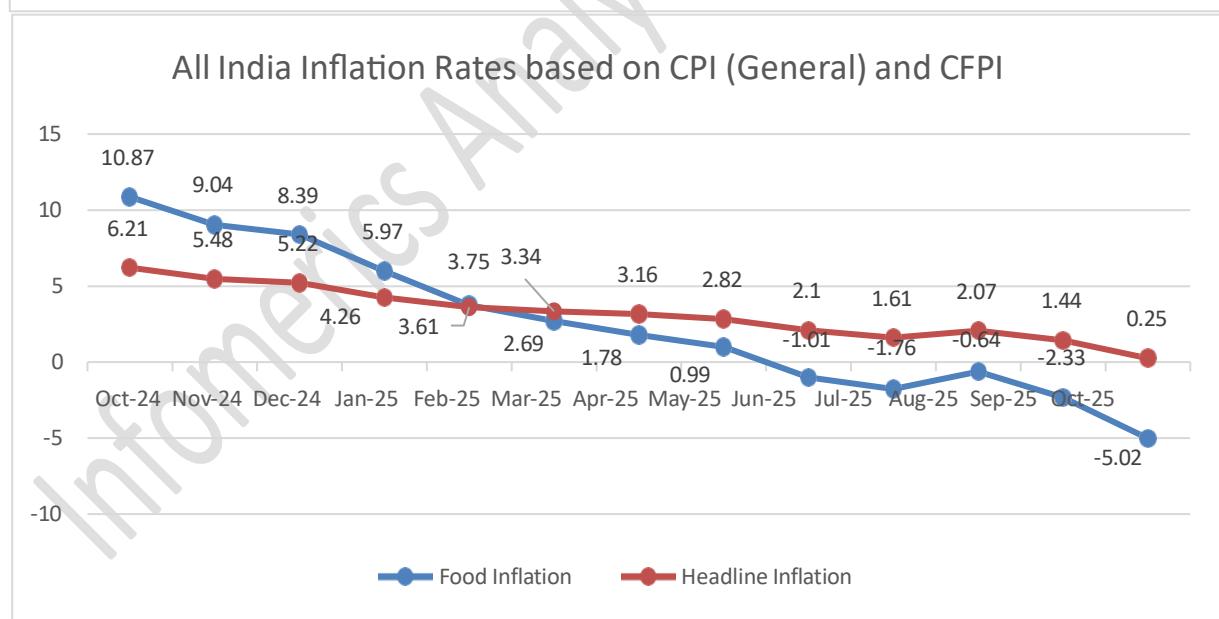
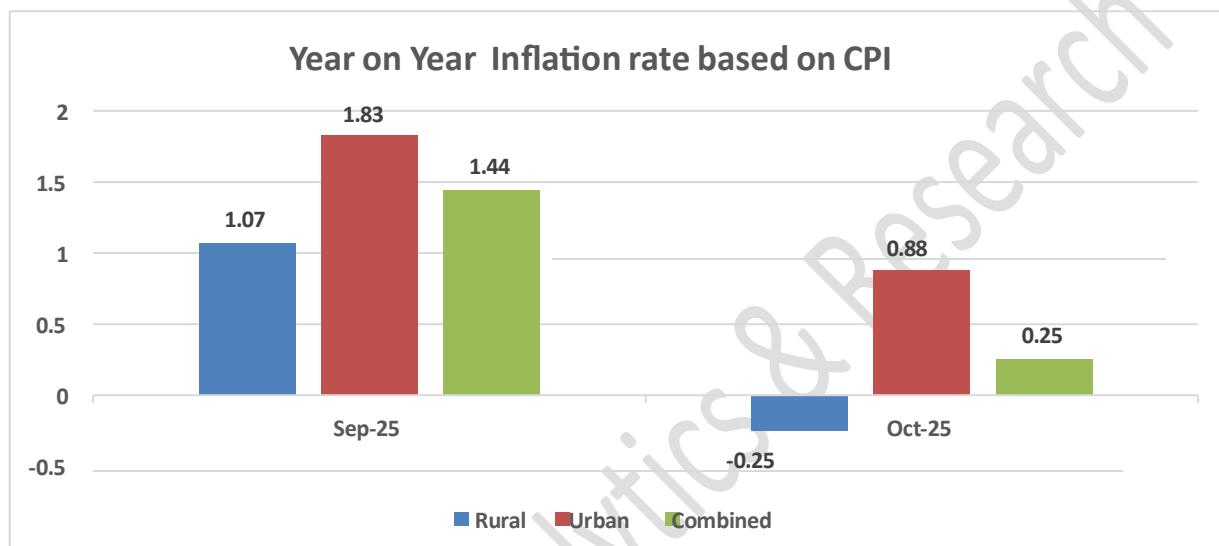
#### **Major Highlights:**

- Real GDP has been estimated to grow by 8.2% in Q2 of FY 2025-26 against the growth rate of 5.6% during Q2 of FY 2024-25.
- Nominal GDP has witnessed a growth rate of 8.7% in Q2 of FY 2025-26.
- The Secondary (8.1%) and Tertiary Sector (9.2%) has boosted the Real GDP growth rate in Q2 of FY 2025-26 to rise above 8.0%.
- Manufacturing (9.1%) and Construction (7.2%) in the Secondary Sector, has registered above 7.0% growth rate at Constant Prices in this quarter.
- Financial, Real Estate & Professional Services (10.2%) in the Tertiary Sector has sustained a substantial growth rate at Constant Prices in Q2 of FY 2025-26.
- Agriculture and Allied (3.5%) and Electricity, Gas, Water Supply and Other Utility Services Sector (4.4%) has seen moderated Real growth rate during Q2 of FY 2025-26.
- Real Private Final Consumption Expenditure (PFCE) has reported 7.9% growth rate during Q2 of FY 2025-26 as compared to the 6.4% growth rate in the corresponding period of previous financial year.

## 2.3 Consumer Price Index (CPI)

### *CPI is at its lowest level*

Year-on-year (YOY) inflation rate based on All India Consumer Price Index (CPI) for the month of October 2025 over October 2024 is 0.25% (Provisional). There is decrease of 119 basis points in headline inflation of October 2025 in comparison to September 2025. It is the lowest year-on-year inflation of the current CPI series.

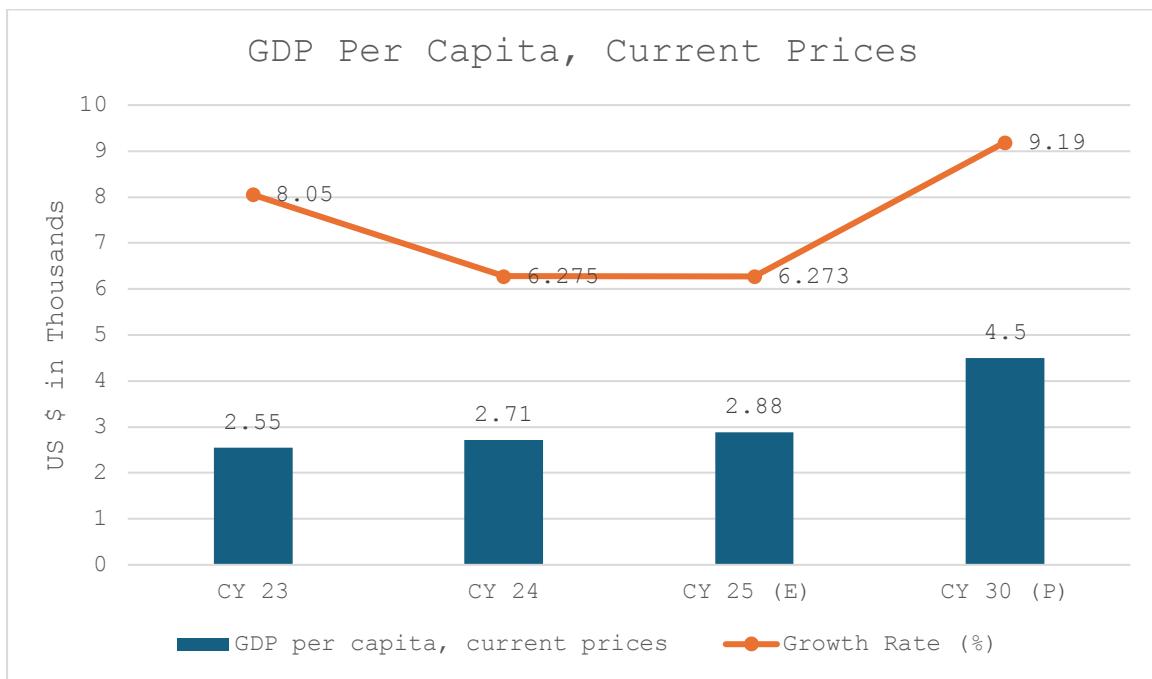


Source: MOSPI, GOI

The decline in headline inflation and food inflation during the month of October 2025 is mainly attributed to full month's impact of decline in GST, favorable base effect and to drop in inflation of Oils and fats, Vegetables, Fruits, Egg, Footwear, Cereals and products, Transport and Communication etc.

## 2.4 India Per Capita GDP Forecast

Per capita GDP growth for India is estimated at 9.19 % CAGR between CY2025-CY2030. Increased individual incomes are expected to create additional discretionary spending, which may be beneficial for the sector.



*Note: E = Estimated, P = Projected*

Source: IMF Data Mapper, World Economic Outlook April 2025, India, GDP Per Capita

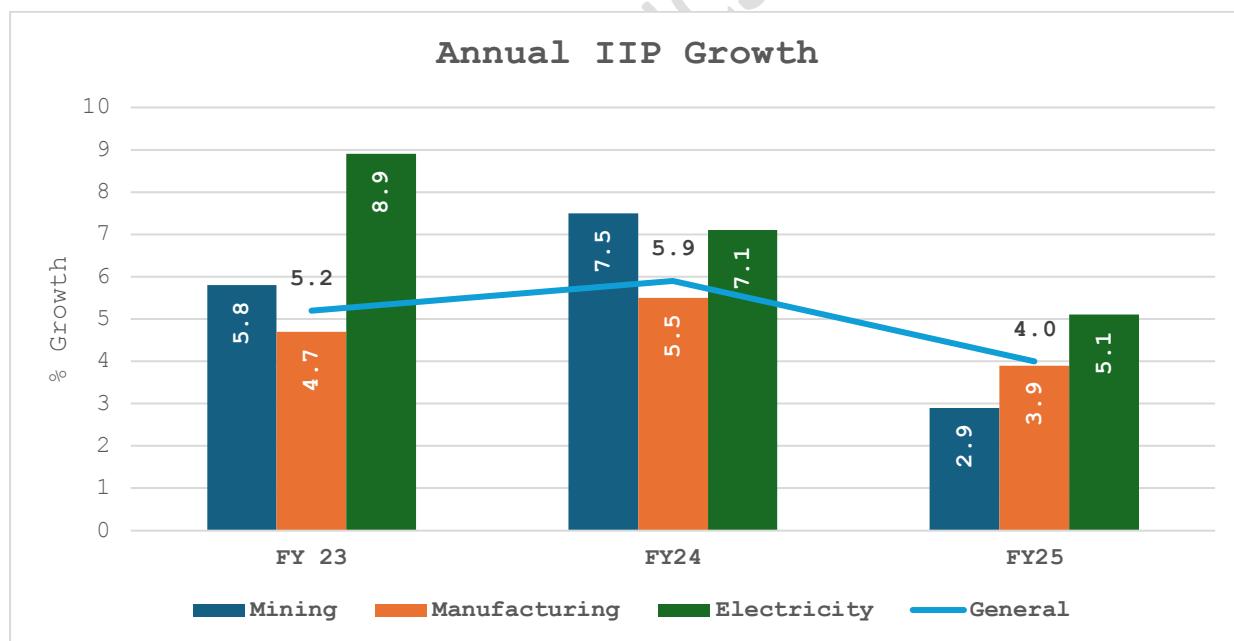
## 2.5 Index of Industrial Production (IIP) Growth Trends:

As per the Index of Industrial Production (IIP), the industrial sector grew by 4.0% in FY 2025, moderating from 5.9% in FY 2024 and 5.2% in FY 2023. This deceleration in overall IIP growth in FY 2025 reflects a softening of industrial momentum amidst global headwinds and tighter financial conditions.

### **Among key components:**

- **Manufacturing** (which holds a 77.6% weight in IIP) registered a slower growth of 3.9% in FY 2025, compared to 5.5% in FY 2024 and 4.7% in FY 2023.
- **Mining** growth also moderated sharply to 2.9% in FY 2025 from 7.5% in FY 2024 and 5.8% in FY 2023.
- **Electricity** growth remained relatively stable at 5.1% in FY 2025, slightly down from 7.1% in FY 2024 and significantly lower than 8.9% in FY 2023.

This slowdown indicates tightening domestic demand and spillover effects from a weaker global industrial cycle.



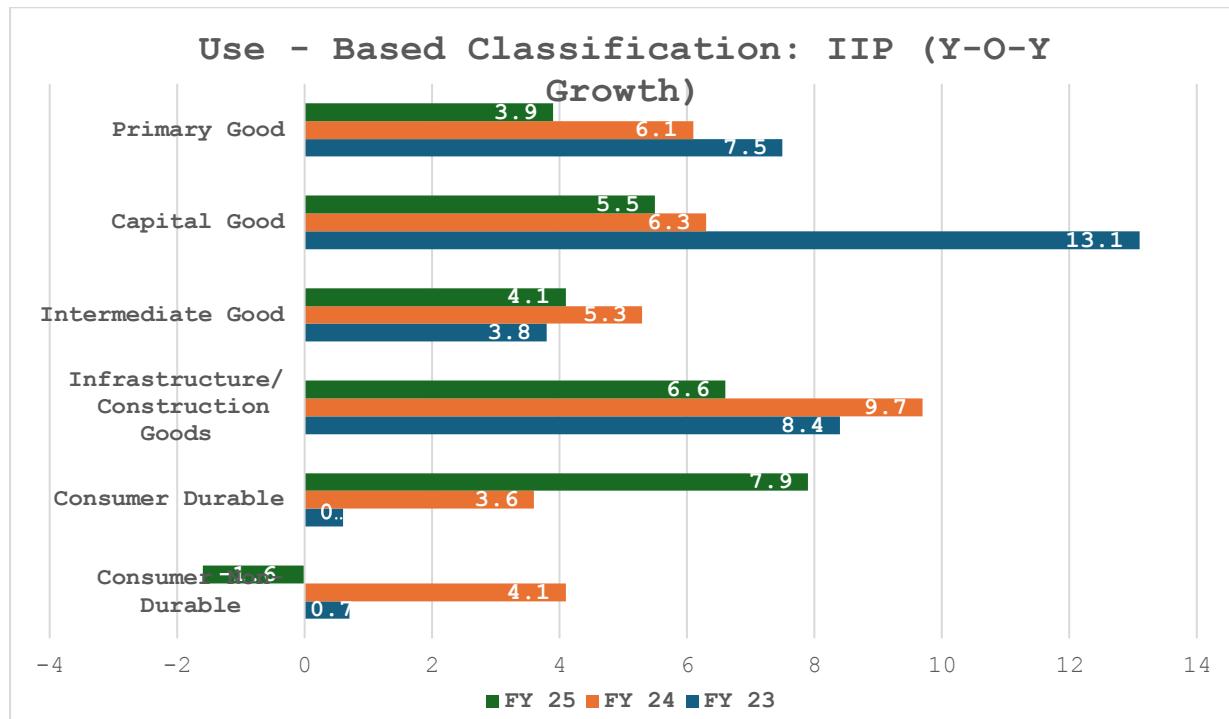
Source: Ministry of Statistics & Programme Implementation (MOSPI)

***Latest IIP data in Oct'25 remains a tad low amid less activity during festival times***

*The Index of Industrial Production (IIP) slows a tad at 0.4% during Oct'25 due to less working days available amid festivals. The growth rates of the three sectors, Mining, Manufacturing and Electricity for the month of October 2025 are (-) 1.8 percent, 1.8 percent and (-) 6.9 percent respectively. Lower demand in October 2025 and subsequent decline in electricity generation was driven by extended rainfall season and comfortable ambient temperature across multiple States/UTs.*

Source: Quick Estimate of Index of Industrial Production and Use-Based Index for the Month of October 2025, MOSPI, December 01, 2025 Release

## Use-Based Classification Trends:



Source: Ministry of Statistics &amp; Programme Implementation (MOSPI)

## According to the use-based classification:

- Capital Goods segment growth slowed to 5.5% in FY 2025, down from a high of 13.1% in FY 2023 and 6.3% in FY 2024, indicating a reduction in investment momentum.
- Primary Goods also witnessed slower growth at 3.9%, compared to 6.1% in FY 2024 and 7.5% in FY 2023.
- Intermediate Goods rebounded modestly to 4.1% in FY 2025, up from 3.8% in FY 2023, although still lower than 5.3% in FY 2024.
- Infrastructure/Construction Goods slowed to 6.6% in FY 2025 from 9.7% in FY 2024 and 8.4% in FY 2023, pointing to softening construction and infrastructure activity.
- Consumer Durables grew significantly by 7.9%, rebounding from 3.6% in FY 2024 and 0.6% in FY 2023, indicating improved demand in consumer electronics and appliances.
- In contrast, Consumer Non-Durables contracted by 1.6% in FY 2025, reversing the 4.1% growth in FY 2024, likely reflecting subdued rural and essential goods demand.

The divergence in growth across segments suggests an uneven industrial recovery in FY 2025. While certain consumer categories have rebounded, investment-related and primary sectors remain under pressure.

*The latest growth rates of IIP as per Use-based classification in October 2025 over October 2024 are (-)0.6 percent in Primary goods, 2.4 percent in Capital goods, 0.9 percent in Intermediate goods, 7.1 percent in Infrastructure/ Construction Goods, (-) 0.5 percent in Consumer durables and (-)4.4 percent in Consumer non-durables. Based on use-based classification, top three positive contributors to the growth of IIP for the month of October 2025 are Infrastructure/ construction goods, Intermediate goods and Capital goods.*

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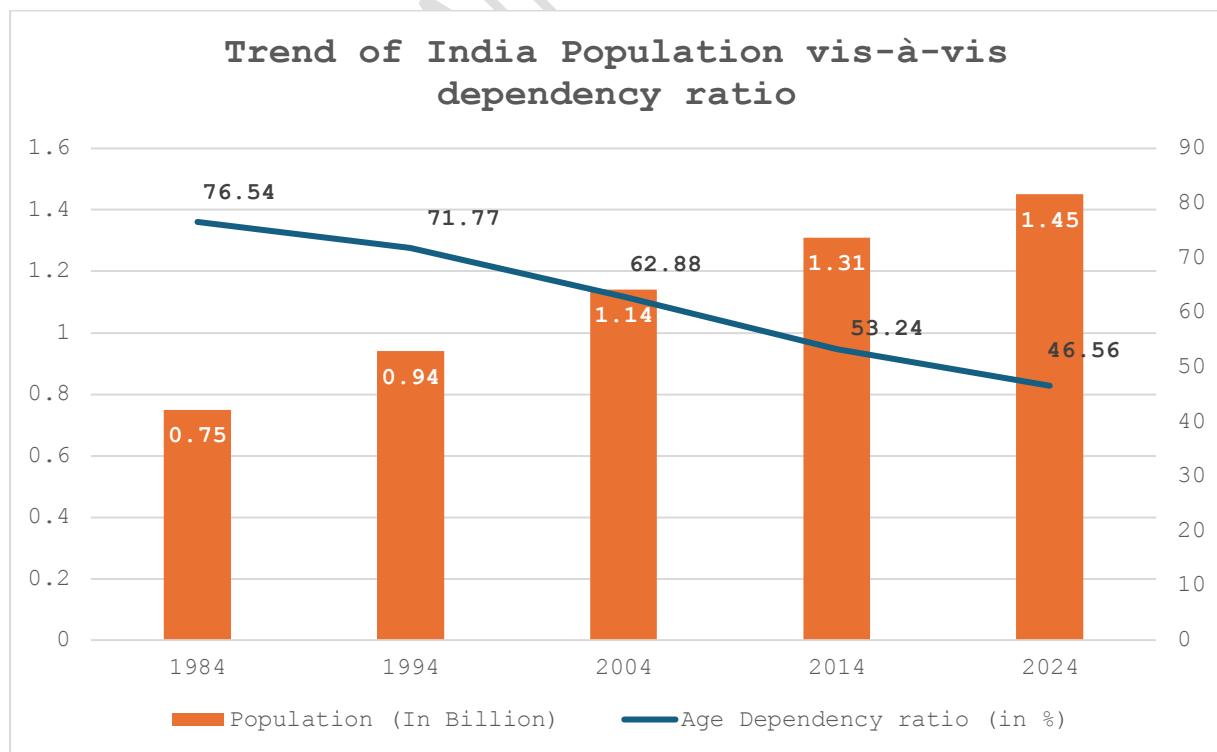
## 2.6 Overview on Key Demographic Parameters

### 2.6.1 Population growth and Urbanization

India's economic trajectory and consumption dynamics are closely tied to its demographic shifts. According to the World Bank, India's population expanded from approximately 0.75 billion in 1984 to 1.45 billion in 2024, consolidating its position as the world's most populous nation. This growth underlines the emergence of a vast labour force and consumer base, essential for driving sustained economic progress.

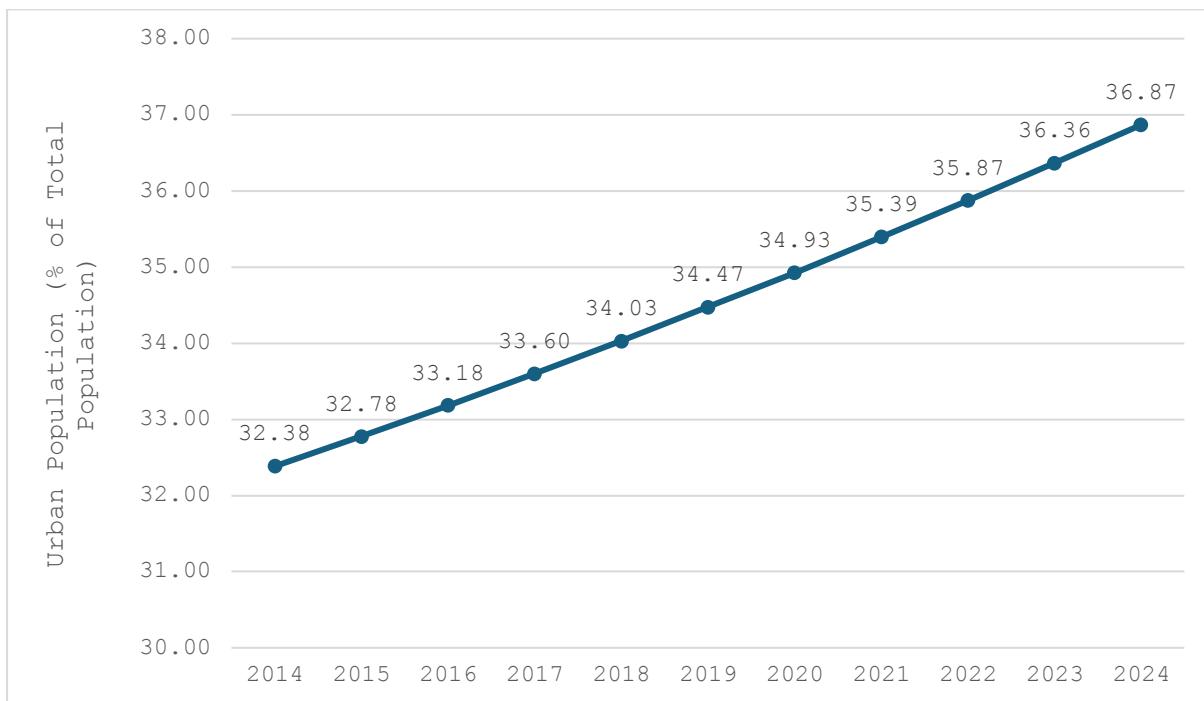
A key demographic indicator—the age dependency ratio—has witnessed a steady decline over the last four decades. From a high of 76.54% in 1984, it reduced to 71.77% in 1994, 62.88% in 2004, and 53.24% in 2014, before reaching a low of 46.56% in 2024. This downward trend signifies that for every 100 working-age individuals, there are now fewer than 47 dependents, compared to over 76 dependents in the mid-1980s. Such a shift reflects a growing share of the working-age population, unlocking India's demographic dividend—a critical driver of productivity, savings, and investment.

Together, the rising total population and declining dependency ratio provide a dual advantage: a larger workforce capable of supporting economic activity and a lower demographic burden, which allows for higher disposable incomes and consumption growth. These demographic fundamentals form a strong backbone for India's long-term economic and private consumption expansion.



Source: World Bank Database, Infomerics Analytics & Research

### Urbanization Trend in India



Source: World Bank Database

Urbanization, too, is transforming India's socio-economic fabric. The urban population rose from 424.96 million in 2014 (32.38% of total population) to 522.93 million in 2023 (36.36%), and further to approximately 534.91 million in 2024 (36.87%), according to World Bank estimates. This rapid growth in urban areas underscores the need for sustainable urban planning, investment in infrastructure, and development of smart cities to accommodate and benefit from the shifting population dynamics.

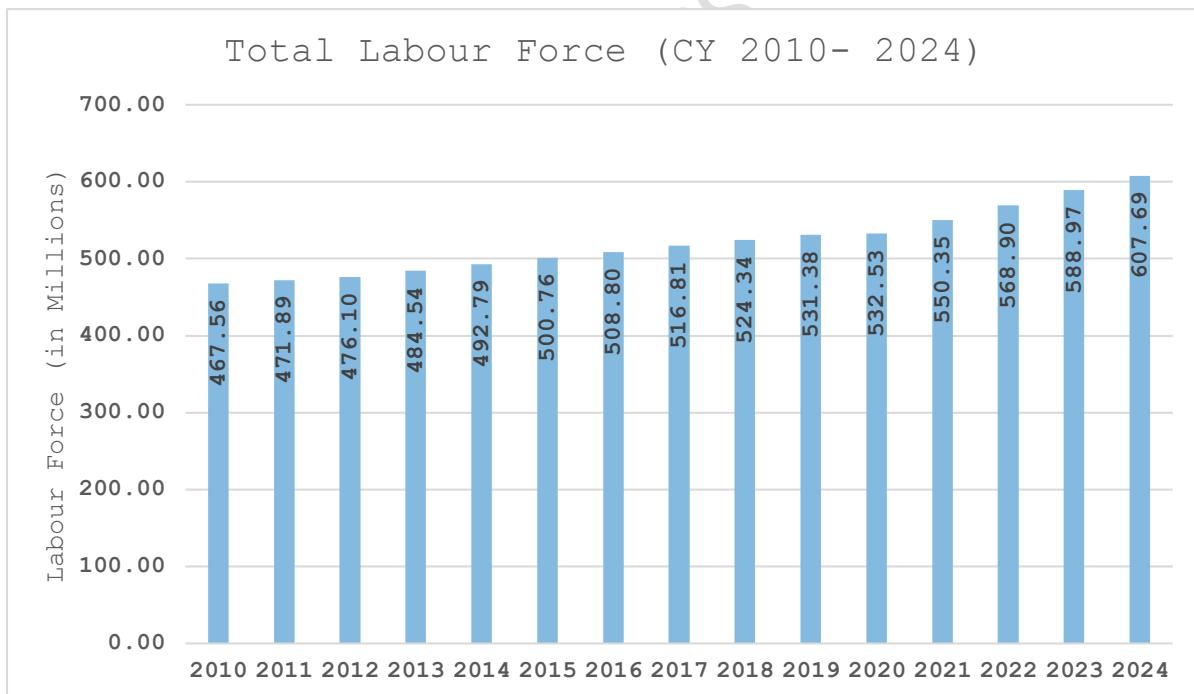
## **2.6.2 Labour Force in India**

India's labour force has experienced significant growth over the past decade. In 2010, the total labour force was approximately 467.56 million. By 2024, this number had increased to 607.69 million, reflecting a Compound Annual Growth Rate (CAGR) of 1.89% over the 14-year period.

This upward trend underscores the expanding working-age population and the country's ongoing economic development. However, it also highlights the need for effective employment policies to ensure that the growing labour force is adequately absorbed into productive sectors.

The labour force participation rate (LFPR) has also seen fluctuations, influenced by various socio-economic factors. As of 2024, the LFPR stood at 45.1%, indicating the percentage of the working-age population that is either employed or actively seeking employment.

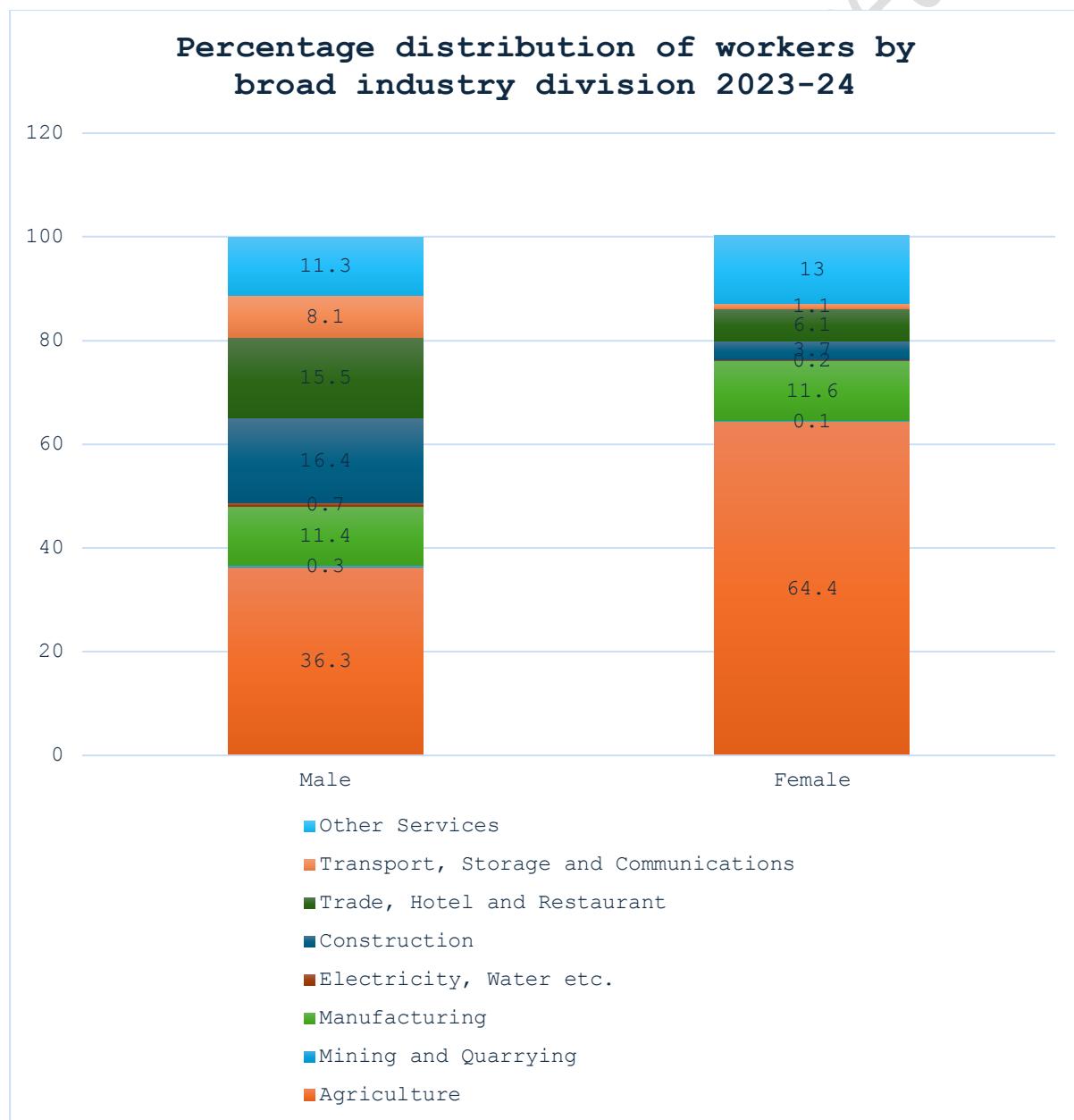
These statistics emphasize the importance of implementing strategies that not only create employment opportunities but also enhance the quality and inclusivity of jobs across different sectors of the economy.



Source: World Bank Database

### **2.6.3 Breakdown of Employment by Sector**

According to the Periodic Labour Force Survey (PLFS) 2023–24, the employment distribution across various sectors exhibits distinct gender-based patterns. A significant portion of male workers are engaged in agriculture, followed by notable participation in construction, manufacturing, and trade-related activities. In contrast, female workers are predominantly employed in agriculture, with considerable involvement in manufacturing and other services sectors. While female representation in trade and construction is lower compared to males, Additionally, a substantial proportion of employed women are self-employed, often contributing as unpaid helpers in household enterprises or operating small businesses, indicating a reliance on informal employment avenues.

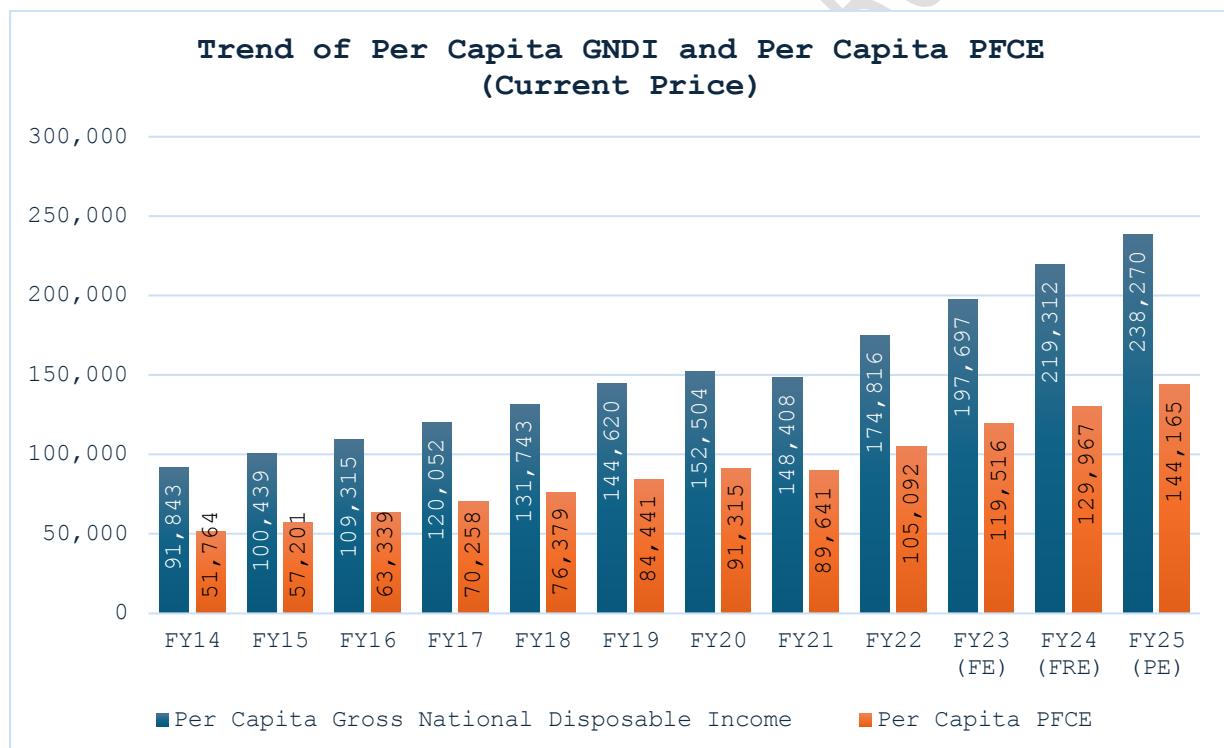


Source: Annual Report 2023-24, Periodic Labour Force Survey

#### **2.6.4 Disposable Income and Consumer Spending**

Gross National Disposable Income (GNDI) represents the total income available to a nation's residents for consumption and saving after accounting for income transfers with the rest of the world. In FY24, Per capita GNDI grew by 10.9%, followed by a moderate growth of 8.6% in FY25. This steady increase indicates that households and businesses had more income at their disposal, which is critical for supporting both consumption and savings—key components of economic resilience and expansion.

The rise in GNDI has translated into higher consumer spending, as reflected in the growth of Private Final Consumption Expenditure (PFCE), which measures the total value of goods and services consumed by households. Per Capita PFCE grew by 8.7% in FY24 and further accelerated to 10.9% in FY25, highlighting strong consumer confidence and robust domestic demand.



Note: Data mentioned is in INR, FE – Final Estimates, FRE – First Revised Estimates, PE – Provisional Estimate; Source: PIB, *Provisional estimates of GDP 2024-25 released on May 30<sup>th</sup>, 2025*

## **2.7 Union Budget FY25-26 Highlights**

The Union Budget FY 2025–26, presented by Finance Minister Nirmala Sitharaman, introduces a comprehensive set of measures aimed at stimulating economic growth, enhancing infrastructure, and fostering inclusive development. With a focus on sectors such as agriculture, MSMEs, infrastructure, innovation, and exports, the budget seeks to create a conducive environment for sustained economic expansion.

- Capital Expenditure and Infrastructure Development**

The government has earmarked a substantial ₹11.21 lakh crore (3.1% of GDP) for capital expenditure in FY 2025–26. This allocation is directed towards infrastructure projects, including rural development, manufacturing, and skill-building initiatives. Notably, the Urban Challenge Fund has been established with a corpus of ₹1 lakh crore, aimed at financing 25% of the cost of bankable urban infrastructure projects, thereby promoting sustainable urban development.

- Support for MSMEs**

Recognizing the pivotal role of Micro, Small, and Medium Enterprises (MSMEs) in India's economic landscape, the budget introduces several measures to bolster this sector. The Credit Guarantee cover has been enhanced to ₹10 crore, unlocking ₹1.5 lakh crore in additional funding for MSMEs over the next five years. Additionally, the establishment of a Fund of Funds with a ₹10,000 crore corpus aims to provide equity support to startups and potential MSMEs, focusing on high-growth sectors such as electronics and renewable energy.

- Tax Reforms and Disposable Income**

To stimulate consumption and investment, the budget introduces significant tax reforms. The tax-free income threshold has been raised to ₹12 lakh, and the new tax regime offers reduced rates for higher income brackets. These changes are expected to increase disposable income, thereby encouraging higher savings and investment among the middle class.

- Focus on Agriculture and Exports**

The budget prioritizes agriculture as a key engine of development, with increased allocations for agricultural credit and initiatives aimed at enhancing productivity. Furthermore, measures to promote exports include the reduction of customs duties on select goods and the introduction of policies to facilitate easier market access for Indian products.

- Urban Development Initiatives**

A significant increase in the budget allocation for the Ministry of Housing and Urban Affairs to ₹96,777 crore reflects the government's commitment to urban development. Key initiatives include the establishment of the Urban Challenge Fund, enhanced loans under the PM SVANidhi scheme, and substantial provisions for the Pradhan Mantri Awas Yojana

and Urban Rejuvenation Mission, all aimed at improving urban infrastructure and living standards.

The Union Budget FY 2025–26 presents a balanced approach to economic growth by addressing immediate consumption needs and laying the foundation for long-term sustainability. Through targeted investments in infrastructure, support for MSMEs, tax reforms, and sector-specific initiatives, the budget aims to foster an inclusive and resilient economy. These measures are expected to create new opportunities for financial institutions, as the growing demand for investment products will provide avenues for expansion and innovation in the financial services sector.

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## **2.8 Concluding Remarks about Macroeconomic Scenario**

FED has softened the benchmark interest rate by 25bps to the range of 3.50%-3.75% as expected by majority of the market in Dec'25. The RBI has also reduced its policy rate, namely repo rate by 25 bps to bring it down from 5.50 to 5.25 bps, amid robust Q2FY26, 8.2% real GDP growth and lowest retail inflation at 0.25 in India. A Fed rate cut is expected to channelise FII inflows to India and help in easing the ongoing pressure on INR. In fact, the Real Effective Exchange Rate (REER) for which INR was thought to have been overvalued previously, has softened in recent periods, thus INR is moving in the right direction to correct its fundamentals though possibly at a slight stretch as RBI is struggling a lot to maintain the "volatility in the INR movement" as the Governor tried to clarify the market. Nonetheless, many other emerging market economies (EMs) are also facing pressure on their currencies. Notably, Central Banks (CBs) of many countries have accumulated their gold holdings amid this turbulent time, after the "Trump Tariff" factor and geopolitical tensions have injected heightened uncertainties in the global economy.

IMF recently reclassified India's "de facto" exchange rate regime as a "crawl-like arrangement", two years after branding it "stabilised", indicating that RBI is allowing a measured flexibility, a managed float, where RBI primarily intervene to check excessive volatility in the INR and/or to manage the liquidity situation. India's strategic position as a manufacturing hub is further strengthened by government initiatives, a skilled labour force, and a dynamic startup ecosystem, all of which bolster the country's economic outlook. The ongoing reforms and focus on innovation are enabling India to seize emerging opportunities, making it a growing player in the global manufacturing landscape. In addition, several high-frequency growth indicators—such as the Purchasing Managers' Index (PMI), E-way bills, bank credit, toll collections, and GST collections—have shown a positive trajectory in FY25. These factors are expected to further support the investment cycle and strengthen India's economic resilience in the coming years.

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### **3. Industry Overview – Solar Power Equipment Industry**

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#### **3.1 Introduction**

The global Solar Power Equipment Industry forms a core pillar of the world's transition toward clean, reliable, and low-carbon energy systems. This industry includes the full suite of technologies required to generate, convert, manage, and store solar energy, covering photovoltaic (PV) modules, solar inverters, hybrid inverters, power conversion systems (PCS), charge controllers, mounting structures, lithium-ion and lead-acid energy storage systems, battery management systems (BMS), and digital monitoring solutions. As solar energy emerges as one of the fastest-growing sources of new power capacity worldwide, the demand for efficient power electronics and dependable storage technologies has become increasingly critical.

Global momentum toward decarbonization—supported by the Paris Agreement, national net-zero targets, renewable energy policies, and rising sustainability investments—has significantly accelerated solar deployment across residential, commercial & industrial (C&I), and utility-scale segments. Continuous declines in PV module prices, advancements in inverter topologies, and rapid adoption of Battery Energy Storage Systems (BESS) have strengthened the integration of solar energy into mainstream power systems.

The industry is characterized by a broad set of interlinked product categories, including string inverters, hybrid/off-grid inverters, solar-plus-storage systems, lithium-ion batteries, lead-acid batteries, charge controllers, EMS (Energy Management Systems), and AI/IoT-based remote monitoring platforms. Ongoing technological innovation—such as higher MPPT efficiencies, transformer-less designs, wide-bandgap semiconductor technology (IGBTs/SiC), intelligent hybrid inverters, and high-voltage lithium storage—is redefining performance benchmarks, improving safety, and enhancing system reliability.

Rising adoption of rooftop solar, distributed energy resources, and C&I solar installations is driving substantial demand for advanced power conversion and energy storage equipment. Lithium-ion technologies, especially LFP (LiFePO<sub>4</sub>), have become the preferred storage solutions due to superior energy density, long life cycles, and rapidly declining battery costs. The industry is also moving toward emerging innovations, including solid-state batteries, virtual power plants (VPPs), and bidirectional smart inverters capable of providing grid support and demand response services.

As solar energy continues its transition into a mainstream global energy source—particularly across Asia-Pacific, North America, and Europe—the Solar Power Equipment Industry is

positioned for sustained growth. Increasing electrification, rising grid instability, the need for energy independence, and the evolution of flexible, distributed power networks will drive large-scale adoption of hybrid inverters, residential and commercial battery systems, smart controllers, and integrated solar energy management technologies. The industry will continue advancing through technological innovation, cost optimization, digitalization, and the integration of next-generation energy storage solutions.

### Market Segmentation

Segmentation Category	Sub-Segments
<b>By Equipment's</b>	<ul style="list-style-type: none"> <li>• Solar Panels</li> <li>• Mounting Systems</li> <li>• Racking Systems</li> <li>• Tracking Systems (Single-Axis, Dual-Axis)</li> <li>• Storage Systems (Battery Energy Storage Systems)</li> <li>• Solar Inverters</li> <li>• Others (Charge Controllers, Wiring, Connectors, Junction Boxes, and Other Balance-of-System Components)</li> </ul>
<b>Applications Covered</b>	<ul style="list-style-type: none"> <li>• Residential</li> <li>• Non-Residential (Commercial &amp; Industrial)</li> <li>• Utility (Utility-Scale Solar Plants)</li> </ul>

#### **4. Global Outlook**

##### **4.1 Global Solar Energy**

The global power stack is rapidly shifting from thermal baseload generation toward variable renewables, with utility-scale solar emerging as the dominant driver of new capacity additions worldwide. Solar PV has become the centrepiece of modern power buildouts, supported by sustained policy incentives, declining module and balance-of-system costs, higher efficiencies, and improved digital O&M. Falling LCOE across mature and emerging markets continues to accelerate adoption, even as the sector navigates challenges such as grid congestion, interconnection delays, land-use constraints, and trade-related measures (tariffs, AD/CVD).

Storage attachment rates are rising sharply, enabling solar-plus-storage systems to enhance grid flexibility and value creation. Despite operational and regulatory bottlenecks, solar has transitioned from a niche growth segment to a core global asset class, attracting record investment and reinforcing its position as the leading technology in the global clean energy transition. Between CY2019 and CY2024, total global solar capacity expanded from 592.65 GW to 1,865.49 GW, reflecting a remarkable CAGR of 25.78%. This trajectory underscores the sector's pivotal role in driving the global energy transition toward net-zero pathways.

In GW	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CAGR '19'24
World Solar	592.65	723.63	866.83	1060.52	1413.54	1865.49	25.78%
Solar PV On-Grid	586.29	717.23	860.46	1053.96	1406.68	1858.62	25.96%
Solar PV Off grid	3.02	3.52	3.81	4.41	4.71	6.29	15.82%
Others	3.34	2.88	2.56	2.15	2.15	0.58	-29.54 %

*Note: Others include concentrated solar power, solar power heating and cooling, Agro voltaic, Building integrated solar, solar fuels, other hybrid solar cells*

*Source: IRENA 2025, Infomerics Analytics & Research*

Within the broader solar ecosystem, on-grid PV systems—which are directly connected to national and regional grids—account for approximately 99% of solar energy. On-grid PV capacity grew from 586.29 GW in CY2019 to 1,858.62 GW in CY2024, delivering a robust CAGR of 25.96%. These installations, spanning utility-scale plants and commercial/industrial rooftops, dominate the market by ensuring grid-level integration, large-scale power delivery, and reliable contribution to national energy security.

In contrast, Off-grid PV systems—comprising stand-alone home systems, lanterns, and rural mini-grids—remain a smaller but strategically significant segment. Global off-grid solar capacity increased from 3.02 GW in CY2019 to 6.29 GW in CY2024, achieving a CAGR of 15.82%. Although representing less than 2% of global solar capacity, off-grid systems are vital in bridging energy access gaps, particularly across Africa, South Asia, and rural Asia-Pacific, where electrification through centralized grids remains challenging.

The bifurcation between on-grid and off-grid PV reflects the dual imperatives of global solar growth: scaling utility-scale projects to anchor national power generation, while deploying decentralized solutions to deliver last-mile energy access. Together, these dynamics reinforce solar PV's status as the fastest growing and most transformative pillar of global renewable energy.

#### **4.1.1 Global Solar Power Installed Capacity by Region (CY19–CY24) – On Grid**

Solar PV On-Grid constitute about 41.78% of the Total Renewable Energy. It has delivered the largest increment among renewables since 2019, led overwhelmingly by China and the rest of Asia, with Europe and India rising fast since 2021.

In Gigawatts	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024	CAGR '19'24	Share of global %
<b>World</b>	586.29	717.23	860.46	1,053.96	1406.68	1,858.62	25.96%	100%
<b>Asia ex.India</b>	295.59	372	438.34	537.65	767.97	1058.43	29.06%	56.9%
<b>India</b>	34.90	39.36	49.60	63.048	72.51	97.04	22.69%	5.22%
<b>Europe</b>	137.41	157.45	184.40	220.39	277.29	336.07	19.59%	18.0%
<b>North America</b>	70.06	86.21	108.08	127.65	154.50	194.07	22.60%	10.44 %
<b>Africa</b>	8.19	9.55	10.48	11.52	12.43	14.29	11.77%	0.77%
<b>Middle East excl. Saudi</b>	5.56	7.304	9.42	13.17	16.37	17.81	26.19%	0.96%
<b>Saudi Arabia</b>	0.05	0.35	0.389	0.39	2.53	4.29	135.68 %	0.23%
<b>Others</b>	34.48	44.98	59.72	80.11	103.06	136.61	31.70%	7.35%

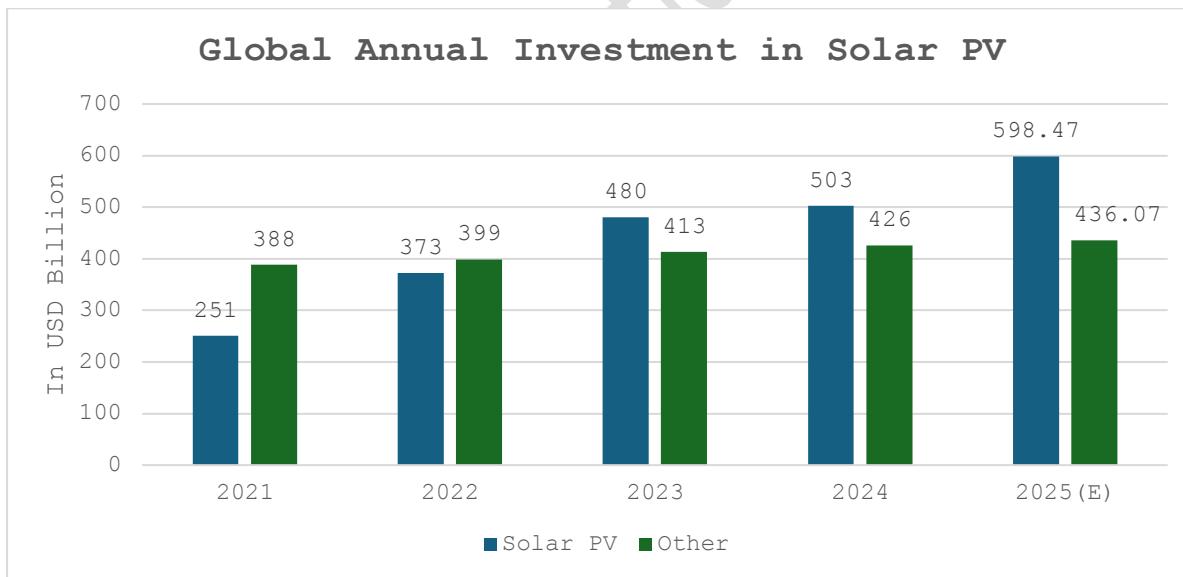
Source: IRENA 2025, For India the figures are estimated.

Asia (ex-India) emerged as the undisputed leader, with installed capacity surging from 295.59 GW in CY2019 to 1,058.43 GW in CY2024, reflecting a CAGR of 29.06% and capturing 56.95% of global share. China remains the overwhelming driver of this growth, leveraging economies of scale, state-backed manufacturing dominance, and rapid utility-scale deployment to cement its position as the world's largest solar market. Saudi Arabia, though a smaller player in absolute terms, posted exponential growth. Installed solar PV capacity expanded from just 0.05 GW in CY2019 to 4.29 GW in CY2024, translating into a world-leading CAGR of 135.68%. This surge reflects the early impact of Saudi Arabia's Vision 2030 diversification program and its accelerated pipeline of mega-projects across the Middle East.

Asia (China) and Europe dominate global solar buildout, enabled by both policy support and falling costs. The Middle East and Africa show the fastest proportional increases, but from smaller bases. India and Saudi Arabia are rapidly scaling utility PV via government-led tenders.

#### **4.1.2 Global Annual Investment in Solar PV (CY21–CY25)**

Annual investment in solar PV rose sharply from USD 251 billion in 2021 to USD 503 billion in 2024, delivering a robust 18.98% CAGR. This growth far outpaced other renewables, where capital inflows expanded only marginally.

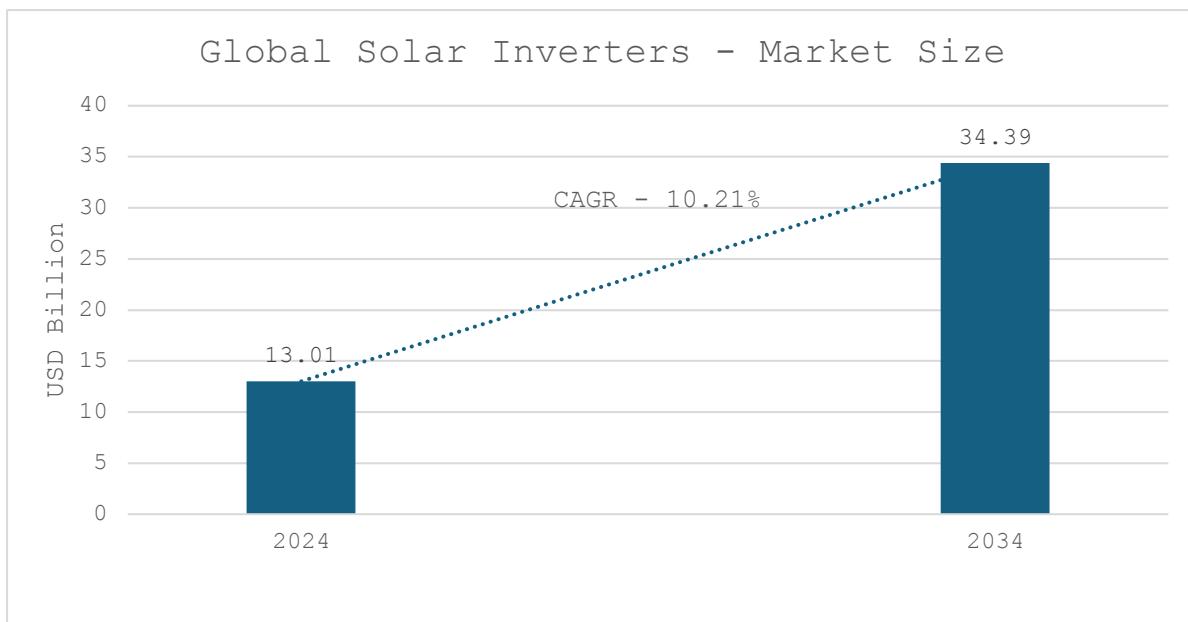


*Source: IEA, Infomerics Analytics & Research*

The investment surge reflects accelerating deployment pipelines, resilient policy frameworks (net-zero mandates, competitive auctions), expanding green finance pools, and strong corporate demand for decarbonization. Despite volatility in module pricing and supply chain costs, EPC-led deployment capital remained on an upward trajectory, underscoring solar PV's role as the anchor technology in the global energy transition.

#### 4.2 Global Solar Inverters

The global Solar Inverter industry is estimated at USD 13.01 billion in 2024 and is projected to reach USD 34.39 billion by 2034, reflecting a CAGR of 10.21% over the period.



Source – Infomerics Analytics & Research

This strong expansion underscores the critical role of inverters in the solar value chain, as they enable efficient power conversion, grid compatibility, and system monitoring. Growth is supported by several structural drivers, including the rapid scaling of utility-scale solar farms, increasing adoption of residential and commercial rooftop systems, and the shift toward smarter, higher-efficiency inverter technologies such as string inverters, central inverters, and hybrid/solar-plus-storage solutions. Additionally, global decarbonisation targets, declining solar installation costs, and supportive regulatory frameworks continue to accelerate inverter demand across major markets in Asia-Pacific, Europe, and North America. Overall, the projections indicate a steadily expanding market with rising technological sophistication and broader integration of energy storage systems.

Lithium-ion batteries have become central to the manufacturing of modern hybrid and off-grid solar inverters because these systems are now designed to operate as integrated solar-plus-storage solutions rather than simple power-conversion devices. The shift toward lithium-based storage—especially LFP, which offers higher cycle life, faster charging, deeper discharge capability, and improved thermal stability—has pushed inverter manufacturers to redesign power electronics, battery management systems (BMS), and communication protocols for seamless integration. As battery prices fall and storage adoption rises, inverter manufacturers increasingly incorporate lithium-ion-compatible MPPT controllers, advanced BMS communication (CAN/RS485), and higher voltage battery inputs, enabling greater efficiency,

longer backup duration, and better system reliability. This makes lithium-ion technology a critical enabler of the next generation of smart, energy-efficient hybrid inverters widely used in homes, commercial facilities, and industrial energy storage systems.

Lithium-ion batteries—particularly LFP chemistry, which is ~30% cheaper per kWh—play a critical role in modern solar inverters and energy storage systems by providing fast-charging, high-cycle, and high-efficiency storage required for managing intermittent solar generation. As global battery prices fell 20% in 2024 and LFP penetration reached ~50%, hybrid and off-grid solar inverters increasingly integrate lithium-ion packs to enable load shifting, backup power, and peak shaving. In India, the rapid growth of the lithium-ion market (USD 1.79 billion in 2024, projected to USD 7.49 billion by 2034) is directly supporting the adoption of residential, commercial, and industrial solar-plus-storage systems, driven by rising demand for reliable power, policy incentives, and the shift from lead-acid to lithium-based solutions.

### **Supply Dynamics:**

#### ➤ **Cell Manufacturing:**

- Global battery cell production capacity reached 3 TWh in 2024, nearly three times annual demand. China accounted for 85%, while Korea, Japan, and the US supplied the balance. By 2030, global capacity is projected to reach 6.5 TWh, with China's share moderating to ~66%.
- Korean manufacturers remain the largest foreign investors, with overseas production potentially reaching 1.1 TWh by 2030. US and European capacity is expanding, supported by government incentives and cross-border investments. Tesla, LG Energy Solution, Samsung, and SKI are driving US capacity growth, while Europe sees increased Chinese investment, despite domestic production challenges.

#### ➤ **Lithium Supply:**

- In 2024, global lithium demand exceeded 200 kt Li (~1.1 Mt LCE), predominantly for EV batteries. Supply rose ~35%, stabilising prices at ~USD 12,000 per tonne LCE. Australia, China, and Argentina accounted for 77% of global lithium supply, with China refining ~70% of lithium chemicals.
- Looking ahead, supply diversification is expected from Africa (notably Zimbabwe and Mali) and the Americas (Canada, Argentina, USA), although China will continue to dominate refining, especially for hard rock lithium (~95% of hard rock refining).

## Market Trends

- 1. Rapid Expansion of Energy Storage Technologies** - Energy storage—especially lithium-ion, LFP, and emerging sodium-ion batteries—is becoming the backbone of modern renewable energy systems. As solar and wind installations surge, grid operators require reliable storage solutions to manage intermittency, stabilize supply, and support peak demand. This has triggered massive investments in battery manufacturing, with many companies expanding gigafactory capacities and improving cycle life, safety, and energy density. Storage is also enabling hybrid systems, off-grid solutions, and backup power for households and industries, making battery energy storage one of the fastest-growing renewable equipment segments.
- 2. Increasing Adoption of Hybrid Renewable Systems** - Hybrid systems that combine solar + energy storage, solar + wind, or solar + diesel replacement is gaining significant traction. These systems improve energy reliability, reduce lifecycle costs, and operate independently of grid disturbances. Due to declining inverter and battery prices, hybrid renewable systems are becoming mainstream in commercial & industrial (C&I) facilities, telecom towers, agricultural pumps, and residential applications. Equipment manufacturers are designing inverters and controllers that seamlessly integrate multiple energy sources, making hybrids a transformative trend in the sector.
- 3. Rise of Smart Inverters and Digital Energy Management** - Smart inverters equipped with IoT, advanced monitoring, grid-forming capabilities, and AI-based optimization are becoming essential components of renewable installations. These inverters can communicate with utilities, provide reactive power support, ensure frequency stabilization, and perform remote diagnostics. Digital energy management platforms also allow users to track real-time energy consumption, performance ratios, and system health through mobile apps. As electricity networks modernize, smart inverters are evolving into key grid-interactive devices that strengthen overall system resilience.
- 4. Growth of Utility-Scale Solar and Wind Projects** - The renewable energy equipment industry is experiencing a strong push from large utility-scale solar PV parks, offshore wind farms, and hybrid renewable plants. These large installations require high-capacity inverters, advanced switchgear, heavy-duty wind components, transformers, and utility-grade storage systems. Government auctions, long-term PPAs, and cost reductions have accelerated deployments. The scale of these projects drives higher demand for efficient, high-wattage modules, central inverters, multi-MVA transformers, and grid-balancing solutions, boosting the equipment manufacturing ecosystem globally.
- 5. Decentralized and Off-Grid Renewable Solutions on the Rise** - Demand for decentralized energy—mini-grids, rooftop solar, home batteries, and off-grid solar systems—is expanding rapidly, especially in rural regions and emerging markets. These systems help overcome grid limitations, reduce dependency on diesel generators, and provide reliable power for

households, shops, telecom sites, agriculture, and small industries. Equipment manufacturers increasingly design rugged inverters, DC systems, and modular batteries suited for off-grid environments. This trend is widening access to clean energy while creating new market opportunities for distributed renewable technologies.

**6. Sustainability and Circularity in Manufacturing** - There is a rising emphasis on sustainable and circular manufacturing practices, driven by regulatory pressure and corporate goals. Renewable energy equipment manufacturers are adopting eco-friendly materials, improving recyclability of solar panels and batteries, reducing carbon footprints in production, and implementing take-back programs. Lithium battery recycling is becoming a major growth segment, with companies recovering lithium, nickel, cobalt, and graphite for reuse. Circularity is emerging as a strategic differentiator for global renewable energy brands.

**7. Technological Advancements in Solar and Wind Equipment** - Solar equipment is witnessing rapid innovation—including high-efficiency n-type TOPCon and HJT modules, bifacial panels, larger wafer formats, and tracker-integrated systems. Wind energy equipment is evolving with larger rotor diameters, taller towers, and more efficient direct-drive turbines. These advancements reduce the levelized cost of energy (LCOE), increase capacity factors, and expand deployment in lower-wind-speed regions. Manufacturers are investing heavily in R&D to deliver high-performance systems that maximize power generation per unit area.

## 5. Indian Outlook – Solar Power Equipment Industry

### 5.1 Overview of the Solar Power Equipment Industry in India

The solar power equipment industry in India is a key driver of the country's clean energy transition, supplying the technologies essential for generating, converting, and storing solar electricity. Supported by rising power demand, grid challenges, and India's target of 500 GW non-fossil capacity by 2030, the sector has grown rapidly from heavy import dependence to stronger domestic manufacturing capabilities. It plays a central role across residential rooftop systems, commercial and industrial (C&I) installations, and large utility-scale solar projects. The industry includes solar PV modules, string and hybrid inverters, battery energy storage systems (primarily LFP-based lithium batteries), mounting and racking structures, tracking systems, and balance-of-system (BOS) components such as cables, connectors, junction boxes, charge controllers, and monitoring devices. Solar inverters remain one of the most critical components, with increasing adoption of hybrid, grid-interactive, and smart digital inverters. Energy storage solutions are gaining momentum as customers demand higher reliability, backup power, and integration with rooftop and C&I solar systems. Overall, the solar power equipment industry in India is expanding quickly, driven by improvements in module efficiency (TOPCon, HJT), smart inverter technologies, digital monitoring, and solar-plus-storage solutions. With growing rooftop penetration, rising C&I adoption, and increasing investments in large-scale solar and hybrid renewable projects, the industry remains dynamic, competitive, and central to India's long-term clean energy goals.

#### India – 3<sup>rd</sup> largest solar power producer

India has become the world's third-largest solar power producer, generating 1,08,494 GWh of solar energy in FY 2024–25, surpassing Japan's 96,459 GWh. As of July 2025, India's cumulative solar power capacity stood at 119.02 GW, comprising:



Ground-mounted  
solar plants



Grid-connected  
rooftop solar  
systems



Hybrid projects



Off-grid installations

- **90.99 GW** – Ground-mounted solar plants
- **19.88 GW** – Grid-connected rooftop solar systems
- **3.06 GW** – Hybrid projects
- **5.09 GW** – Off-grid installations

India's solar progress is central to its renewable energy growth, with renewables making up 50.07% of the country's total installed power capacity (484.82 GW) – a COP26 commitment achieved five years ahead of schedule.

The total solar sector potential of the Indian subcontinent is 748 GW. High potential states include Rajasthan, Gujarat, Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Madhya Pradesh, Chhattisgarh, and Odisha. Notably, Palli village (Jammu & Kashmir) has become India's first carbon-neutral panchayat, fully powered by solar energy.

### **Domestic Manufacturing Growth**

India's solar manufacturing ecosystem has witnessed unprecedented expansion in the last two years, positioning the country as a self-reliant and globally competitive player across the solar value chain.

#### **1. Solar Module Manufacturing**

- Capacity nearly doubled within a year, rising from 38 GW in March 2024 to 74 GW in March 2025.
- This rapid expansion has been enabled by large-scale investments, government-led tendering, and Production Linked Incentive (PLI) schemes.
- The higher domestic module capacity reduces dependence on imported products, especially from China, and strengthens India's export competitiveness.

#### **2. Solar PV Cell Manufacturing**

- Capacity increased almost three-fold, from 9 GW in FY 2023–24 to 25 GW in FY 2024–25.
- This scaling up addresses one of the critical gaps in India's solar supply chain, where domestic PV cell production earlier lagged module assembly.
- Increased cell production ensures greater backward integration and lowers import reliance, particularly for projects supported under government-linked programs.

#### **3. Ingot-Wafer Manufacturing**

- A major milestone was achieved with the commissioning of India's first ingot-wafer manufacturing facility (2 GW capacity).

- Ingot-wafer production is a critical upstream process that provides the base material for solar cells. Until now, India depended almost entirely on imports for this stage of the value chain.
- Establishing this facility marks the beginning of India's transition towards a fully integrated solar manufacturing ecosystem, reducing vulnerabilities to global supply chain disruptions.

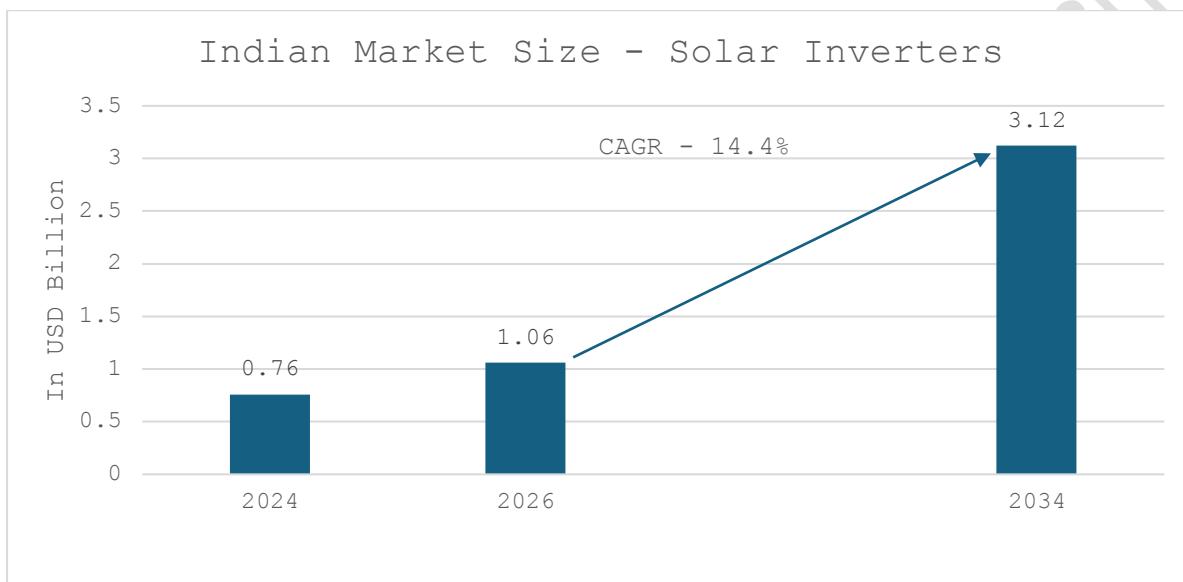
Policies such as Basic Customs Duty (BCD) on imported modules/cells and mandatory domestic sourcing under government schemes have supported this expansion.

India has emerged as a global leader in advancing solar energy cooperation through multilateral platforms. The International Solar Alliance (ISA), co-founded by India and France in 2015, now brings together over 100 member countries with the objective of mobilising USD 1 trillion in solar investments by 2030, reducing technology costs, and promoting affordable solar deployment, particularly in Least Developed Countries (LDCs) and Small Island Developing States (SIDS). Complementing this, the One Sun, One World, One Grid (OSOWOG) initiative, launched by India in 2018, envisions the creation of a transnational solar grid to enable cross-border electricity trade under the principle that "the sun never sets." By linking solar-rich regions across South Asia, Africa, and Europe, OSOWOG aims to ensure reliable, sustainable, and cost-effective energy access, reinforcing India's leadership in shaping the global clean energy transition.

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### 5.1.1 India Solar Inverters market

According to Ministry of Power, the market projections for the Indian Solar Inverters segment up to 2026, and building on these official estimates, we have extended the forecast horizon to 2034. Based on this, the Indian Solar Inverters market is valued at USD 0.76 billion in 2024 and is projected to reach USD 1.06 billion by 2026. Extending this growth trajectory further, the market is expected to achieve USD 3.12 billion by 2034, corresponding to a CAGR of 14.4% over the projection period.



Source – Ministry of Power, Infomerics Analytics & Research

This accelerated growth is driven by rising rooftop solar adoption in the residential and C&I segments, strong government push through schemes like PM-KUSUM and net metering reforms and increasing demand for hybrid and grid-interactive inverters. The market's expansion also reflects the broader surge in solar PV installations under India's 500 GW renewable energy target, coupled with a shift toward higher-efficiency, smart, and communication-enabled inverter technologies. India's solar ecosystem has rapidly advanced from basic inverter systems supporting only lights and fans to modern transformer-less technologies capable of powering wider household and commercial loads

Overall, the growth trajectory underscores the critical role of inverters as a core enabling technology within India's evolving solar ecosystem.

## 6. Market Dynamics

### 6.1 Key Growth Drivers

India's solar equipment industry is expanding rapidly, supported by rising electricity demand, strong government targets (500 GW RE by 2030), falling equipment costs, and increasing adoption across residential, commercial, industrial, and utility-scale segments. The shift toward domestic manufacturing—spurred by PLI schemes, ALMM regulations, and import diversification—has strengthened supply chains and boosted competitiveness. Technological advancements in inverters, batteries, trackers, and high-efficiency modules (TOPCon, HJT), along with digitalised monitoring systems, are further accelerating industry growth and improving system reliability.

#### Market Drivers and Impact Assessment

*(All values represent directional impact based on industry estimates and qualitative analysis)*

Drivers	Impact		
	1-2 Years	3-4 Years	5-7 Years
1. Shift to Advanced Inverter Technologies (Transformer-less, Hybrid, High-Efficiency MPPT)	High	High	High
2. Transition from Lead-Acid to Lithium (LFP) Batteries & Storage Growth	High	High	High
3. Growth in Rooftop Solar & Behind-the-Meter Storage	High	High	High
4. Increasing Demand for Smart, Communication-Enabled Inverters (WiFi/GPRS/IoT)	Medium	High	High
5. Declining Costs of Solar Modules & Balance of System Components	High	High	High
6. Domestic Manufacturing Push (PLI, ALMM, DCR, China+1 Strategy)	Medium	High	High
7. Utility-Scale Solar, Hybrid, RTC & Storage-Linked Projects	High	High	High
8. ESG Commitments & Corporate Net-Zero Targets	Medium	High	High

9. Financing Support & Green Investments (Green Bonds, Infra Funds)	Medium	Medium	High
10. Improvements in Grid Infrastructure & Need for Grid Stability Through Smart Inverters	Low	Medium	High

Source – Infomerics Analytics & Research

### Detailed Overview

#### 1. Shift to Advanced Inverter Technologies (Transformer-less, Hybrid, High-Efficiency MPPT)

- The industry is moving from basic inverters to advanced transformer-less and hybrid systems that offer higher efficiency, lower heat loss, and better integration with batteries and the grid. Features such as improved MPPT algorithms and grid-forming capabilities enhance system reliability and energy yield, making these advanced technologies critical for residential, C&I, and utility-scale applications.

#### 2. Transition from Lead-Acid to Lithium (LFP) Batteries & Storage Growth

- The shift toward lithium (LFP) batteries is accelerating because of their superior cycle life, safety, depth of discharge, and lower maintenance requirements. As lithium costs continue to decline, adoption of solar-plus-storage solutions is rising, driving demand for hybrid inverters that seamlessly integrate with modern BMS-based storage systems for both backup and peak-shaving applications.

#### 3. Growth in Rooftop Solar & Behind-the-Meter Storage

- Rooftop solar adoption is accelerating due to rising electricity costs, government incentives, and higher consumer awareness. This growth directly drives demand for compact, efficient string and hybrid inverters. At the same time, behind-the-meter battery storage is expanding as users seek backup power and greater energy independence, strengthening demand for hybrid solutions.

#### 4. Smart & Connected Inverters, Digitalisation, and Remote Monitoring

- Smart inverters equipped with WiFi/GPRS connectivity, IoT integration, and advanced monitoring platforms are becoming mainstream. Remote fault detection, predictive maintenance, and energy analytics enable better asset management and improve overall system uptime. Digitalisation also supports seamless integration with BMS, EMS, and SCADA for data-driven solar operations.

#### 5. Declining Costs of Solar Modules & BOS Components

- Falling prices of solar modules and BOS components are reducing overall system costs, improving payback periods and making solar installations more financially attractive. This cost drop encourages capacity expansion across all segments and increases demand for high-efficiency inverters capable of supporting oversizing and high DC-to-AC ratios.

**6. Domestic Manufacturing Push: PLI, ALMM, DCR, China+1** - Government initiatives such as PLI, ALMM mandates, and DCR requirements are strengthening domestic production and reducing dependence on imports. As supply chains localize, inverter manufacturers benefit from improved availability of components, reduced lead times, and enhanced competitiveness. The broader China+1 diversification strategy is also boosting investment in local inverter assembly and R&D.

**7. Utility-Scale Solar, Hybrid, RTC & Storage-Linked Projects** - Large utility-scale solar, solar-wind hybrid, and energy-storage-linked RTC projects are becoming major growth engines for the sector. These projects require high-capacity central or string inverters with advanced grid-support features. With major tendering activity and long-term renewable procurement commitments, the utility segment remains a stable and high-volume driver of inverter demand.

**8. Corporate ESG, Sustainability, and Net-Zero Commitments** - Corporates are increasingly adopting solar to meet ESG commitments, reduce carbon footprints, and comply with net-zero targets. This shift is driving strong demand for high-quality, communication-enabled inverters that support detailed performance monitoring and sustainability reporting. C&I solar adoption is expected to accelerate under corporate decarbonisation mandates.

**9. Financing Support: Green Bonds, Infra Funds & ESG Capital** - Access to green financing is improving through instruments such as green bonds, renewable energy funds, and ESG-aligned capital. Lower cost of funds accelerates rooftop and utility-scale project execution, boosting overall inverter demand. Financing innovations are expected to play a major role in scaling solar capacity additions in the medium to long term.

**10. Improvements in Grid Infrastructure & Need for Grid Stability Through Smart Inverters** - As renewable penetration rises, the grid requires smarter inverters capable of providing reactive power support, frequency regulation, voltage stabilization, and anti-islanding functions. These advanced grid-support capabilities are increasingly becoming regulatory requirements. Over time, mandatory smart inverter standards will drive adoption of more sophisticated inverter technologies.

## 6.2 Challenges

Despite rapid capacity expansion and strong government policy support, the Solar Power Equipment Industry in India faces a series of structural, operational, and market-linked constraints that affect scalability, competitiveness, and long-term value creation. Domestic manufacturers continue to operate in a price-sensitive environment shaped by global module oversupply, fluctuating raw material costs, and elevated interest rates for capital-intensive manufacturing.

Challenges and Threats	Impact		
	1-2 Years	3-4 Years	5-7 Years
1. High Capital Intensity & Technology Upgradation Costs	High	Medium	Low
2. Dependence on Imported Cells, Wafers, Power Electronics & Battery Materials + Trade Policy & Tariff Uncertainty	High	High	Medium
3. Raw Material Price Volatility (Polysilicon, Glass, Aluminium, Silver, Copper)	High	High	Medium
4. Rapid Technology Obsolescence & Inventory/Compatibility Risks	Medium	High	High
5. Grid Integration Constraints & Interconnection Delays	High	High	Medium
6. Limited Availability of Skilled Technical Workforce	Medium	High	High
7. Price Competition & Margin Pressure from Global Oversupply	High	High	Medium
8. Compliance Burden: ALMM, DCR, Certification Delays	Medium	High	High
9. High Financing Costs & Interest Rate Sensitivity	High	Medium	Medium

Source – Infomerics Analytics & Research

## Detailed Overview

- 1. High Capital Intensity & Technology Upgradation Costs** - The solar equipment industry requires significant upfront capital for manufacturing lines, R&D, testing infrastructure, and continual technology upgrades. As global standards rapidly shift toward TOPCon, HJT, high-efficiency modules, advanced inverters, and BESS integration, manufacturers must frequently reinvest to stay competitive. This high capital intensity increases entry barriers and pressures cash flows, especially for mid-sized players.
- 2. Dependence on Imported Cells, Wafers, Power Electronics & Battery Materials + Trade Policy & Tariff Uncertainty** - Despite progress in domestic manufacturing, India remains heavily import-dependent for critical components such as wafers, cells, MOSFETs, IGBTs, lithium cells, and rare materials. Any change in global supply, tariff structures, or geopolitical relations can disrupt costs and availability. This dependence remains a major risk over the next 3–4 years, though domestic capacity expansion may gradually reduce exposure.
- 3. Raw Material Price Volatility (Polysilicon, Glass, Aluminium, Silver, Copper)** - Volatility in raw material prices directly impacts module, inverter, and BOS equipment costs. Polysilicon and silver prices, in particular, are highly sensitive to global demand cycles, geopolitical tensions, and mining supply constraints. Sudden spikes raise manufacturing costs, compress margins, and disrupt project-level financial planning, especially in utility-scale tenders with fixed tariffs.
- 4. Rapid Technology Obsolescence & Stranded Inventory Risk** - Solar technology is evolving rapidly—from poly to mono, PERC to TOPCon/HJT, and from string inverters to hybrid and grid-forming inverters. Fast transitions make older technologies obsolete sooner, creating stranded or slow-moving inventory for manufacturers and distributors. This shortens product lifecycles, increases working capital risk, and complicates demand forecasting.
- 5. Grid Integration Constraints & Interconnection Delays** - Utility-scale solar projects often face delays due to limited substation capacity, congested transmission corridors, and slow power evacuation approvals. Weak distribution networks also hinder rooftop and C&I adoption. These bottlenecks increase project timelines, raise integration costs, and impact equipment utilisation rates—directly affecting manufacturers dependent on predictable installation pipelines.
- 6. Limited Availability of Skilled Technical Workforce** - The industry requires skilled technicians for module assembly, inverter servicing, BESS commissioning, SCADA integration, and quality assurance. A shortage of trained manpower prolongs installation cycles, increases error rates, and limits the industry's ability to scale rapidly. This challenge becomes more pronounced as technologies become more advanced and digitalised.

**7. Price Competition & Margin Pressure from Global Oversupply** - Global manufacturing overcapacity—especially from China—continues to create downward pressure on module and inverter prices. Indian manufacturers face stiff competition from low-cost imports, which reduces margins and limits the ability to recover R&D or capacity-expansion investments. Intense price wars also force companies to operate on thinner cost structures.

**8. Compliance Burden: ALMM, DCR, Certification Delays** - Mandatory certifications such as ALMM listing, BIS compliance, safety testing, and periodic audits create additional time and cost burdens for manufacturers. Delays in approval cycles impact market entry, restrict supply availability, and slow down project execution. Smaller companies especially face challenges in meeting stringent documentation and quality requirements.

**9. High Financing Costs & Interest Rate Sensitivity** - Solar equipment manufacturing and installation rely heavily on debt financing. Higher interest rates increase the cost of capital for both manufacturers and developers, making projects less viable. Financing challenges are acute for rooftop and C&I markets, where payback periods are sensitive to borrowing costs. Expensive financing slows adoption and reduces equipment offtake.

## 7. PESTEL Analysis of the Industry

Factor	Key Insights and Implications
<b>Political</b>	<ul style="list-style-type: none"> <li>Government strongly promotes domestic solar manufacturing through PLI Scheme, make in India, and Atmanirbhar Bharat, accelerating India's transition from import dependence to local value chain integration.</li> <li>Updated ALMM (2024–2025) mandates procurement from approved domestic manufacturers for government projects, boosting demand for Indian-made modules, inverters, and BoS equipment.</li> <li>Domestic Content Requirement (DCR) tightened cells made from imported diffused wafers are not considered domestic, encouraging deeper manufacturing (wafers, ingots).</li> <li>State and central solar policies (Gujarat, Rajasthan, Karnataka, MNRE) continue to expand rooftop and utility-scale installations.</li> </ul>
<b>Economic</b>	<ul style="list-style-type: none"> <li>India added 44.2 GW of solar module and 7.5 GW of solar cell manufacturing capacity in the first half of 2025, indicating rapid scale-up and strong production growth.</li> <li>Demand is driven by falling solar tariffs, strong RPO mandates, and rising industrial/commercial power needs.</li> <li>Persistent dependence on certain imports—over 352.57 in lakhs solar PV modules imported from China in FY25—creates exposure to global price volatility.</li> <li>Fluctuating prices of key materials such as polysilicon, aluminium, copper, and silver affect equipment costs and margins.</li> <li>Financing challenges arise due to high interest rates and long project cycles, impacting procurement of solar inverters, modules, and storage systems.</li> </ul>
<b>Social</b>	<ul style="list-style-type: none"> <li>Rising awareness toward sustainability, energy independence, and lower electricity bills strengthens adoption across residential and C&amp;I segments.</li> <li>Government-backed rooftop programs like PM–Surya Ghar Yojana boost household demand for panels, inverters, and batteries.</li> <li>Stronger consumer trust in domestic manufacturers due to better branding, certification, and quality monitoring.</li> <li>Growing acceptance of hybrid inverters and solar storage solutions as reliable alternatives to diesel generators.</li> <li>Increasing urbanization and electrification in rural/semi-urban regions expand the market base.</li> </ul>

<b>Technological</b>	<ul style="list-style-type: none"> <li>• Rapid adoption of TOPCon, HJT, and high-efficiency mono-PERC technologies with modules now exceeding 700+ Wp output.</li> <li>• Updated ALMM for solar cells pushes manufacturers toward deeper production (ingots → wafers → cells → modules).</li> <li>• Growing integration of IoT-enabled and smart inverters, remote monitoring, and AI-based performance analytics for power optimization.</li> <li>• Manufacturers increasingly use automation—robotic handling, AI-driven QC systems, and advanced testing—to meet PLI-linked efficiency benchmarks.</li> <li>• Fast-moving innovation risks obsolescence of older plants and increases capex needs for technology upgrades.</li> </ul>
<b>Environmental</b>	<ul style="list-style-type: none"> <li>• Solar manufacturing aligns with India's 500 GW non-fossil capacity by 2030 and broader decarbonization goals.</li> <li>• New environmental compliance norms require waste management systems, effluent treatment, and emission control from module and cell manufacturing units.</li> <li>• Emphasis on solar module recycling is increasing; draft recycling guidelines are being prepared to reduce landfill waste and recover critical materials.</li> <li>• Use of renewable energy in manufacturing is encouraged, improving the lifecycle sustainability of domestic products.</li> <li>• Climate-focused policies and green procurement norms create higher expectations for ESG-aligned manufacturing.</li> </ul>
<b>Legal</b>	<ul style="list-style-type: none"> <li>• Mandatory BIS certification for solar modules, inverters, and most BoS components ensures standardized quality across the industry.</li> <li>• Updated ALMM Order (2024–2025) introduces strict traceability and higher domestic value-add norms, ensuring modules and cells meet tighter Indian made component norms.</li> <li>• PLI beneficiaries must comply with rigorous efficiency, testing, and backward-integration requirements; compliance deadlines were extended by two years.</li> <li>• EPCs and manufacturers must meet safety and performance standards set by MNRE, CEA, and state regulators.</li> <li>• Increasing focus on contract enforcement, warranty obligations, and performance guarantees in large solar projects.</li> </ul>

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### **8. Government Initiatives and Policy Support**

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India's solar power equipment industry is strongly shaped by a wide range of government policies aimed at accelerating domestic manufacturing, reducing import dependency, promoting renewable adoption, and ensuring long-term investment stability. These initiatives—spanning fiscal incentives, tariff protections, quality standards, supply-chain localization, and public procurement—form the backbone of India's fast-growing solar manufacturing ecosystem. Below are a detailed assessment of key government policies and their implications for manufacturers of modules, cells, inverters, batteries, and balance-of-system (BOS) components.

**1. Production Linked Incentive (PLI) Scheme for High-Efficiency Solar PV Modules** - The MNRE's PLI Scheme (Tranche I & II) with a total outlay of ₹24,000 crore is designed to develop a fully integrated domestic manufacturing ecosystem—from polysilicon to modules. It supports gigawatt-scale capacity creation and has already allocated incentives to manufacturers for setting up end-to-end production lines. The scheme directly boosts domestic supply of modules, cells, wafers, and ancillary equipment, reducing dependency on Chinese imports and ensuring long-term supply-chain stability.

**2. India Achieving 100 GW ALMM-Listed Module Capacity** - As announced by MNRE in August 2025, India has crossed 100 GW of domestic module manufacturing capacity registered under the Approved List of Models and Manufacturers (ALMM). This milestone reflects rapid industry expansion and ensures that government-backed projects—rooftop, utility-scale, PM-KUSUM—are supplied with domestically verified and quality-certified modules, further stimulating local manufacturing investment.

**3. Introduction of ALMM List-II for Solar PV Cells** - On 31 July 2025, MNRE released the ALMM List-II, containing the first set of approved solar cell manufacturers in India. This strengthens the upstream manufacturing segment by ensuring that government projects procure domestically produced, traceable, and quality-certified solar cells. It also complements the PLI scheme by increasing demand for local cell production, reducing import reliance in the midstream component of the value chain. (Source – PIB)

**4. Rooftop Solar Programme (Phase II) – 40 GW Target** - MNRE's Grid-Connected Rooftop Solar Programme Phase-II targets 40,000 MW (40 GW) rooftop installations by 31 March 2026. Central financial assistance (CFA) for residential consumers has driven large-scale adoption of modules, inverters, hybrid inverters, and storage systems. This programme creates a steady domestic offtake market for small and medium-capacity solar equipment manufacturers, especially those producing inverters, batteries, and mounting structures.

**5. Solar Goods Order Extension for Large SPV Inverters (>200 kW)** - In August 2025, MNRE extended the implementation of the Solar Systems, Devices & Components Goods Order, 2025 for inverters above 200 kW until 30 June 2026. This directive provides manufacturers with regulatory clarity and a compliance window to meet local certification norms. It specifically benefits utility-scale inverter manufacturers, encouraging investments in large central and string inverters aligned with future grid-integration needs.

**6. Physical Progress: Solar & Hybrid Capacity Deployment** - As per MNRE's October 2025 progress report, India has installed 129.92 GW of solar capacity, supplemented by 3.33 GW of solar-wind hybrid projects. The growing share of hybrid installations indicates rising demand for advanced hybrid inverters, grid-supporting electronics, smart controllers, and battery management systems. This deployment data highlights the expanding market base for technologically advanced solar power equipment.

**7. BEE Standards & Labelling (S&L) Program for Solar Inverters** - The Bureau of Energy Efficiency (BEE) launched a Standards & Labelling (S&L) program for grid-connected solar inverters starting in March 2024. This program sets Minimum Energy Performance Standards (MEPS) for inverters up to 100 kW, requiring a minimum efficiency of 92% for very small units up to 98% for larger ones. Only BIS-certified inverters (IS 16221-2:2015) can participate, helping consumers choose higher-quality, more efficient inverters.

**8. PM Surya Ghar Yojna** - The PM Surya Ghar: Muft Bijli Yojana is a national rooftop-solar scheme launched in February 2024 to equip 1 crore households with rooftop solar systems and provide up to 300 units of free electricity per month. The government offers a central subsidy of ₹30,000 per kW up to 2 kW and ₹18,000 per kW for the next 1 kW, capped at ₹78,000, along with low-interest, collateral-free loans to reduce the upfront cost. Households apply through the national portal, select empanelled vendors, and receive the subsidy directly after installation and DISCOM approval. The scheme aims to lower electricity bills, promote clean energy adoption, boost domestic solar manufacturing, and add nearly 30 GW of residential rooftop solar capacity across India. *(Source – Ministry of New and renewable energy)*

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## **9. Technology and Digital Transformation**

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The solar power equipment industry in India is being reshaped by a rapid wave of technological innovation and digital transformation. From advanced cell and module architectures to smart inverters, automated manufacturing lines, and IoT-enabled asset management, the sector is evolving to address the needs of a dynamic energy market. These developments are not only improving system efficiency and reliability but are also enabling the widespread integration of storage-backed (hybrid) solar solutions, paving the way for greater energy independence, grid resilience, and digital-first operations.

**1. Rapid Advancement in PV Cell & Module Technologies** - India's solar equipment industry is undergoing a major technology shift as manufacturers transition from polycrystalline modules to high-efficiency technologies like TOPCon, HJT, and bifacial modules. As per Mercom & MNRE's 2025 manufacturing update, India added 44.2 GW of new module capacity and 7.5 GW of solar cell capacity in the first half of 2025, with TOPCon alone contributing 39.9 GW of the new additions. This rapid adoption of advanced cell architectures is helping Indian manufacturers achieve higher module efficiencies (22–24%), reduce LCOE for utility-scale plants, and align with global competitive benchmarks. Innovation in materials—such as high-transparency glass, light-weight composite back sheets, and metallization pastes with lower silver content—is further driving technology-led cost reduction and performance gains.

**2. Transformation in Solar Inverter Technologies (String, Hybrid & Grid-Forming)** - Solar inverters are experiencing a major technological leap driven by digital control electronics, AI-enabled energy management, and hybrid storage integration. Manufacturers in India are rapidly shifting from older PWM-based designs to transformer less, high-frequency MPPT, and grid-forming inverters, enabling better system efficiency (>98%), flexible grid support, and seamless mode switching. Hybrid inverter technology has been a key focus area—boosted by policy momentum on rooftop & residential storage—leading to the widespread adoption of hybrid inverters with integrated Li-ion BMS, remote monitoring apps, and cloud diagnosis tools. Advanced DSP controllers, Wi-Fi/GPRS-based smart dashboards, and export-limit controls are becoming standard features, enabling smart grid readiness and better demand-response coordination.

**3. Digitization & Automation of Manufacturing Ecosystems** - Automation has become central to India's solar equipment manufacturing expansion. India's module manufacturing capacity increased from 38 GW in March 2024 to 74 GW by March 2025, driven largely by investments in automated line technologies such as multi-busbar (MBB) stringers, AI-assisted EL testing, automated bussing stations, and precision laser cutting for cells. Several upcoming PLI-backed factories are integrating Industry

4.0 systems—including automated material handling, robotics for lamination and cutting, digital quality control, and inline performance diagnostics. For inverter companies, digitalized PCB assembly (SMT lines), AI-based thermal modelling, and automated firmware testing environments are significantly improving design reliability and reducing failure rates.

**4. Smart Monitoring, IoT, and Cloud-Based Asset Management** - Digital transformation is reshaping operations and field performance of solar assets. IoT-enabled hardware and cloud platforms now allow real-time monitoring of string voltages, MPPT performance, inverter temperatures, and degradation patterns across utility and rooftop systems. Modern inverters come with built-in Wi-Fi, RS485, 4G SIM communication, and cloud dashboards that offer predictive maintenance alerts, fault analytics, and remote firmware upgrades. Asset management platforms used by DISCOMs and EPCs increasingly integrate SCADA, digital twins, and machine learning to optimize generation forecasts, scheduling, and inverter operational windows. The rise of hybrid rooftop systems is accelerating adoption of mobile app-based monitoring, empowering consumers with consumption analytics and battery performance insights.

**5. R&D Acceleration and Domestic Innovation in Solar Components** - India's solar R&D ecosystem is strengthening as manufacturers pursue backward integration and high-end product innovation. MNRE-supported testing facilities and R&D centres—such as NISE (Gurugram)—are working on next-generation PV cell architectures, grid-supportive inverter functions, and heat-resilient module technologies suitable for India's high irradiance and temperature profile. In FY 2025, India commissioned its first 2 GW ingot-wafer manufacturing line, marking a critical step toward achieving the full PV value chain domestically. Inverters are witnessing significant innovation in firmware reliability, adaptive MPPT algorithms, AI-based reactive power control, and cybersecurity layers, enabling them to operate more intelligently within modernized grid environments.

**6. Digital Transformation Across Sales, Distribution & After-Sales** - Digital commerce and analytics-driven customer engagement are playing an increasingly important role in the solar equipment industry. Manufacturers and distributors now rely on digital B2B platforms, online configurators, QR-coded warranty systems, and app-based service support for installers. For rooftop and hybrid inverter markets, digital comparison engines, remote commissioning tools, and integrated mobile apps have become standard, reducing installer time and improving system configuration accuracy. AI-enabled sales forecasting, CRM automation, and digital lead funnels are enhancing efficiency, especially for hybrid inverter and residential segments where consumer interaction is high.

**7. Technology for Sustainability & Resource Optimization** - Sustainability is being embedded into solar manufacturing through resource-efficient and low-carbon technologies. Large module factories are installing rooftop solar plants, energy-efficient curing ovens, and water-

recycling systems in EVA lamination and cleaning lines. Digital tools are being used to track energy consumption per MW of module output, enabling compliance with global sustainability reporting standards (ESG). Inverter makers are transitioning to more recyclable enclosures, RoHS compliance for components, and energy-optimized thermal management architectures. For the broader system, high-efficiency modules and hybrid inverters are improving the integration of renewable energy with storage—supporting grid stability, reducing fossil-fuel ramping, and enabling peak-shaving operations.

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## **10. Competitive Landscape**

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The Indian solar equipment industry operates in a highly competitive and fast-evolving ecosystem characterised by a mix of large domestic manufacturers, global technology players, low-cost Chinese suppliers, specialised inverter and storage companies, and emerging MSME component makers. This diversity reflects the sector's transition from a price-driven market to one defined by technology advancement, localisation mandates, and performance reliability. Companies are continually repositioning themselves through efficiency upgrades, backward integration, digitalisation, and portfolio expansion into hybrid inverters and energy-storage-integrated systems to capture long-term growth opportunities.

### **10.1 Key Factors Shaping Competition**

- 1. Technology-Led Differentiation & Efficiency Leadership** - Competition is increasingly defined by advancements in module and inverter technology — including TOPCon, HJT, bifacial modules, transformer-less inverters, and hybrid inverter–battery integrated systems. Manufacturers with superior efficiency, lower degradation rates, longer warranties, and AI-enabled monitoring platforms gain a clear advantage, especially in utility-scale tenders and distributed rooftop markets where lifetime performance matters more than upfront cost.
- 2. Vertical Integration & Domestic Value Addition** - Players that integrate cell–module manufacturing, in-house BMS design, inverter R&D, and batteries gain cost control and greater ALMM/PMP compliance. India's push for backward integration is shifting the competitive edge to firms with captive cell manufacturing, PCB assembly lines, and EMS setups for inverter production. Integrated players can offer bundled hybrid solutions, creating higher entry barriers.
- 3. Price Competition & Chinese Supplier Dominance** - Despite increasing domestic capacity, Chinese firms continue to shape pricing for modules, inverters, and battery packs due to scale advantages and global supply-chain control. Indian firms compete by offering ALMM-compliant products, shorter delivery cycles, and after-sales strength. The competitive landscape is highly price-sensitive, especially in the residential and C&I inverter segments.
- 4. Digitalisation, Smart Inverters & Remote Monitoring Capabilities** - Smart energy management systems, IoT-based inverter platforms, Wi-Fi-enabled hybrid inverters, and AI-driven predictive maintenance are becoming key differentiators. Companies that provide seamless app-based monitoring, grid-interactive features, and real-time analytics hold a competitive edge, especially among rooftop installers and commercial users who demand transparency and uptime assurance.

**5. Quality, Reliability & Warranty Performance** - Long-term reliability — including degradation warranties for modules, MTBF for inverters, battery cycle life, and temperature management — plays a crucial role in winning EPC and distributor trust. Firms offering 10–25 year warranties, robust service networks, and guaranteed after-sales responsiveness are preferred over low-cost suppliers, driving a shift from price-only competition to value-led competition.

**6. Policy Alignment & Compliance with ALMM, BIS, and PMP Norms** - The competitive landscape is heavily influenced by regulatory requirements such as the Approved List of Models & Manufacturers (ALMM), BIS certification, and Production Linked Incentive (PLI) norms. Companies that proactively align with domestic manufacturing rules, traceability mandates, and localisation standards gain procurement preference in government, utility, and DISCOM-led projects.

**7. Supply Chain Resilience & Component Security** - Given India's high dependence on imported cells, wafers, PCBs, MOSFETs, and lithium-ion cells, firms with diversified sourcing, localisation strategies, or captive manufacturing enjoy better stability. Supply chain disruptions (China, freight, raw materials) directly impact pricing and delivery schedules, making resilience a competitive differentiator.

**8. Expansion into Hybrid & Storage-Integrated Solutions** - Competition is shifting toward hybrid solar inverters, energy storage systems (ESS), and integrated solar-plus-battery packages as demand rises in residential, C&I, telecom, and rural markets. Companies offering advanced hybrid inverters with seamless switching, higher charging efficiency, and intelligent load management are capturing faster market share.

**9. Distribution Network Strength & Installer Loyalty** - In the rooftop and C&I inverter market, channel strength — including dealer networks, installer partnerships, training programs, and service centres — strongly shapes market competitiveness. Brands with pan-India distributor coverage and faster on-site service resolution outperform technically comparable competitors.

**10. Global Partnerships, JVs & Technological Collaborations** - Indian manufacturers increasingly partner with global technology leaders for advanced cell tech, inverter design expertise, BMS systems, and ESS platforms. Joint ventures, licensing arrangements, and OEM–ODM relationships help companies reduce development time and match global quality standards, intensifying competitive pressure within the domestic market.

## 10.2 Competitive Strategies

India's solar power equipment industry is undergoing rapid technological advancement, accelerated domestic manufacturing expansion, and intensifying price competition. Leading players are deploying multi-layered strategies to enhance efficiency, deepen backward integration, strengthen domestic value addition, and differentiate through digitalized and storage-integrated solutions. These strategies reflect both the market's shift toward higher-performance solar assets and the industry's response to policy incentives, import risks, and evolving consumer demand. The following competitive levers define the current competitive landscape:

- 1. Technology Upgradation & High-Efficiency Product Portfolios** - Manufacturers are aggressively transitioning from conventional polycrystalline modules and basic string inverters to advanced technologies such as TOPCon and HJT modules, bifacial architectures, transformer-less inverters, and hybrid inverters with integrated MPPT and energy management systems. Firms investing in R&D, higher module efficiencies (22%+), superior inverter conversion efficiency (98%+), and smart grid-ready features are capturing premium market share across utility and C&I segments.
- 2. Vertical Integration & Localization of Critical Components** - To reduce import dependence and meet ALMM/BIS/PMP compliance, firms are expanding into backward integration—cell lines, wafer slicing, BMS design, lithium battery pack assembly, PCB manufacturing, and EMS for inverter electronics. Fully integrated producers gain cost advantages, supply-chain resilience, and eligibility for government-linked contracts while enabling bundled inverter–battery–module solutions for hybrid systems.
- 3. Hybrid Inverter & Storage-Led Market Positioning** - With rising rooftop and C&I demand for backup power, players are repositioning themselves as “solar-plus-storage solution providers” rather than standalone equipment suppliers. Firms offering hybrid inverters with seamless switching, higher charge/discharge efficiencies, intelligent load prioritization, and app-based monitoring are gaining strategic differentiation. This shift supports premium pricing and long-term AMC-driven recurring revenue.
- 4. Digitalization, Smart Monitoring & IoT-Enabled Inverter** - Companies are embedding IoT-enabled monitoring, remote diagnostics, predictive maintenance, Wi-Fi/GPRS communication, and AI-driven energy optimization into inverters and energy management systems. Digital platforms that provide real-time performance analytics, fault alerts, and grid-interactive controls improve customer retention, reduce service costs, and strengthen distributor and installer loyalty.

**5. Quality, Warranty Strength & Premium Reliability Positioning** - As customers demand 25-year module performance guarantees and 8–12-year inverter warranties, firms are strengthening quality assurance, thermal stability, and long-term reliability metrics. Brands with robust on-ground service networks, faster replacement turnaround times, and bankable warranties are winning EPC and tender-driven opportunities where risk mitigation is a key procurement factor.

**6. Cost Optimization & Scale-Based Manufacturing** - With price competition driven heavily by Chinese imports, leading Indian firms are expanding manufacturing capacity, optimizing sourcing, automating production lines, and leveraging economies of scale to compete effectively. Cost competitiveness—especially in modules, inverters, and battery packs—is critical for defending market share in highly price-sensitive rooftop and C&I segments.

**7. Strategic Distribution Network Expansion & Installer Engagement** - A strong footprint of distributors, dealers, and certified installers has emerged as a key competitive differentiator. Firms are investing in channel programs, installer training, co-branded marketing, and regional service hubs to enhance product visibility and improve last-mile delivery. This strategy is particularly important for residential solar, hybrid inverters, and small C&I markets.

**8. Policy Alignment, Certification Readiness & Tender Compliance** - Companies are proactively aligning with government norms—ALMM compliance, BIS certification, traceability rules, domestic value-add requirements, and PLI eligibility. Early policy alignment ensures access to utility-scale tenders, rooftop schemes, and government procurement, creating a competitive moat for compliant manufacturers over low-cost non-compliant imports.

**9. Global Partnerships, Technology Licensing & OEM/ODM Models** - To shorten innovation cycles, Indian manufacturers are forming joint ventures, licensing next-generation cell technologies, partnering with battery and inverter specialists, and leveraging OEM/ODM manufacturing. These collaborations enhance product performance, accelerate time-to-market, and enable companies to compete with global leaders in efficiency and reliability benchmarks.

### **10.3 Barriers to Entry**

Despite strong policy support and rising demand for renewable energy, the Indian solar power equipment industry presents significant structural and capability-driven barriers that make it difficult for new firms to enter and scale. These barriers arise from high capital requirements, technology complexity, stringent compliance norms, and the dominance of established domestic and global players. Key barriers include:

#### **1. High Capital Intensity and Advanced Manufacturing Requirements**

- Setting up a competitive solar equipment facility—whether for modules, cells, inverters, or lithium battery packs—requires substantial upfront investment in automated production lines, clean-room environments, precision testing equipment, and quality assurance systems.
- Entry is especially challenging in high-value segments such as cell lines, wafering, TOPCon/HJT manufacturing, and hybrid inverter design, where technology acquisition, R&D, and certification costs are prohibitively high for new entrants.

#### **2. Technology Complexity, Efficiency Requirements & Continuous R&D**

- Competing in today's market requires deep expertise in high-efficiency cell technologies (TOPCon, HJT, bifacial), MPPT algorithms, grid-interactive controls, IoT-enabled monitoring platforms, and lithium battery safety systems.
- Without strong R&D capabilities, thermal engineering expertise, and power electronics talent, new firms struggle to meet efficiency benchmarks or reliability expectations—especially for hybrid inverters and storage-integrated systems.

#### **3. Compliance with ALMM, BIS Certification & Traceability Norms**

- Mandatory government standards—such as ALMM approval, BIS certification, inverter safety testing, battery standards (IS 16270/IS 16893), and traceability norms—pose significant regulatory hurdles for new firms.
- Achieving compliance requires extensive documentation, testing cycles, and audit readiness; failure to obtain timely approvals prevents access to rooftop schemes, government tenders, DISCOM programs, and utility-scale EPC markets.

#### **4. Supply Chain Dependence & Raw Material Constraints**

- Critical components such as wafers, high-efficiency cells, semiconductor chips, power MOSFETs, PCBs, BMS components, and lithium cells remain heavily import-dependent.

- New entrants face long lead times, limited supplier relationships, volatile pricing, and minimum order quantity constraints—factors that established players mitigate through bulk contracts, global partnerships, and deeper backward integration.

## 5. Brand Trust, Bankability & Service Network Expectations

- Solar equipment purchases—especially inverters and storage—are long-term, risk-sensitive decisions, with customers and EPCs preferring brands with strong performance track records, fast service response, and bankable warranties.
- New entrants struggle to win trust without long-term field data, reliability certifications, established service hubs, and a nationwide installer/dealer network—areas dominated by incumbent global and Indian brands.

## 6. Economies of Scale & Price Competition with Global Players

- Market pricing for modules and inverters is strongly influenced by large-scale Chinese, Southeast Asian, and established Indian manufacturers with massive capacity, optimized procurement, and lower per-unit production costs.
- Small or new manufacturers cannot match these price levels without scale, automation, or integrated supply chains, making cost competitiveness a major entry barrier.

## 7. Distribution, Installer Ecosystem & After-Sales Infrastructure

- Solar sales are heavily channel-driven, requiring extensive dealer networks, certified installer programs, regional warehouses, and service centres for rapid maintenance and inverter replacements.
- New firms without existing channel partnerships or on-ground service capabilities face significant delays in customer adoption and EPC onboarding.

## 8. Tender Participation Criteria & Financial Strength Requirements

- Utility-scale and government-backed EPC projects require strict financial eligibility, performance guarantees, multi-year service contracts, and bank guarantees—requirements difficult for smaller or new firms to meet.
- Established firms with stronger balance sheets, insurance backing, and prior tender experience hold a structural advantage, further limiting new entrant access to large-volume demand.

## 10.4 Consolidation Trends

India's solar power equipment industry is undergoing rapid consolidation as domestic manufacturers scale capacity, global players strengthen their India presence, and supply chains become more integrated across modules, inverters, and energy storage. Policy incentives, technology shifts, and rising demand for high-efficiency products are accelerating M&A, joint ventures, and ecosystem partnerships. The following trends reflect how consolidation is reshaping competitiveness and manufacturing depth across the sector:

### 1. Strategic M&A for Capacity Expansion and Technology Upgradation

- Leading Indian manufacturers are acquiring smaller module and cell producers to expand capacities, especially in high-efficiency TOPCon and HJT lines.
- M&A is increasingly focused on gaining access to advanced cell technology, wafer expertise, and power electronics capabilities for next-generation string and hybrid inverters.
- Acquisitions also support entry into high-growth segments such as lithium battery packs, BMS design, and integrated solar-plus-storage solutions.

### 2. Global Solar Majors Deepening India Manufacturing Presence

- International module and inverter companies are consolidating their Indian operations through local JV partnerships, manufacturing tie-ups, and technology licensing with domestic firms.
- Global inverter brands are integrating India operations into their APAC supply chains, streamlining R&D, certification, and after-sales support under unified regional leadership.
- This consolidation is bringing advanced engineering practices, high-efficiency inverter platforms, and grid-interactive hybrid technologies into Indian manufacturing ecosystems.

### 3. Private Equity Interest & Platform Roll-Ups in Renewables Manufacturing

- Strong policy stability and long-term demand visibility for solar equipment have attracted private equity funding into module, cell, and inverter manufacturers.
- PE-backed platform roll-ups are emerging, where multiple mid-sized solar equipment units—such as inverter assemblers, battery pack makers, and BOS suppliers—are merged into integrated clean-energy manufacturing platforms.
- This capital infusion accelerates automation, backward integration, and entry into export markets.

#### **4. Vertical Integration Across the Solar Value Chain**

- Large Indian players are aggressively integrating backward and forward—covering polysilicon, ingots, wafers, cells, modules, inverters, mounting structures, and storage systems under one umbrella.
- Inverters and hybrid energy management systems are being vertically aligned with module manufacturing to deliver bundled solutions for rooftop and C&I customers.
- Such integration reduces supply chain volatility, improves cost competitiveness, and enhances control over quality and technology.

#### **5. Rise of Platform-Centric Energy Solutions Models**

- Manufacturers are consolidating energy tech capabilities to build integrated platforms combining modules, inverters, batteries, smart meters, and IoT monitoring tools.
- These unified platforms enable seamless solar-plus-storage management, remote fleet monitoring, advanced MPPT analytics, and grid-synchronization features for hybrid inverters.
- Consolidation around digital IP—such as EMS software, AI-based predictive maintenance, or BMS firmware—is becoming a key driver of M&A.

#### **6. Regional Consolidation and Expansion into Tier-II Manufacturing Clusters**

- Domestic players are acquiring regional manufacturers in Gujarat, Tamil Nadu, Telangana, and Rajasthan to build multi-location manufacturing clusters and reduce logistics costs.
- Companies are consolidating assembly and testing facilities for inverters and battery packs in Tier-II industrial zones to access lower-cost labor and state incentives.
- This regional clustering supports resilient supply chains and faster market access across India.

#### **7. Quality Compliance, ALMM Norms & Tender Eligibility Driving Consolidation**

- Firms lacking BIS certification, ALMM approval, or inverter safety compliance are being acquired by larger manufacturers that require compliant facilities to meet tender requirements.
- Consolidation is particularly strong in hybrid inverter and battery storage segments, where safety certifications, traceability norms, and test requirements are stringent. As government and DISCOM procurement tighten quality standards, non-compliant or subscale firms increasingly merge into structured entities capable of meeting regulatory and technical benchmarks.

## 10.5 Key Industry Players

India's solar equipment market is witnessing strong participation from both established manufacturers and emerging high-tech players who are scaling rapidly across residential, commercial, and small industrial segments. While larger companies compete on distribution networks, production capacity, and nationwide after-sales support, agile brands such as Smarten and iNVERGY are carving out niche leadership through innovative hybrid inverters, smart energy-storage systems, and IoT-enabled monitoring platforms.

### • **Smarten Power Systems Limited**

Smarten Power Systems Ltd. is a leading India-based manufacturer of solar and power-backup products, incorporated in 2014. The company offers a diversified product portfolio that includes solar hybrid inverters, off-grid and on-grid solar PCUs, MPPT charge controllers, UPS systems, and solar management units (SMUs). Smarten has developed over 350+ SKUs and distributes across 23 states and 2 union territories through an established dealer and distributor network. The company differentiates itself by offering high-efficiency MPPT technology, robust energy-backup solutions, and scalable inverter systems suitable for households, shops, small commercial units, and rural electrification. With a focus on indigenous design and expanding manufacturing capabilities, Smarten continues to strengthen its presence in the fast-growing solar-power equipment market by integrating reliability, cost-efficiency, and customer-centric product innovation.

### • **iNVERGY (Invergy Power Supply India)**

iNVERGY is a fast-growing smart solar inverter and energy-storage solutions provider headquartered in India, operating under GP Eco Solutions. The company specializes in advanced new-energy technologies and offers a wide product range including hybrid solar inverters (1 kW to 50 kW), on-grid inverters, off-grid inverters, energy-storage systems (LFP batteries), battery management systems (BMS), EV charging equipment, and intelligent Energy Management Systems (EMS) with real-time monitoring. iNVERGY has established itself as a technology-driven player through features such as UPS-grade switching (as low as 10 ms), 110% overload capability, WiFi/GPRS connectivity, mobile-app integration, and compatibility with both lithium and lead-acid battery technologies. Through its partnerships with global innovators such as Solinteg, the company delivers high-performance hybrid inverters and smart BESS units tailored to Indian grid conditions. With a focus on digitalization, safety, and low-carbon energy solutions, iNVERGY is emerging as a preferred choice for residential and commercial customers seeking modern solar-plus-storage solutions.

## 10.6 Company Positioning

Cellcronic Technologies Limited is a fast-growing power-electronics and solar-storage solutions provider, uniquely positioned at the intersection of advanced inverter engineering, energy-storage innovation, and digital intelligence. The company offers a comprehensive, end-to-end solar-plus-storage portfolio: hybrid solar inverters, LiFePO<sub>4</sub> battery packs, and associated accessories such as battery wiring harnesses and protection boxes — delivering complete, plug-and-play solar systems for homes, SMEs, commercial establishments, and emerging C&I applications. The company operates through a robust dealer-installer distribution model, supported by regional service centres to ensure rapid installation, after-sales service, and technical support. Compared to competitors, Cellcronic distinguishes itself by offering an integrated smart energy ecosystem in which inverters, batteries, wiring, protection hardware, and monitoring platforms work seamlessly together — backed by rugged design, digital intelligence, and user-centric convenience. By supplying not only inverters and batteries but also critical wiring and protection components, Cellcronic simplifies procurement and installation for customers and installers. This full-spectrum offering reinforces its positioning as a reliability-focused, performance-driven, and convenience-oriented brand — well placed to capitalise on India's accelerating shift toward decentralized solar energy, hybrid storage solutions, and clean-energy adoption across residential, commercial, and industrial user segments. The Company is set to introduce a new benchmark in product durability with the launch of IP54-rated hybrid solar inverters — currently unmatched by any other hybrid inverter manufacturer in India. These inverters deliver a strong balance of protection and affordability, offering dust-tight design and resistance to water splashes, making them ideal for India's dusty, humid and semi-outdoor installation environments.

Cellcronic Technologies Limited operates in segments that are structurally supported by government-led renewable energy and electrification initiatives. The Company's focus on solar inverters, hybrid power solutions, lithium battery systems and power-backup products aligns with national programmes such as the National Solar Mission, PM-KUSUM, Rooftop Solar Programme, and broader renewable energy capacity expansion targets. These initiatives promote increased adoption of solar and hybrid energy systems across residential, commercial and institutional users, thereby supporting sustained demand for power electronics and energy management solutions. Such policy-driven demand dynamics enhance the Company's market opportunities, support scalable growth and reinforce its competitive positioning in the renewable and power electronics ecosystem, without dependence on discretionary consumption cycles.

### Industries & Customer Segments Served

Cellcronic's solutions serve:

- Residential households requiring solar backup and hybrid systems.
- SMEs such as clinics, offices, and shops that need reliable power continuity.
- Solar installers & EPCs seeking quality inverters and batteries for projects.
- Dealers & distributors operating in the solar retail ecosystem.
- Rural & off-grid users dependent on solar-based electrification.

These initiatives reinforce Cellcronic's positioning as an innovation-led power electronics company enabling India's transition toward reliable and affordable clean energy.

Infomerics Analytics & Research

## 10.7 Financial Performance Analysis

The financial performance analysis of Cellcronic Technologies Limited presents an overview of its operational and profitability trends over FY 2023 to FY 2025. The assessment highlights key indicators such as revenue from operations, total income, EBITDA, and profitability margins, reflecting the company's operational efficiency and financial stability.

*Figures are in INR lakhs (Except for ratios and percentages)*

Key Indicators (in INR Lakhs)	Cellcronic Technologies Limited		
	FY 2023	FY 2024	FY 2025
<b>Total Operating Income</b>	924.05	1711.52	2591.96
<b>Total Income</b>	924.05	1711.52	2599.40
<b>EBITDA</b>	17.30	233.44	547.39
<b>EBITDA Margin (%)</b>	1.87%	13.64%	21.12%
<b>PAT</b>	2.41	145.88	359.71
<b>PAT Margin (%)</b>	0.26%	8.52%	13.84%
<b>Current Ratio (in times)</b>	1.55	1.72	1.56
<b>Tangible Net worth</b>	14.42	160.30	520.01
<b>Total Debt</b>	355.77	289.26	299.60
<b>Debt Equity Ratio (in times)</b>	24.67	1.80	0.58
<b>ROCE (%)</b>	7.99%	55.77%	85.41%
<b>Return on Net Worth (%)</b>	33.43%	166.99%	105.75%

*Source – Restated Financials as provided by the Company*

Formula Used:

- EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortisation): Total Operating Income - Operating Expenses (excluding Depreciation & Amortisation, Interest, and Taxes)
- EBITDA Margin:  $(\text{EBITDA} / \text{Total Operating Income}) * 100$
- PAT Margin:  $(\text{Profit after Tax} / \text{Total Income}) * 100$
- Current Ratio: Current Assets / Current Liabilities
- Tangible Net Worth: Share Capital + Reserve & Surplus – Intangible Assets -Deferred Tax Assets – Misc Expenditure not written off – Revaluation Reserves
- Return on Net Worth (RONW):  $(\text{Profit After Tax} / \text{Average Tangible Net Worth}) * 100$
- Total Capital Employed: Fixed Assets + Long term fixed assets + Net Working Capital

- Return on Capital Employed (ROCE): (Earnings before Interest & Taxes/Average Capital Employed) \*100

The Company has demonstrated significant improvement in its financial performance and balance sheet strength over the period. Revenue from operations increased sharply from INR 924.05 lakh in FY 2023 to INR 1,711.52 lakh in FY 2024 and further to INR 2,591.96 lakh in FY 2025, driven by wider domestic market penetration for inverters and batteries.

Operating profitability improved materially over the review period, with EBITDA increasing from INR 17.30 lakh in FY 2023 to INR 547.39 lakh in FY 2025. Correspondingly, EBITDA margin improved from 1.87% in FY 2023 further to 21.12% in FY 2025. Profit after tax rose from INR 2.41 lakh in FY 2023 to INR 359.71 lakh in FY 2025, with PAT margin increasing from 0.26% in FY 2023 further to 13.84% in FY 2025. The improvement in margins was primarily driven by higher scale of operations, enhanced operational efficiencies, and optimized procurement practices. These retained earnings, together with an increase in fixed assets undertaken to strengthen operational infrastructure and support expansion of operations, warehousing, and related infrastructure requirements, contributed to a substantial increase in tangible net worth from INR 14.42 lakh as of March 31, 2023, to INR 520.01 lakh as of March 31, 2025.

Total debt remained broadly stable, leading to a sharp decline in the debt-equity ratio from 24.67 times in FY 2023 to 0.58 times in FY 2025, reflecting a significantly strengthened capital structure and enhanced financial flexibility. Improved operating performance and efficient utilization of capital were also reflected in return indicators, with Return on Capital Employed (ROCE) increasing from 7.99% in FY 2023 to 85.41% in FY 2025 and Return on Net Worth remaining strong at 105.75% in FY 2025, notwithstanding the enlarged equity base.

Overall, the Company's performance over the review period reflects a phase of rapid revenue growth supported by improving profitability, strong retained earnings, and strategic strengthening of its tangible asset base to support ongoing and future expansion.

## 10.8 Peer Benchmarking Analysis

The peer benchmarking analysis assesses the financial performance of Cellcronic technologies Limited in comparison with relevant players in the Solar equipment industry. For this analysis, Cellcronic Technologies Limited has been benchmarked against Smarten Power Systems Limited and Invergy.

*Figures are in INR lakhs (Except for ratios and percentages)*

Key Indicators	Cellcronic Technologies Limited	Smarten Power Systems Limited	Invergy
<b>Total Operating Income</b>	2591.96	20174.85	4269.36
<b>Total Income</b>	2599.40	20319.67	4273.11
<b>EBITDA</b>	547.39	1691.96	58.26
<b>EBITDA Margin</b>	21.12%	8.39%	1.36%
<b>PAT</b>	359.71	1277.03	41.19
<b>PAT Margin</b>	13.84%	6.28%	0.96%
<b>Current Ratio</b>	1.56	1.55	1.56
<b>Tangible Net worth</b>	520.01	3828.69	736.42
<b>Total Debt</b>	299.60	1658.91	60.20
<b>Debt Equity Ratio</b>	0.58	0.43	0.08
<b>ROCE (%)</b>	85.41%	58.74%	13.47%
<b>Return on Net Worth (%)</b>	105.75%	66.71%	11.19%

*Source - FY2025 financials for peer comparison are based on restated figures for Cellcronic Technologies (as provided by the company), Smarten Power Systems Limited (as filed on NSE) & Invergy India private limited (as on MCA).*

Cellcronic Technologies Limited demonstrates a strong financial position relative to Smarten Power Systems Limited and Invergy, particularly in terms of profitability, efficiency, and return ratios. While the Company operates at a smaller scale with a Total Operating Income of INR 2,591.96 lakh, compared to Smarten's INR 20,174.85 lakh and Invergy's INR 4,269.36 lakh, its profitability metrics exceed both peers. Cellcronic reports an EBITDA of INR 547.39 lakh, resulting in an EBITDA margin of 21.12%, significantly higher than Smarten's EBITDA margin of 8.39% and Invergy's 1.36%. This demonstrates the Company's ability to maintain tighter cost control and better pricing efficiency despite lower revenue.

Similarly, Cellcronic's PAT of INR 359.71 lakh corresponds to a PAT margin of 13.84%, which is more than double Smarten's 6.28% and substantially above Invergy's 0.96%. These figures reflect stronger operational profitability and superior net-level performance, indicating the

Company's effective expense management and healthy contribution margins across its product portfolio. From a liquidity perspective, the Company maintains a current ratio of 1.56, highlighting Cellcronic's stronger short-term solvency and its ability to meet current obligations.

The Tangible Net Worth stands at INR 520.01 lakh, compared to Smarten's ₹3,828.69 lakh and Invergy's ₹736.42 lakh, aligning with the Company's smaller scale of operations. Cellcronic's Total Debt of INR 299.60 lakh results in a debt-equity ratio of 0.58, which, although marginally higher than Smarten's 0.43, remains conservative and comparable to Invergy's 0.08, indicating prudent leverage deployment.

Notably, the Company's return ratios are significantly higher than those of its peers. Cellcronic records a ROCE of 85.41%, compared to 58.74% for Smarten and 13.47% for Invergy, underscoring efficient utilization of capital employed. Additionally, the Company achieves a Return on Net Worth of 105.75%, outperforming Smarten's 66.71% and Invergy's 11.19%, reflecting exceptionally strong profitability relative to its equity base.

In summary, although Cellcronic operates at a smaller revenue scale, it outperforms both Smarten Power Systems Limited and Invergy on key profitability metrics, liquidity indicators, and return measures. The Company's superior margins, conservative leverage, efficient capital deployment, and robust return ratios collectively demonstrate strong financial resilience and establish its competitive strength within the industry

## 10.9 SWOT Analysis

Strengths (Internal / Competitive Advantages)	Weaknesses (Internal / Limitations)
<p><b>✓ Robust Revenue &amp; Profit Growth:</b> Strong YoY expansion with Total Operating Income rising from ₹924 lakh (FY23) to ₹2,592 lakh (FY25) and EBITDA margin improving from 2.59% to 21.12%, reflecting operational efficiency and rising brand acceptance.</p> <p><b>✓ High ROCE &amp; Profitability Momentum:</b> Exceptional improvement in ROCE from 11.28% (FY23) to 84.74% (FY25), demonstrating superior capital productivity and efficient utilization of assets.</p> <p><b>✓ Strong Market Position in Solar &amp; Hybrid Inverters:</b> Focus on fast-growing segments like hybrid solar inverters, lithium battery systems, and power-backup solutions positions the company in high-demand renewable categories.</p> <p><b>✓ Lean, Scalable Business Model:</b> Asset-light structure and reliance on technology-led product development support rapid scaling, faster product launches, and flexibility in expanding into new solar categories.</p>	<p><b>✗ Declining Liquidity Position:</b> Current Ratio dropped sharply from 36.32 (FY23) to 1.85 (FY25), indicating rising working-capital pressure and lower short-term liquidity cushion.</p> <p><b>✗ High Dependency on Imported Components:</b> Heavy reliance on foreign suppliers for PCBs, MOSFETs, BMS units, lithium cells, and electronic components exposes the company to supply-chain delays and price volatility.</p> <p><b>✗ Limited Manufacturing Integration:</b> Low backward integration increases dependence on third-party assemblers and EMS vendors, which may affect cost control and margins.</p>

Opportunities (External / Market Realities)	Threats (External / Sector Challenges)
<p><b>₹ Rapid Growth in Hybrid Solar &amp; Battery Storage:</b> Rising rooftop solar adoption, load-shedding challenges, and MNRE-backed schemes create strong demand for hybrid inverters and Li-ion storage systems.</p> <p><b>₹ Import Substitution Push by Government:</b> Policies such as ALMM, BESS initiatives, and increased domestic cell manufacturing provide opportunities for local brands to replace Chinese imports.</p> <p><b>₹ Expansion into Smart Energy Solutions:</b> Opportunities to launch IoT-enabled monitoring systems, smart meters, energy management software, and integrated solar-plus-storage packages.</p> <p><b>₹ Growing Residential &amp; C&amp;I Solar Markets:</b> India's rooftop solar target of 40 GW and growing backup-power demand in Tier 2/3 cities provide strong avenues for scaling distribution and channel partnerships.</p>	<p><b>⚠ Intense Competition from Chinese &amp; Domestic Brands:</b> Aggressive pricing by established global inverter suppliers and domestic EMS-based brands can impact margins and market share.</p> <p><b>⚠ Supply Chain Vulnerability:</b> Dependence on imported electronics and lithium cells exposes the business to geopolitical risks, freight cost spikes, and technology obsolescence cycles.</p> <p><b>⚠ Regulatory &amp; Policy Shifts:</b> Changes in BIS standards, ALMM requirements, or import duties on batteries/inverters can increase compliance costs and affect pricing.</p> <p><b>⚠ Technology Disruption Risk:</b> Fast-evolving inverter technologies (Wi-Fi-enabled systems, AI-based energy management, advanced MPPT algorithms) require continuous R&amp;D investment to remain competitive.</p>

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## **11. Future Outlook**

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The solar power equipment industry is entering a decade of accelerated expansion, driven by global decarbonization commitments, rising electricity consumption, and rapid advancements in photovoltaic and power electronics technologies. In India, the sector's long-term outlook remains exceptionally strong due to the government's push toward achieving 500 GW of renewable energy capacity by 2030, growing grid instability, rising power tariffs, and increasing adoption of distributed energy systems such as rooftop solar, hybrid inverters, and residential battery storage. Demand for solar inverters—especially hybrid, three-phase, and high-voltage variants—is expected to surge as consumers shift from basic grid-tie systems to solar-plus-storage solutions that support larger household loads and offer resilience during outages. The introduction of smart, IoT-enabled inverters with remote monitoring, higher-efficiency MPPT circuits, and safer lithium battery chemistries (LFP and NMC) will significantly enhance system reliability and performance, driving adoption in both urban and rural markets. Utility-scale solar parks, green hydrogen production using solar power, and the expansion of solar-wind hybrid projects will create new demand for high-capacity central inverters, string inverters, and grid-forming technologies that enhance grid stability.

On the manufacturing side, India's emphasis on domestic production through PLI schemes, BCD tariffs, Approved List of Models and Manufacturers (ALMM) and state incentives will reduce import dependence on components such as modules, cells, PCBs, MOSFETs, and BMS units, gradually shifting the industry toward localized value chains. However, short-term challenges such as raw material price volatility, lithium supply constraints, and reliance on Chinese electronics ecosystems may create cost pressures. Overall, the next 5–10 years will see solar power equipment becoming more efficient, modular, and affordable, with increasing integration into smart homes, microgrids, and electric mobility infrastructure—positioning India as a competitive global hub for renewable energy equipment manufacturing.



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