

Infomerics Analytics & Research

CIN: U74999DL2020PTC369018

Flat No.108, Golf Apartments, Sujan Singh Park New Delhi – 110 003
iar@infomerics.com, Phone: +9111 41410243, 4141 0244



**Dual Horizons:
Navigating the
Crude Soybean
Oil and Solar
Power Industries**

Date: September 02, 2025

Table of Contents

Sections	Title	Page
	Disclaimer	2
1	Global Macroeconomic Scenario	3
2	India's Macroeconomic Scenario	10
3	Industry Overview	
	A. Crude Soybean Oil and De-oiled Cake	17
	B. Solar Power	34
4	Market Dynamics	
	A. Crude Soybean Oil and De-oiled Cake	48
	B. Solar Power	52
5	Regulatory and Policy Framework	
	A. Crude Soybean Oil and De-oiled Cake	55
	B. Solar Power	58
6	PESTEL Analysis	
	A. Crude Soybean Oil and De-oiled Cake	61
	B. Solar Power	63
7	Competitive Landscape	
	A. Crude Soybean Oil and De-oiled Cake	65
	B. Solar Power	69
8	Future Outlook	
	A. Crude Soybean Oil and De-oiled Cake	72
	B. Solar Power	73
9	Works Cited	74

Disclaimer

This report is prepared by Infomerics Analytics & Research Private Limited. Infomerics Analytics & Research has taken utmost care to ensure accuracy and objectivity while developing this report based on information available in Infomerics Analytics & Research 's proprietary database, and other sources considered by Infomerics Analytics & Research as accurate and reliable including the information in public domain. The views and opinions expressed herein do not constitute the opinion of Infomerics Analytics & Research to buy or invest in this industry, sector or companies operating in this sector or industry and is also not a recommendation to enter into any transaction in this industry or sector in any manner whatsoever.

This report has to be seen in its entirety; the selective review of portions of the report may lead to inaccurate assessments. All forecasts in this report are based on assumptions considered to be reasonable by Infomerics Analytics & Research; however, the actual outcome may be materially affected by changes in the industry and economic circumstances, which could be different from the projections.

Nothing contained in this report is capable or intended to create any legally binding obligations on the sender or Infomerics Analytics & Research which accepts no responsibility, whatsoever, for loss or damage from the use of the said information. Infomerics Analytics & Research is also not responsible for any errors in transmission and specifically states that it, or its directors, employees, parent company – Infomerics Valuation & Rating, or its directors, employees do not have any financial liabilities whatsoever to the subscribers/users of this report. The subscriber/user assumes the entire risk of any use made of this report or data herein. This report is for the information of the authorized recipient in India only and any reproduction of the report or part of it would require explicit written prior approval of Infomerics Analytics & Research Private Limited

Infomerics Analytics & Research shall reveal the report to the extent necessary and called for by appropriate regulatory agencies, viz., SEBI, RBI, Government authorities, etc., if it is required to do so. By accepting a copy of this Report, the recipient accepts the terms of this Disclaimer, which forms an integral part of this Report.

1. Global Macroeconomic Scenario

The global economy is projected to experience a deceleration in growth, with global GDP expanding by 2.8% in CY 2025, down from 3.3% in CY 2024.¹ This slowdown is attributed to escalating trade tensions, particularly due to new U.S. tariffs, and heightened policy uncertainties. Global headline inflation is expected to decline to 4.3% in CY 2025 and further to 3.6% in CY 2026, as inflationary pressures ease across advanced economies, aided by tighter monetary policy, improved labour market conditions, and the resolution of supply disruptions.¹ However, global trade growth is forecasted to slow significantly to 1.7% in CY 2025, reflecting the effects of escalating trade barriers and geopolitical instability.¹

In China, economic prospects remain constrained as the IMF downgraded its CY 2025 GDP growth forecast to 4.0%, due to persistent challenges in the real estate sector, weak consumer demand, and trade-related pressures.¹ In Europe, growth is expected to stagnate, with Germany's GDP forecast at 0.0% in CY 2025, amidst trade disruptions and domestic weaknesses.¹ The EU is actively seeking to address these challenges through renewed trade dialogue with the U.S.

Meanwhile, India continues to show resilience, with the IMF projecting stable real GDP growth of 6.2% in CY 2025, followed by a slight uptick to 6.3% in CY2026.¹ This is supported by robust rural consumption and sustained infrastructure investment. The IMF notes that India remains one of the fastest-growing major economies, driven by favourable demographics, expanding digital infrastructure, and rising investment activity. Consumer price inflation in India is projected to moderate to 4.2% in CY 2025, staying within the Reserve Bank of India's (RBI) target range of 2–6%, which helps maintain purchasing power and economic stability.¹ The IMF also highlights the importance of continued structural reforms in India, particularly in labour markets, logistics, and capital formation, to sustain medium-term growth momentum.

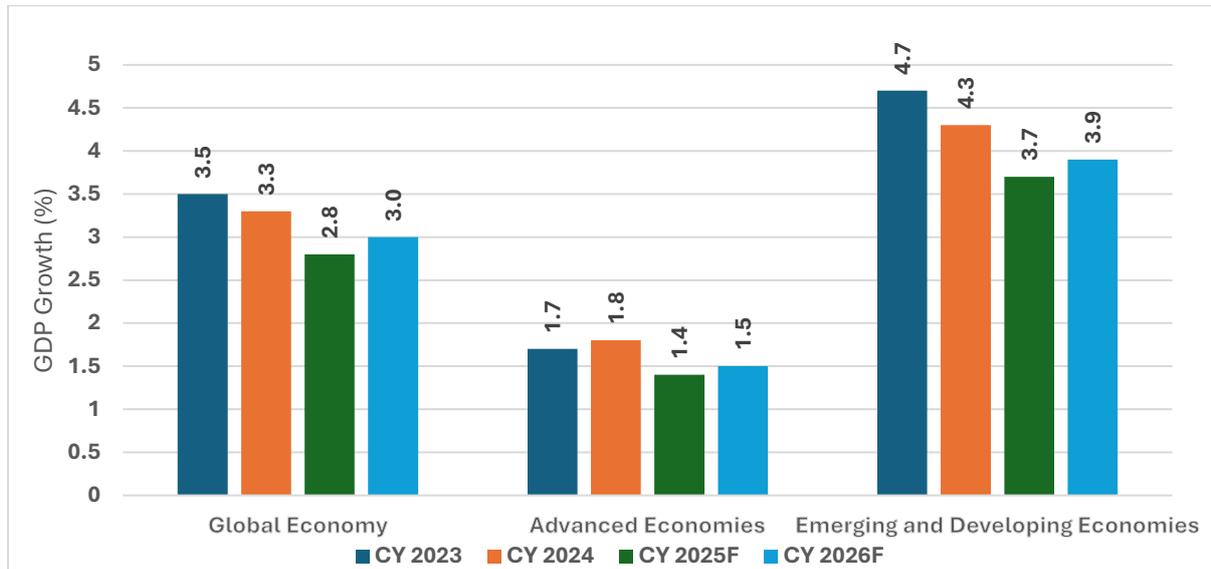
Overall, while inflation is declining globally, the economic outlook remains clouded by geopolitical uncertainty, trade fragmentation, and region-specific structural challenges. However, India's relative macroeconomic stability, demographic advantage, and ongoing investment cycle place it in a strong position amid global headwinds.

1.1 Global GDP Growth Scenario

The global economy entered CY 2023 with cautious optimism, supported by the easing of inflationary pressures and the gradual normalization of supply chains. However, the recovery remained uneven across regions and below pre-pandemic trends, particularly in emerging and developing economies. The lingering effects of the pandemic, elevated geopolitical tensions, monetary tightening by major central banks, and adverse climate events continued to weigh on global output. As a result, global real GDP growth moderated slightly to 3.5% in CY 2023, down from 3.6% in CY 2022.¹

The global economy maintained moderate momentum in CY 2024, with real GDP growth estimated at 3.3%, supported by easing inflationary pressures, recovering supply chains, and resilient consumer demand in some major economies.¹ Advanced economies, particularly the U.S., benefitted from strong labour markets and improved private consumption. However, growth remained uneven across regions, with emerging markets facing tighter financial conditions and subdued export demand. Inflation declined faster than anticipated in many regions, enabling some central banks to consider gradual monetary easing by the end of the year.

1.2 Historical GDP Growth Trends



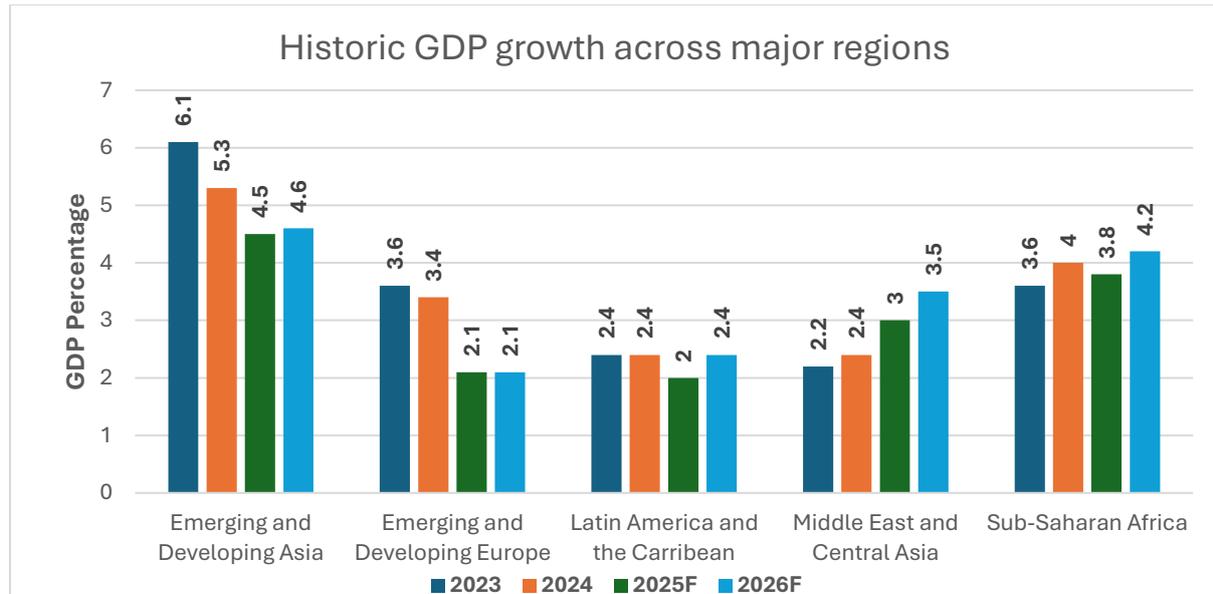
F – Forecast, Source – IMF World Economic Outlook April 2025

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.)

In the current scenario, global GDP growth is projected to decelerate to 2.8% in CY 2025, ¹ reflecting mounting economic pressures across both advanced and emerging markets. This marks a significant slowdown driven by intensifying trade fragmentation, the impact of new U.S. tariffs, and elevated geopolitical tensions. Structural weaknesses such as the ongoing real estate crisis in China, stagnant growth in the Eurozone, and tight financial conditions in major economies are expected to weigh heavily on global output. Additionally, stress in housing and banking sectors, coupled with subdued industrial activity, is contributing to a muted growth outlook. On the inflation front, the IMF projects global headline inflation to decline to 4.3% in CY 2025, ¹ continuing a disinflationary trend as energy prices stabilize and supply-side disruptions ease. The softening of labour markets—reflected in lower job vacancy rates and modest increases in unemployment—is also expected to help reduce core inflation. This provides room for some central banks to initiate cautious interest rate cuts, although the broader economic outlook remains uncertain due to persistent global risks.

1.3 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 April 2025 update.

In Emerging and Developing Asia, growth is projected to moderate from 5.3% in CY 2024 to 4.5% in CY 2025, before recovering slightly to 4.6% in CY 2026. ¹ India is expected to grow at 6.2% in CY 2025, supported by resilient rural consumption and sustained infrastructure investments, though lower than 6.5% growth recorded in CY 2024. In contrast, China's growth is likely to decelerate to 4.0% in CY 2025, amid persistent real estate concerns and weak domestic demand. ¹

Emerging and Developing Europe remains subdued, with growth estimated at 2.1% in CY 2025, down from 3.4% in CY 2024, expected to be stable at 2.1% by CY 2026. The region continues to face structural manufacturing challenges, particularly in major economies like Germany.¹

For Latin America and the Caribbean, modest growth of 2.0% is forecast for CY 2025, holding steady from CY 2024, with expectations of a rebound to 2.4% in CY 2026, helped by stronger macroeconomic management across key economies. ¹

In the Middle East and Central Asia, the economy is forecasted to expand at 3.0% in CY 2025, up from 2.4% in CY 2024, and further strengthen to 3.5% in CY 2026, driven by stabilization in oil production and ongoing economic reforms. ¹

Sub-Saharan Africa is projected to grow at 3.8% in CY 2025, slightly below the 4.0% growth in CY 2024, with a further improvement to 4.2% in CY 2026. ¹ The recovery is being aided by improved weather conditions and better functioning supply chains.

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

1.4 Global Economic Outlook

At the midpoint of the year, so far in 2025 the global economy continues to exhibit mixed performance, with divergence in outcomes across regions due to differences in economic growth, inflation dynamics, and policy responses. The global GDP growth is projected at 2.8% in CY 2025, down from an estimated 3.3% in CY 2024.¹ While short-term prospects have improved since early 2024 due to easing inflation and gradual loosening of monetary policy in several regions, the broader environment remains challenging. Structural headwinds, such as tighter credit conditions, supply-side bottlenecks, and lingering geopolitical risks, are keeping global growth below historical averages.

The United States has continued to outperform other advanced economies, with growth projected at 1.8% in 2025, though slightly down from 2.8% in 2024, as the economy absorbs the lagged effects of previous monetary tightening and persistent inflation. In contrast, the Euro Area remains subdued, with GDP growth expected to 0.8% in 2025, supported by the European Central Bank's first-interest rate cuts since 2019 (implemented in June 2024) and stronger domestic demand.¹ However, countries like Germany, France, and Italy continue to struggle due to weak manufacturing performance, whereas Greece and Spain have benefited from robust tourism activity.

In China, growth has held up at a projected 4.0% for CY 2025, supported by targeted stimulus and a gradual recovery in the real estate sector.¹ Growth in the rest of Asia is also benefiting from a revival in global trade and domestic demand. India remains one of the strongest performers globally, with GDP growth forecasted at 6.2% in 2025, supported by robust consumption, capital investment, and favourable demographics.¹

In Latin America, growth is more uneven. Larger economies like Brazil and Mexico are seeing moderate expansions, but the overall regional outlook is weaker, with GDP growth forecast at 2.0% in 2025, due to external headwinds, commodity price volatility, and political uncertainty.¹ Meanwhile, Sub-Saharan Africa's growth is expected to slow slightly to 3.8%, as global financial conditions tighten, and oil-exporting nations face declining revenues.¹ The Middle East and North Africa (MENA) region is also seeing tempered prospects, with growth revised down to 2.6%, influenced by lower oil prices and ongoing geopolitical pressures.

Globally, industrial production has remained sluggish through the first half of 2025, constrained by high interest rates, trade fragmentation, and lingering supply chain disruptions. However, a mild recovery is anticipated in the second half of the year as global trade stabilizes and domestic demand for goods strengthens. Central banks in several advanced economies—including the Eurozone, Switzerland, Sweden, and Canada—have begun cutting rates to support demand, though inflation trends remain uneven. Disinflation has progressed slower than expected, particularly in services and wage-heavy sectors, making monetary easing cautious and data-dependent.

Overall, the global economy appears to be stabilizing, but growth in CY 2025 remains below historical averages. Advanced economies continue to grow modestly under the weight of tight policies and weak external demand, while emerging markets, particularly in Asia, show stronger but slowing momentum. The outlook for the remainder of 2025 depends significantly on geopolitical developments, the trajectory of inflation, and the pace of monetary easing.

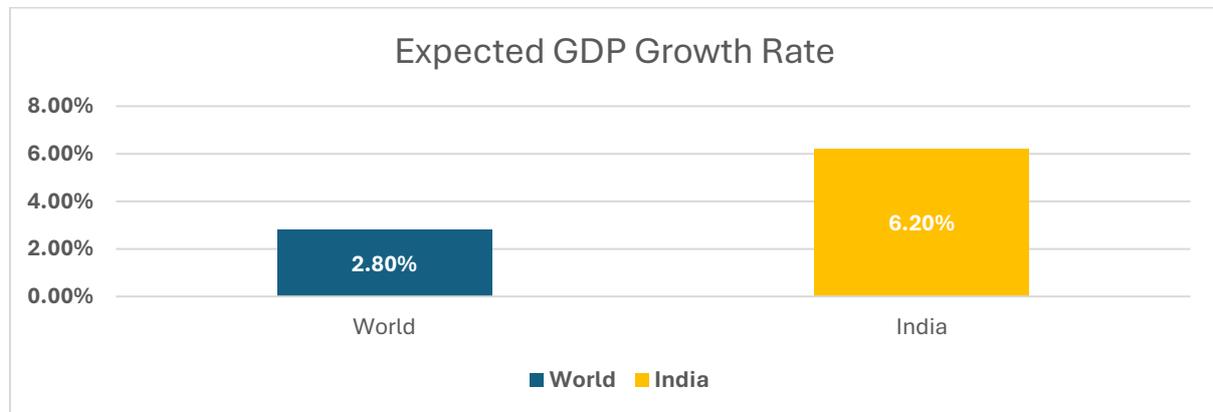
2. India's Macroeconomic Scenario

2.1 Gross Domestic Product (GDP)

India Expected to Grow at Twice the Pace of Global Economic Growth

The global economy continues to face persistent challenges, including the lingering effects of the COVID-19 pandemic, heightened geopolitical tensions, and climate-related disruptions that have affected energy and food supply chains. Global real GDP growth is projected at 2.8% in 2025¹, indicating a moderation in global momentum. In contrast, India's real GDP is projected to grow at 6.2% in 2025¹, continuing its trend of significantly outpacing global averages and reaffirming its position as the fastest-growing major economy. This implies that India is expected to grow at more than twice the pace of global GDP, supported by strong domestic demand, structural reforms, and increased infrastructure investment. India's resilience among the G20 economies further strengthens its role as a key driver of global economic growth in the coming years.

Global and India Growth Outlook Projections (Real GDP growth)



Notes: P-Projection; Source: IMF – World Economic Outlook, April 2025

India's Economic Growth Momentum Remains Strong, Poised to Surpass USD 4 Trillion by 2025

In FY 2024-25, India was the fifth-largest economy globally, with an estimated real Gross Domestic Product (GDP) at constant prices of INR 184.88 lakh crore, against the Provisional Estimate of GDP for the year 2023-24 of INR 173.82 lakh crore registering a GDP growth rate of 6.4% as compared to 8.2% in FY 2023-24². Since FY 2005, India's GDP growth has consistently outpaced global economic growth, often growing at nearly twice the global average, and this trend is expected to continue over the medium term.

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 trillion³.

GDP Growth Rate Projections for India

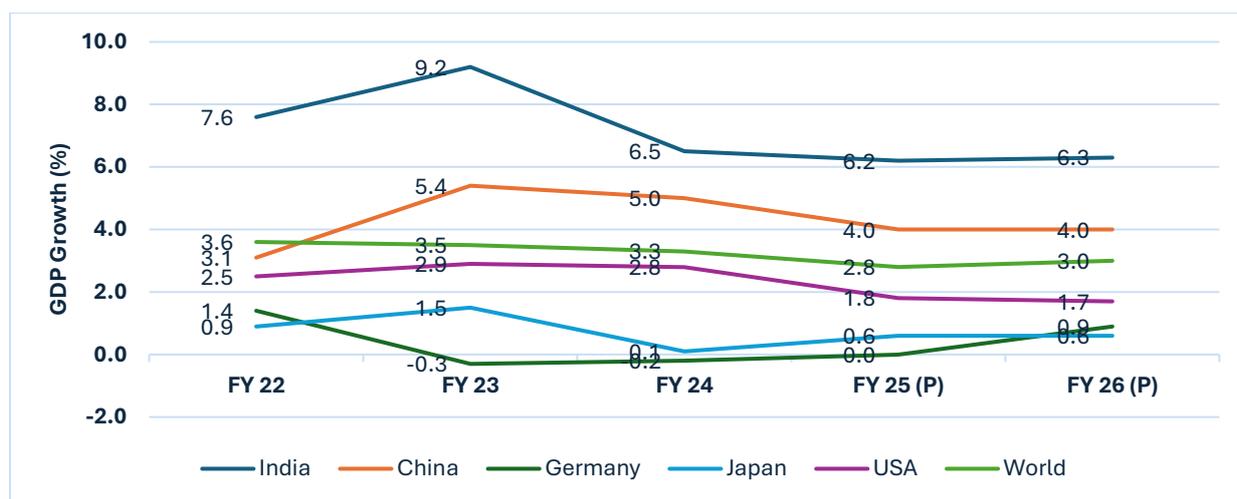
GDP growth projections by Government of India and other agencies are summarised below:

	Estimated GDP Growth Rate		
	FY 25E	FY 26E	FY 27E
Ministry of Finance, GOI	6.4%	6.3%-6.8%	N.A.
IMF*	6.2%	6.3%	N.A.
RBI#	6.6%	6.5%	N.A.
National Statistical Office (NSO)@	6.4%	N.A.	N.A.
PHDCCI@	6.5%	6.7%	6.7%
S&P Global@	6.8%	6.5%	6.8%
Morgan Stanley@	6.3%	6.5%	6.5%
Asian Development Bank#	6.5%	6.7%	N.A.
Moody's Agency	6.1%	N.A.	N.A.
Fitch Ratings@	6.3%	6.5%	6.3%

* Source: World Economic Outlook Update April 2025

@ Data is updated as of 28th March 2025, #updated as of 10th April 2025

India and Top 5 Global Economies GDP Growth Forecast

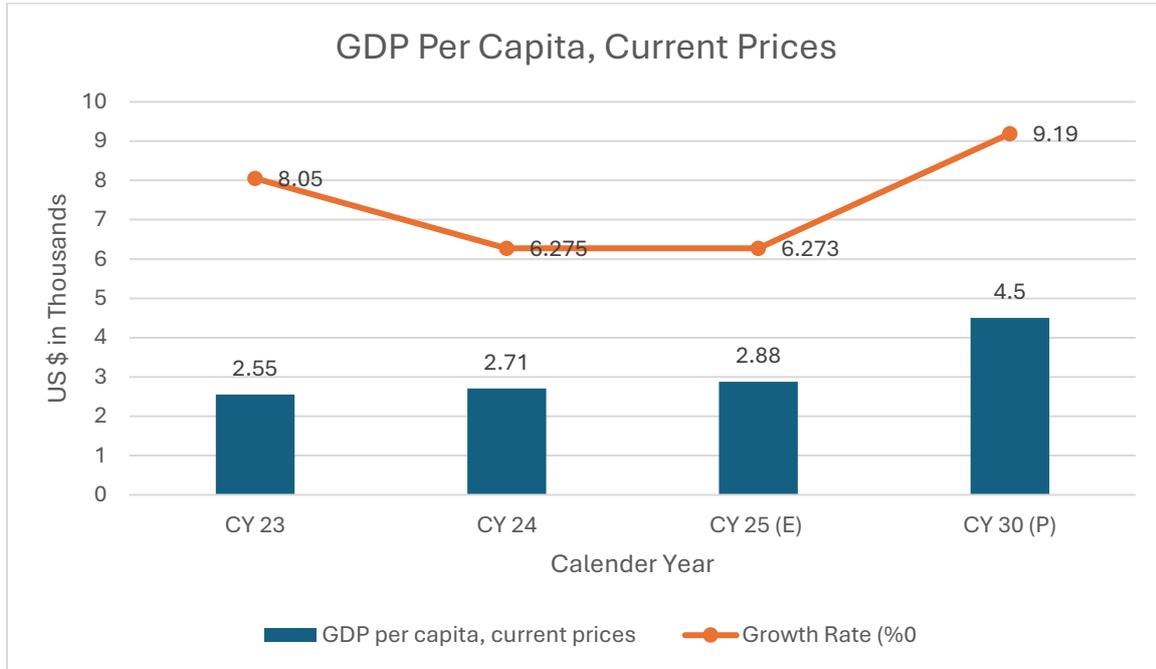


Note: P = Projections, Source: IMF World Economic Outlook April 2025 update.

India surpassed Japan to become the third-largest power in the Asia Power Index, reflecting its increasing geopolitical stature. This achievement is driven by India's dynamic growth, youthful population, and expanding economy, solidifying its position as a leading force in the region.⁴

2.2 India Per Capita GDP Forecast

Per capita GDP growth for India is estimated at 9.19 % CAGR between FY 2025-FY 2030.⁵ 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

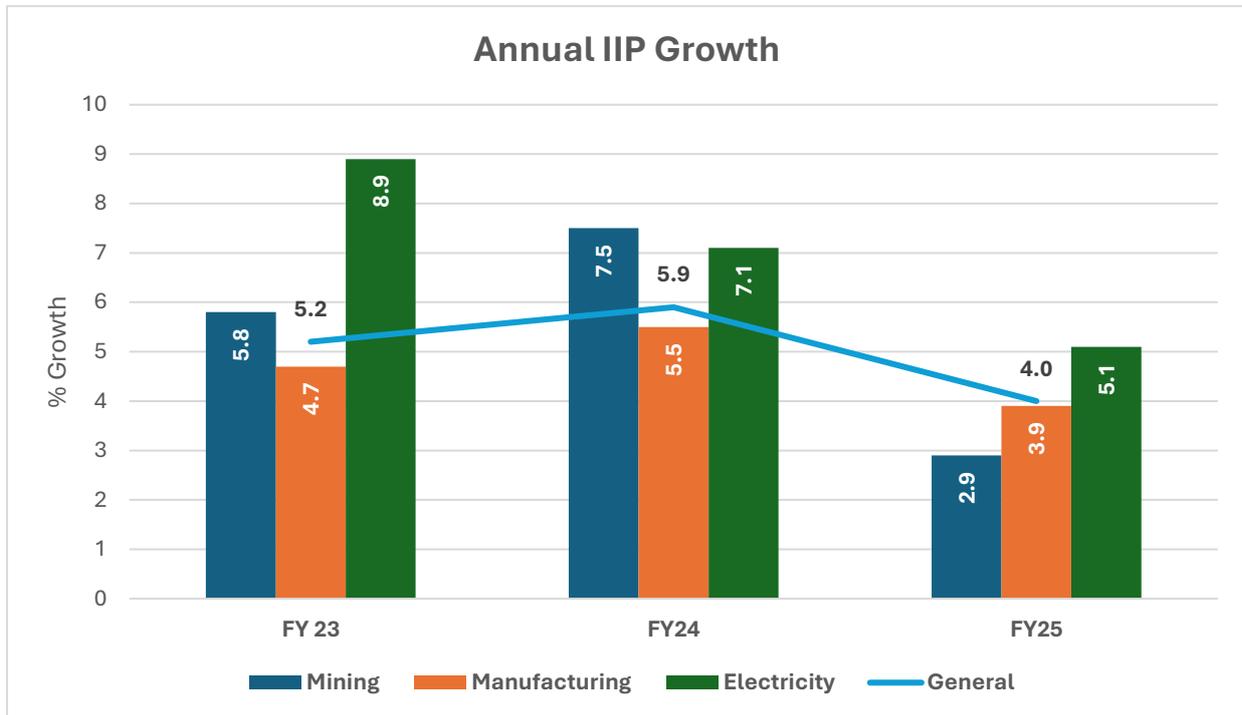
2.3 IIP Growth – Index of Industrial Production

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.⁷

Among key components:

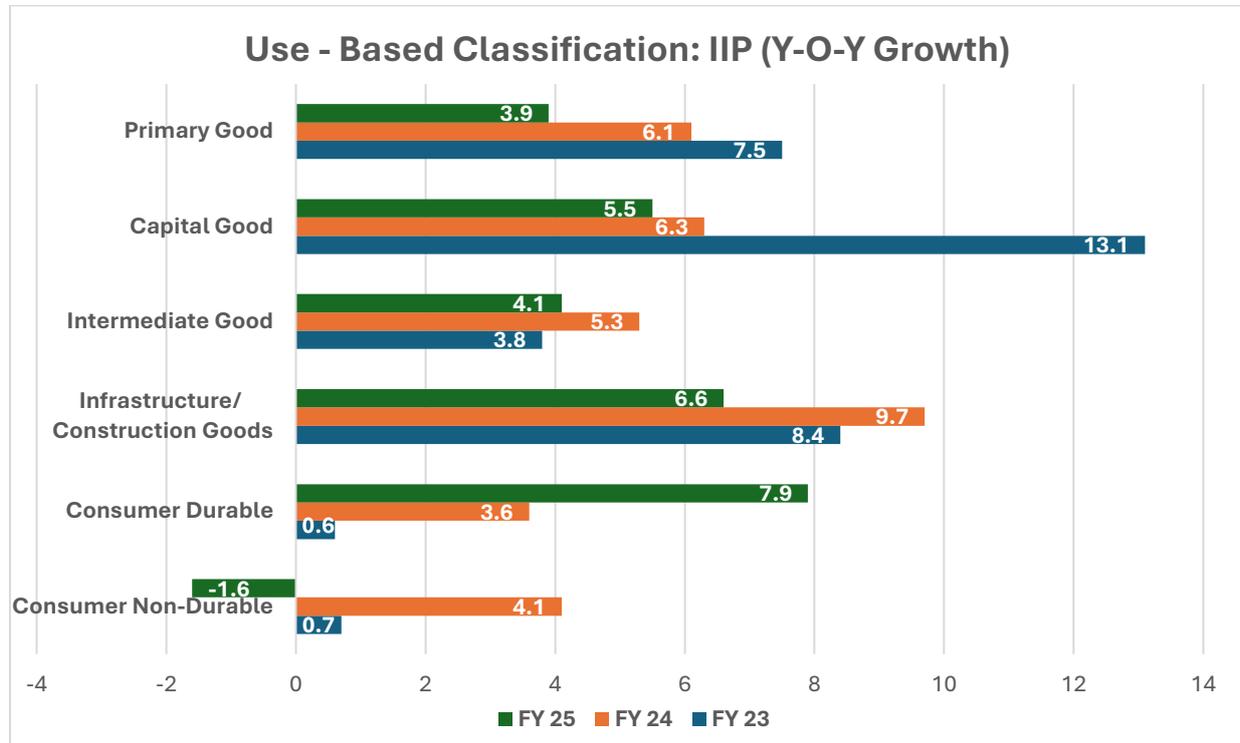
- **Manufacturing** (which holds a 77.6% weight in IIP) registered a slower growth of 3.9% in FY 2025, compared to 5.5% in FY 2024 and 4.7% in FY 2023.
- **Mining** growth also moderated sharply to 2.9% in FY 2025 from 7.5% in FY 2024 and 5.8% in FY 2023.
- **Electricity** growth remained relatively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

Use-Based Classification Trends:



Source: Ministry of Statistics & 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.

2.4 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 2025-26.⁸ This allocation is directed towards infrastructure projects, including rural development, manufacturing, and skill-building initiatives.⁸ 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.⁸

- **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.⁸ 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.⁸

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.

2.5 Concluding Remarks about Macroeconomic Scenario

The major headwinds to global economic growth remain significant, with escalating geopolitical tensions, volatile global commodity prices, high interest rates, inflationary pressures, instability in international financial markets, climate change, rising public debt, and the rapid evolution of new technologies. Despite these challenges, India's economy is relatively well-positioned compared to other emerging markets. According to the latest IMF forecast, India's GDP growth is expected to be 6.2% in 2025¹, maintaining its position as the fastest-growing major economy globally, well above the global growth projection of 2.8%¹. Key positive factors for the Indian economy include continued strong domestic demand, robust government support for capital expenditure, moderating inflation, growing investments in technology, and improving business confidence.

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. The normalization of employment post-economic reopening is expected to provide further support to consumption expenditure.

Public investment is also poised to grow, with the government allocating a significant ₹11.21 lakh crore for capital expenditure in FY25.⁸ The private sector's investment intentions are showing positive signs, as evidenced by increased new project investments and a strong import of capital goods. Furthermore, rural demand is likely to improve, bolstered by healthy sowing, better reservoir levels, and the positive progress of the southwest monsoon, coupled with the government's push for infrastructure investment and other policy measures. These factors are expected to further support the investment cycle and strengthen India's economic resilience in the coming years.

3A. Industry Overview – Crude Soybean Oil and Deoiled Cake Industry

3A.1 Introduction

Behind the rise of India’s plant-based economy are two quiet yet powerful contributors—crude soybean oil and de-oiled cake (DOC). While they emerge from the same oilseed, they serve vastly different but equally vital roles in the agricultural and industrial landscape. Extracted from soybean seeds, these two products power sectors ranging from food processing and renewable energy to animal nutrition and global trade.

Crude soybean oil is the unrefined output of soybean crushing, rich in fatty acids, pigments, and volatile compounds. Though unsuitable for direct consumption, it is the essential input for producing refined edible soybean oil, one of the most widely used cooking mediums in India and globally. Through refining processes such as degumming, neutralization, bleaching, and deodorization, crude oil is transformed into a clear, stable, and consumer-ready edible oil.

Beyond its refining pathway, crude soybean oil also plays a significant industrial role. It is increasingly used as a raw material in biofuel production, oleochemicals, paints, lubricants, and cosmetic bases, driven by global demand for low-carbon and biodegradable inputs. With India targeting bioenergy expansion and import substitution under the Atmanirbhar Bharat mission, the role of crude soybean oil as an indigenous industrial feedstock is gaining strategic relevance.

On the other hand, the de-oiled cake (DOC)—the protein-rich by-product left after oil extraction—has carved a critical niche in the animal feed industry. With over 45% protein content, DOC is a cornerstone of nutritious feed formulations for cattle, poultry, and aquaculture. It enhances weight gain, improves feed conversion ratios, and contributes to the nutritional health of livestock, thereby directly supporting dairy, meat, and poultry value chains. India's growing demand for high-protein, cost-effective animal feed has elevated DOC's importance as both a domestic resource and an export commodity, particularly to Southeast Asian markets.

Together, crude soybean oil and de-oiled cake represent an efficient, zero-waste value chain. One drives the edible oil and industrial sectors, while the other fuels animal nutrition and agriculture.

3A.2 Market Segments

Soybean is a vital crop in agricultural and industrial landscape. It contributes significantly to the country's oilseed production, livestock feed sector, and value-added food and industrial products.

Key Market Segments

- 1. Raw Soybeans** - Raw soybeans serve as the foundational agricultural commodity within the soybean value chain. Cultivated predominantly during the kharif season, soybeans are harvested once annually and utilized across various downstream applications. The key end-uses of raw soybeans include:
 - **Direct Human Consumption:** A limited share of harvested soybeans is consumed directly in the form of roasted beans, sprouts, and other traditional preparations, owing to their high protein and nutrient content.
 - **Seed Stock for Cultivation:** A portion of the crop is preserved as seed for the subsequent season. Quality-certified seeds are critical for enhancing sowing coverage, productivity, and disease resistance.
 - **Processing Raw Material:** A majority of soybeans are directed to oil extraction units, where they are processed into crude soybean oil, edible soybean oil and soybean meal.
- 2. Crude Soybean Oil** - Crude soybean oil is the intermediate product obtained from the extraction of oil from whole soybeans. It is not directly consumable and requires further refining. Extraction is undertaken through the following industrial processes:
 - **Mechanical Expeller Pressing:** Involves cleaning, dehulling, flaking, and pressing of soybeans to extract approximately 70–75% of the available oil. This method is primarily used by small-scale or organic producers.
 - **Solvent Extraction:** Utilizes a food-grade solvent (typically hexane) to dissolve and extract over 95–98% of the oil from soybean flakes. This method is widely adopted in large-scale commercial operations due to its superior efficiency.
 - **Combined Extraction Method:** Many processing units adopt a two-stage approach involving initial mechanical pressing followed by solvent extraction from the residual press cake, optimizing oil recovery and processing efficiency.

Crude soybean oil is used primarily as an input for refining into edible-grade oil. It also finds non-edible applications in sectors such as biodiesel, oleochemicals, and industrial lubricants.

- 3. Edible Soybean Oil** - Edible soybean oil is the refined derivative of crude soybean oil, widely consumed as a cooking medium in households and used extensively in the food processing industry. The refining process typically involves:

- **Degumming:** Removal of phospholipids and mucilage.
- **Neutralization:** Elimination of free fatty acids using alkali.
- **Bleaching:** Reduction of colouring matter and oxidation compounds.
- **Deodorization:** Steam distillation to remove odorous substances.

Key applications of refined soybean oil include:

- Household cooking and frying.
- Use in bakery, snack foods, and ready-to-eat products.
- Food manufacturing processes such as salad dressings and emulsified sauces.

4. Soybean Meal (DE oiled Cake) - Soybean meal, also referred to as deoiled soybean cake, is the solid, protein-rich co-product generated after oil extraction. It constitutes over two-thirds of the processed soybean by weight and contains 44–48% crude protein, making it a critical input in the animal feed industry. The processing of soybean meal includes desolventization and toasting to improve digestibility and reduce anti-nutritional factors.

Primary applications include:

- **Poultry Feed:** Major end-use segment, contributing to rapid broiler growth and egg production.
- **Cattle and Dairy Feed:** Enhances milk yield and animal health.
- **Swine and Aquaculture Feed:** Used in commercial rations to support weight gain and feed efficiency.
- **Organic Fertilizer:** Used in organic farming systems as a nitrogen-rich soil amendment.

Soybean meal is the primary economic driver for crushing operations. Its stable demand supports high-capacity utilization of processing units, influences soybean procurement strategies, and plays a critical role in India's feed security, particularly in the poultry and dairy sectors. It is also a key export commodity, especially to markets in Asia and the Middle East.

3A.3 Global Soybean Industry

The soybean industry holds a pivotal position in global agriculture, serving as a major source of protein and oil for both human consumption and industrial use. It is one of the most widely cultivated crops globally, with immense economic and strategic importance due to its versatile applications across food, feed, fuel, and industrial sectors.

I. Soybean

- **Global Market Overview:** Soybean ranks as the fourth most cultivated and traded oilseed crop in the world, following maize, wheat, and rice. It plays a crucial role in both food and feed industries. The global soybean market is valued at USD 168.86 billion in 2024 and is anticipated to be worth USD 280.70 Billion in 2034 growing at a CAGR OF 5.21%. It is driven by its extensive applications including edible oil extraction, animal feed (soybean meal), and a variety of food and industrial uses.
- **Global Production:** Global soybean production has witnessed consistent growth in recent years, driven by expanding demand for vegetable oil and high-protein feed across both developed and emerging economies. According to USDA estimates, global production stood at 396.93 million metric tons (MMT) in 2023–24 and is estimated at 420.87 MMT in 2024–25 and is projected to rise to 426.82 MMT in 2025–26, reflecting strong acreage expansion and productivity gains. Brazil remains the world’s largest producer, followed by the United States and Argentina, collectively contributing a significant share of global supply. Brazil’s production is projected to reach 175.00 MMT by 2025–26, supported by efficient agronomic practices and infrastructure. The U.S. and Argentina are expected to produce 118.12 MMT and 48.50 MMT, respectively, in the same period. This upward trend underscores the growing strategic importance of soybeans in the global agricultural value chain, driven by their dual utility in oil extraction and animal feed. Continued investments in sustainable farming and trade logistics are expected to support global production growth in the coming years.

World Soybean Supply (Million Metric Tons)

	Production			Imports			Exports		
	23/24	24/25 Est.	25/26 Proj.	23/24	24/25 Est.	25/26 Proj.	23/24	24/25 Est.	25/26 Proj.
World	396.93	420.87	426.82	178.13	178.16	186.82	177.69	180.87	188.43
Major Exporters									
Brazil	154.50	169.00	175.00	0.87	0.15	0.15	104.17	104.50	112.00
United States	113.27	118.84	118.12	0.57	0.68	0.54	46.13	50.35	49.40
Argentina	48.21	49.00	48.50	7.79	6.00	7.20	5.11	4.20	4.50
Paraguay	11.00	10.20	11.00	0.01	0.02	0.02	7.99	6.80	7.70
Major Importers									
China	20.84	20.65	21.00	112.00	108.00	112.00	0.07	0.10	0.10
European Union	2.81	2.92	2.95	13.46	14.60	14.30	0.25	0.30	0.30
Southeast Asia	0.47	0.45	0.42	9.09	10.36	11.00	0.02	0.01	0.02
Mexico	0.20	0.27	0.27	6.46	6.70	7.00	0.01	0.01	0.01

Source: USDA World Agricultural Supply and Demand Estimates (WASDE), May 2025

- Global Trade:** The global soybean trade has evolved into a critical pillar of the agri-commodities market, with international flows shaped by regional consumption trends, biofuel demand, and animal feed requirements. Soybeans are among the most traded agricultural commodities globally, with over 150 million metric tons (MMT) moving across borders annually. Brazil, the United States, and Argentina dominate global exports, collectively accounting for the vast majority of traded soybeans. Brazil remains the largest exporter, benefitting from competitive production costs and strong logistics infrastructure. The U.S. continues to hold a significant market share, while Argentina focuses heavily on processed soybean products such as soymeal and soy oil. On the import side, China is by far the largest buyer, consistently accounting for more than 60% of global soybean imports. Other major importing nations include the EU-27, Mexico, and Southeast Asian countries, where growing demand for animal feed and plant-based oils continues to drive import volumes. Trade dynamics are also influenced by factors such as bilateral trade agreements, tariff structures, geopolitical developments, and currency fluctuations. In recent years, diversification of sourcing strategies by importing nations and the rise of alternative suppliers in Latin America have reshaped traditional trade corridors. The global soybean trade is expected to remain resilient, supported by structural demand from feed, food, and industrial sectors. Ongoing investments in port infrastructure, digital supply chain tracking, and sustainable sourcing practices are further enhancing the efficiency and transparency of global trade flows.

II. Soybean Meal (De-Oiled Cake)

- **Global Market Overview:** Soybean meal, the by-product of soybean oil extraction, is the most widely used plant-based protein source in animal feed globally. It constitutes over 98% of total soybean byproduct consumption in the feed industry, supporting the global demand for livestock, poultry, and aquaculture nutrition.
- **Global Production:** Global soybean meal production is projected to rise consistently, reflecting improved soybean crush margins, higher demand from the animal feed sector, and recovery in crop yields in key producing regions. World production is estimated to increase from 259.58 million metric tons (MMT) in 2023–24 to 278.11 MMT in 2024–25, and further to 287.63 MMT in 2025–26. The United States, Brazil, Argentina, and China together account for over 85% of global soybean meal production. The U.S. leads with projections reaching 53.25 MMT in 2025–26, followed closely by Brazil 44.78 MMT and Argentina 33.54 MMT. China also plays a significant role with domestic production expected to cross 85.00 MMT. India's production is expected to remain steady around 9.08 MMT.

World Soybean Meal Supply (Million Metric Tons)

	Production			Imports			Exports		
	2023/ 24	2024/ 25 Est.	2025/ 26 Proj.	2023/ 24	2024/ 25 Est.	2025/ 26 Proj.	2023/ 24	2024/ 25 Est.	2025/ 26 Proj.
World	259.58	278.11	287.63	69.79	76.32	77.40	74.20	79.72	80.93
Major Exporters									
United States	49.08	51.98	53.25	0.62	0.57	0.59	14.61	15.79	16.33
Brazil	41.57	43.99	44.78	0.02	0.01	0.01	22.72	23.00	23.20
Argentina	28.54	33.23	33.54	0.00	0.01	0.01	24.89	29.50	30.00
China	78.41	82.37	85.54	0.03	0.05	0.05	1.43	1.00	1.20
India	9.04	8.80	9.08	0.03	0.05	0.05	1.97	1.10	1.10
Major Importers									
European Union	11.46	11.85	12.09	16.54	18.40	16.90	0.65	0.70	0.60
Mexico	5.16	5.26	5.53	1.94	2.30	2.40	0.00	0.00	0.00
Southeast Asia	3.39	3.98	4.60	18.29	19.83	20.50	0.22	0.34	0.28

Source: USDA World Agricultural Supply and Demand Estimates (WASDE), May 2025

- **Global Trade:** Soybean meal is extensively traded to meet regional feed demand imbalances. Global exports are expected to grow steadily from 74.20 MMT in 2023–24 to 79.72 MMT in 2024–25, and 80.93 MMT in 2025–26. Argentina, Brazil, and the United States dominate global exports. Argentina is projected to remain the world’s largest exporter, with volumes reaching 30.00 MMT by 2025–26. Brazil and the U.S. are forecasted to export 23.20 MMT and 16.33 MMT, respectively, during the same period. On the import side, Europe, Southeast Asia, and Mexico constitute the major consuming regions. The European Union is expected to import over 16.90 MMT in 2025–26, while Southeast Asia’s demand is anticipated to grow to 20.50 MMT, driven by rising feed consumption. The global soybean meal market is poised for moderate, sustained growth, underpinned by structural shifts toward protein-rich animal diets, steady global meat consumption, and enhanced productivity across livestock sectors. Trade flows are likely to remain robust, despite increasing regional crushing capacity, with South America continuing to anchor global supply.

III. Soybean Oil

- **Market Overview:** Soybean oil remains one of the most widely consumed and traded vegetable oils in the world, driven by its multipurpose usage across food, industrial, and biofuel sectors. Extracted as a byproduct during soybean processing, crude soybean oil is refined into edible oil and used in cooking, baking, and food manufacturing, while also serving industrial and oleochemical applications. Global demand is supported by rising populations, increasing consumption of processed foods, and growing industrial uses, especially in emerging economies. Moreover, shifts toward plant-based diets and renewable biofuels have positioned soybean oil as a key component in the sustainable value chain.
- **Global Production Trends:** Global soybean oil production continues to show an upward trajectory, reflecting the sustained expansion in soybean processing capacities across key producer nations. According to the USDA WASDE (May 2025), world soybean oil production stood at 63.97 million metric tons in 2023/24 and is estimated to rise to 68.57 million metric tons in 2024/25 and further to 70.77 million metric tons in 2025/26.
 - United States remains one of the leading producers, with production projected to increase from 12.29 MMT in 2023/24 to 13.06 MMT in 2024/25, reaching 13.33 MMT by 2025/26.
 - Brazil is also expected to grow steadily from 11.06 MMT in 2023/24 to 11.79 MMT in 2025/26.
 - Argentina, another key producer, is projected to increase from 7.25 MMT to 8.58 MMT over the same period.
 - The European Union is set to maintain moderate growth, producing 2.91 MMT by 2025/26.

These trends reflect increased crushing activities, supported by both domestic consumption and export market requirements.

World Soybean Oil Supply (In Million Metric Tonns)

	Production			Imports			Exports		
	2023/ 24	2024/ 25 Est.	2025/ 26 Proj.	2023/ 24	2024/ 25 Est.	2025/ 26 Proj.	2023/ 24	2024/ 25 Est.	2025/ 26 Proj.
World	63.97	68.57	70.77	10.59	13.34	12.58	11.81	14.18	13.74
Major Exporters									
Argentina	7.25	8.50	8.58	0.00	0.01	0.01	5.53	6.55	6.60
Brazil	11.06	11.58	11.79	0.08	0.04	0.04	1.35	1.40	1.40
European Union	2.76	2.85	2.91	0.59	0.65	0.65	0.66	0.90	0.85
United States	12.29	13.06	13.33	0.28	0.23	0.14	0.28	1.09	0.77
Major Importers									
China	18.81	19.76	20.52	0.38	0.30	0.40	0.10	0.20	0.10
India	2.03	1.98	2.04	3.31	5.10	4.60	0.02	0.02	0.02
North Africa	0.93	1.06	1.26	1.15	1.33	1.32	0.14	0.08	0.13

Source: USDA World Agricultural Supply and Demand Estimates (WASDE), May 2025

- Global Trade:** Global soybean oil trade remains robust, driven by rising consumption in key importing regions and consistent export supply from major producers. Total world exports are projected to rise from 11.81 million metric tons (MMT) in 2023/24 to 13.74 MMT by 2025/26, reflecting increasing processing capacities and global demand. Argentina continues to dominate exports, projected at 6.60 MMT by 2025/26, followed by Brazil (1.40 MMT) and the United States (0.77 MMT). On the import side, India is among the top buyers, though its import volume is expected to decline from 5.10 MMT in 2023/24 to 4.20 MMT in 2025/26, due to domestic output growth. China and North Africa remain steady importers, with expected volumes of 0.40 MMT and 1.32 MMT respectively in 2025/26. Trade patterns are shaped by geopolitical dynamics, currency fluctuations, biodiesel demand, and self-sufficiency initiatives by major importing nations.

3A.4 Indian Soybean Industry

Soybean is a major Kharif-season oilseed crop in India and plays a pivotal role in the country’s Agri-economy due to its dual purpose—edible oil extraction and protein-rich deoiled cake (DOC) production for animal feed. It is central to India’s broader objectives of nutritional security, import reduction in edible oils, and Agri-export growth.

India is one of the largest oilseeds producers ranking 5th overall in the world. India contributes about 5-6 per cent of the world oilseeds production. As per the Third Advance Estimates released by the Ministry of Agriculture- production of oilseeds in the Kharif season is expected to be 42.60 Million Tonnes.² The increase in production in the current year is due to an increase in groundnut and soybean production. The more-than-expected sowing of groundnut and soybean may translate to higher overall oilseed production by the final estimate.

Area and Production

India is the fifth-largest producer of soybean globally, with a total cultivated area of 12.95 million hectares (Mha)², the highest among all oilseeds in India. The crop is cultivated majorly in three states: Madhya Pradesh, Maharashtra, and Rajasthan, which collectively contribute to 91.31% of the total soybean production in the country.

Area and Production Share (2024-25)

State	Area Share (%)	Production (in Million Tonne)	Production Share (%)
Madhya Pradesh	45.32	5.28	34.81
Maharashtra	39.15	7.40	48.77
Rajasthan	8.33	1.17	7.73
Karnataka	2.88	0.48	3.18
Gujarat	2.32	0.44	2.90
Telangana	1.19	0.29	1.91
Others	0.81	0.12	0.79
Total (India)	100%	15.18	100%

Data for the year 2024-25 is of 3rd Advance Estimates, Source: DA&FW

Global Yield Comparison of Soybean

Soybean yields vary considerably across countries, primarily due to differences in agro-climatic conditions, farming practices, seed quality, and technological adoption. Developed economies like the United States and Brazil consistently achieve high yields owing to the widespread use of genetically modified seeds, mechanized farming, and advanced agri-inputs. In contrast, countries like India lag behind in yield due to rain-fed cultivation, low seed replacement rates, limited use of technology, and smallholder farming structures.

India's average yield remains significantly below the global average, posing a key challenge to enhancing domestic soybean output. Bridging this yield gap through improved seed varieties, better irrigation infrastructure, and promotion of modern agronomic practices is essential to reduce dependence on imports and improve farmer incomes.

I. Crude Soybean Oil

Crude soybean oil is a key intermediate product in the vegetable oil value chain, extracted from soybeans through mechanical or solvent-based processes. In India, it plays a dual role—serving as a raw material for refining into edible oil and supporting industrial applications such as biodiesel and oleochemicals. The industry is closely integrated with the soybean processing sector and is a critical source of value addition for domestic soybean cultivation. With increasing demand for plant-based oils and a national push toward self-reliance in edible oils, the crude soybean oil segment continues to gain strategic importance in India’s agri-processing and food supply ecosystem.

India’s trade performance in crude soybean oil reflects the country’s growing dependence on imports to meet its crude oil and edible oil demand. Crude soybean oil (HS Code: 15071000) is a major category within India’s edible oil basket, primarily imported for refining and subsequent distribution as edible-grade oil. The sharp rise in import volumes underlines both supply constraints in domestic oilseed processing and increased consumption demand.

Trade Summary Table (FY25 vs FY24)

Metric	FY24 (Revised Final)	FY25 (Final)	Y-o-Y Change (%)
Exports (USD Million)	0.52	0.62	17.93% ↑
Imports (USD Million)	3,294.05	4,662.24	41.54% ↑

■ **Net Trade Deficit:** USD 4,061.84 Million in FY25

✦ Exports remain negligible, while imports surged sharply, highlighting India’s import dependence.

Top Export Destinations (FY25)

Country	Export Value (USD Mn)	Share (%)
Oman	0.34	54.84%
UAE	0.25	40.32%
Nepal	0.02	3.23%
Others	0.01	1.61%
Total	0.62	100%

✦ Total export volumes remain minimal due to limited surplus availability and a strong domestic demand base.

Top Import Sources (FY25)

Country	Import Value (USD Mn)	Share (%)
Argentina	2,630.90	56.43%
Brazil	773.88	16.60%
Switzerland	322.93	6.93%
Russia	314.15	6.74%
Netherland	263.01	5.64%
Others	357.37	7.66%
Total	4,662.24	100%

✦ Argentina remains India’s dominant supplier of crude soybean oil, accounting for over half of total imports, followed by Brazil and Switzerland.

India's rising import bill is largely due to rising international soybean oil prices, currency depreciation, and domestic supply shortfalls in soybean crushing. Despite the global edible oil volatility, India continues to diversify its import sources to ensure price and supply stability.

Source: Directorate General of Commercial Intelligence and Statistics (DGCI&S) | HS Code: 15071000.

II. Edible Soybean Oil

Soybean oil is a key component of India’s edible oil economy, contributing approximately 25% of domestic edible oil production, trailing only mustard oil (45%) and groundnut oil (25%). Despite being the fifth-largest producer of soybean globally, India produces just 2.14% of global soybean oil, highlighting inefficiencies in extraction, processing, and yield optimization.

India’s trade performance in edible soybean oil reflects the country’s increasing reliance on imports to meet domestic consumption requirements. Edible soybean oil (HS Code: 15079010) represents the refined variant of crude soybean oil and is directly consumed in households and food services. The sharp spike in import volumes in FY25 highlights a structural demand-supply gap amid higher consumption trends and domestic processing constraints.

Trade Summary Table (FY25 vs FY24)

Metric	FY24 (Revised Final)	FY25 (Final)	Y-o-Y Change (%)
Exports (USD Million)	19.79	24.55	24.06% ↑
Imports (USD Million)	6.83	386.27	5,556.61% ↑

■ **Net Trade Deficit:** USD 361.72 Million in FY25

✦ While exports grew moderately, imports surged over **50 times**, underlining a dramatic rise in import dependence for refined soybean oil.

Top Export Destinations (FY25)

Country	Export Value (USD Mn)	Share (%)
Bhutan	15.59	63.50%
Malaysia	3.01	12.26%
UAE	2.87	11.69%
Others	3.08	12.55%
Total	24.55	100%

✦ **Bhutan, Malaysia, and UAE** emerged as the top destinations for India’s edible soybean oil exports, accounting for over 87% of the total export value in FY25.

Top Import Sources (FY25)

Country	Import Value (USD Mn)	Share (%)
Nepal	384.31	99.49%
Bangladesh	1.88	0.49%
Others	0.08	0.02%
Total	386.27	100%

✦ **Nepal** accounted for nearly 99.5% of India’s edible soybean oil imports in FY25, followed by minor volumes from Bangladesh and other countries. The dominance of Nepal suggests structured re-export mechanisms and favourable trade routing for refined oil into India.

India's edible oil imports are shaped by global price fluctuations, domestic production limitations, and geopolitical trade dynamics. The massive surge in refined soybean oil imports in FY25 indicates a growing need to augment domestic refining and reduce long-term dependency on processed imports.

Source: Directorate General of Commercial Intelligence and Statistics (DGCI&S) | HS Code: 1507901.

III. Soymeal (De-oiled Cake)

Soymeal, also referred to as de-oiled cake, is the protein-rich residue obtained after oil extraction from soybeans. It typically contains 40–48% protein and is widely used in the animal feed industry as a critical ingredient for poultry, dairy, and aquaculture feed.

There are two primary types of soymeal based on protein content and processing:

Regular (Standard) Soymeal

- **Protein Content:** Typically ranges from 44% to 46%.
- **Composition:** Retains a moderate level of soybean hulls, contributing to higher fiber content.
- **Usage:** Commonly used in dairy and ruminant feed, where slightly higher fiber is acceptable or even beneficial.
- **Cost:** Relatively lower due to less intensive processing.

High Protein Soymeal (HiPro)

- **Protein Content:** Typically, 47% to 49%.
- **Composition:** Produced by dehulling soybeans before oil extraction, resulting in lower fiber and higher protein content.
- **Usage:** Preferred in poultry, piggery, and aquaculture feed, where higher protein digestibility and lower fiber are critical.
- **Cost:** Slightly higher due to additional processing and superior nutritional profile.

Trade Summary Table (FY25 vs FY24)

Metric	FY24 (Revised Final)	FY25 (Final)	Y-o-Y Change (%)
Exports (USD Million)	842.90	747.53	11.31% ↓
Imports (USD Million)	18.19	5.90	67.57% ↓

■ **Net Trade Surplus:** USD 741.63 Million in FY25

✦ India continues to be a **net exporter** of soymeal, although export volumes dipped due to global price fluctuations and logistical challenges.

Top Export Destinations (FY25)

Country	Export Value (USD Mn)	Share (%)
Germany	128.69	17.21%
France	82.61	11.05%
Nepal	80.98	10.83%
Iran	70.63	9.45%
Others	384.62	51.46%
Total	747.53	100%

✦ Germany, France, Nepal, and Iran together accounted for nearly 50% of India's soymeal exports.

Top Import Sources (FY25)

Country	Import Value (USD Mn)	Share (%)
Benin	4.40	74.58%
Ethiopia	1.01	17.12%
Others	0.49	8.31%
Total	5.90	100%

✦ Imports remained negligible, reaffirming India's strong domestic production capacity and export orientation.

India's soymeal trade performance in FY25 was shaped by export competitiveness, protein feed demand in key geographies, and fluctuations in global soybean crushing margins. Going forward, India's export potential is expected to remain resilient with favourable crop cycles and international demand recovery.

Source: Directorate General of Commercial Intelligence and Statistics (DGCI&S) | HS Code: 23040030

3B. Industry Overview: Solar Power

3B.1 Introduction

For many, the world of energy production operates in the background, humming quietly behind the lights in our homes, the factories that produce our goods, and the infrastructure that powers modern life. Yet among the fastest-growing and most transformative sectors in this space is solar power—a clean, renewable, and increasingly indispensable source of energy. Harvested directly from sunlight using photovoltaic (PV) and solar thermal technologies, solar power has moved from the fringes of energy generation to the heart of global strategies for sustainability, energy independence, and economic growth.

The solar power sector is unique in its ability to generate electricity without emitting greenhouse gases, drawing on the virtually limitless energy of the sun. With rapidly advancing technology and falling equipment costs, solar has become the most cost-competitive source of new power generation in many regions. From sprawling utility-scale solar farms in arid deserts to rooftop panels powering individual homes and industries, solar energy is reshaping how power is produced, distributed, and consumed.

India's solar journey exemplifies this transformation. Blessed with high solar irradiance and vast land availability, the country has embraced solar as a strategic pillar of its renewable energy mission. The sector has evolved through policy-driven initiatives aimed at creating a robust and self-reliant ecosystem—from grid-scale solar parks and solar-powered agricultural pumps to domestic manufacturing of modules and cells. The government's emphasis on clean energy has spurred innovation, job creation, and investment across the entire solar value chain.

This shift is not only environmental but economic. Solar energy is now central to reducing the country's dependence on fossil fuel imports and insulating power generation from the volatility of global energy markets. Simultaneously, it is creating opportunities for millions—developers, engineers, technicians, manufacturers, and farmers—who are building and benefiting from the growth of solar infrastructure.

What makes the solar sector particularly dynamic is its close relationship with emerging technologies. Innovations in energy storage, smart grids, and floating solar installations are making solar more flexible, reliable, and efficient. Hybrid models—combining solar with wind or batteries—are enabling around-the-clock clean power solutions, addressing intermittency and helping balance demand. Meanwhile, digital tools like AI-based performance monitoring and predictive maintenance are enhancing operational efficiency and asset longevity.

Beyond its role in clean electricity, solar power is increasingly linked to India's broader developmental goals. Solar irrigation systems reduce the energy burden on farmers. Rooftop solar enables households and small businesses to reduce power bills and become energy self-reliant. In rural and remote regions, decentralized solar mini grids provide electricity where the conventional grid has yet to reach.

As global focus intensifies on decarbonization, and India accelerates its transition to a greener economy, the solar power sector stands at the forefront of this movement. It is not just about harnessing sunlight—it is about reimagining how we produce energy, create livelihoods, and build a future that is cleaner, more resilient, and more inclusive. The establishment of new solar power plants, such as the one being undertaken by the Company, reflects not only a commercial opportunity but a strategic alignment with the nation's energy priorities and global climate ambitions. In doing so, the Company becomes part of a sector that is helping to illuminate the path toward a more sustainable world.

3B.2 Key Market Segments

The solar power industry comprises multiple key market segments, each catering to specific consumer groups, applications, and project scales.

- 1. Utility-Scale Solar Power (Grid-Connected):** Utility-scale solar power represents the largest and most mature segment within the solar industry. These projects consist of large photovoltaic (PV) power plants that are directly connected to the national or state electricity grids. The primary customers in this segment include government-owned agencies such as the Solar Energy Corporation of India (SECI), National Thermal Power Corporation (NTPC), state electricity distribution companies (DISCOMs), and merchant power markets. The business model typically involves competitive bidding processes through tariff-based auctions, with long-term Power Purchase Agreements (PPAs) signed with DISCOMs or end-users. This segment benefits from government incentives like solar parks, waiver of inter-state transmission system (ISTS) charges, and grid access priority. It accounts for the majority share of installed solar capacity in India and plays a critical role in meeting the country's renewable energy targets.
- 2. Rooftop Solar (On-Grid and Off-Grid):** Rooftop solar systems constitute a rapidly growing market segment characterized by solar PV installations on the rooftops of residential, commercial, institutional, and industrial buildings. Customers range from individual households and schools to hospitals, factories, shopping malls, and office complexes. The rooftop segment supports decentralization of power generation and allows consumers to offset electricity consumption, thereby reducing their electricity bills. The business models in this segment include net metering arrangements for grid-connected systems, behind-the-meter consumption, group captive ownership models, and capital or lease financing options. Government initiatives and subsidy schemes have further propelled the adoption of rooftop solar, making it a key driver of distributed renewable energy and energy self-sufficiency.
- 3. Open Access Solar (Commercial & Industrial Segment):** The open access solar segment caters primarily to large commercial and industrial (C&I) consumers who procure solar power generated at offsite solar farms. These customers include manufacturing plants, data centers, logistics hubs, and IT parks that seek to reduce their carbon footprint and electricity costs by sourcing clean energy directly from producers. This segment operates through open access regulations that allow consumers to use state or interstate transmission networks to receive power under group captive or third-party arrangements, usually backed by long-term bilateral PPAs. Driven by rising grid tariffs and increasing corporate Environmental, Social, and Governance (ESG) commitments, this segment is one of the fastest-growing and typically offers better profitability margins compared to utility-scale solar.

- 4. Captive and Group Captive Solar Projects:** Captive solar projects are developed and owned by power consumers themselves, or jointly with developers, to fulfil their own electricity requirements. This segment primarily serves industrial units and manufacturing facilities with high power consumption profiles. The business models include equity participation in captive plants or shared ownership under group captive schemes defined by regulatory frameworks. These arrangements enable consumers to benefit from lower tariffs compared to conventional grid supply and are often exempt from cross-subsidy surcharge payments under certain state policies, making captive solar a financially attractive option for self-generation and cost optimization.
- 5. Agricultural and Decentralized Solar:** Agricultural and decentralized solar represents solar applications targeted at rural and farming communities. This segment includes solar-powered irrigation pumps, mini-grid projects, and standalone off-grid systems. Key customers comprise farmers, panchayats, rural cooperatives, and micro-enterprises in remote areas. These projects are often supported by government subsidy schemes such as the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM), designed to promote sustainable agriculture by reducing diesel usage and ensuring reliable power supply for irrigation.
Decentralized solar solutions also foster rural electrification and income generation while aligning with broader sustainability and energy access goals.
- 6. Floating Solar PV:** Floating solar PV installations involve deploying solar panels on water surfaces such as reservoirs, lakes, and canals. This emerging segment targets public sector utilities, water management agencies, and state governments seeking to optimize land use in regions with land scarcity or environmental constraints. Business models typically include government tenders and public-private partnership arrangements. Floating solar offers several advantages, including reduced land acquisition costs, higher energy yield due to cooler operating conditions, and the added benefit of lowering water evaporation from reservoirs, thereby enhancing water conservation.
- 7. Hybrid Solar Systems (Solar + Wind / Solar + Storage):** Hybrid solar systems combine solar power generation with complementary renewable sources such as wind energy or battery energy storage systems (BESS) to enhance power dispatchability and grid stability. These projects are tailored to utilities, corporate clients under RE100 commitments, data centres, and isolated grid systems such as islanded microgrids. The business models involve participation in central and state-level tenders, corporate renewable procurement, and round-the-clock (RTC) power contracts. Hybrid systems address the intermittency challenges of solar energy, enabling continuous power supply and facilitating the integration of renewables into the grid.
- 8. Solar Manufacturing (Upstream Segment):** The solar manufacturing segment encompasses the production of essential components such as solar cells, modules, inverters, mounting structures, and other balance-of-system (BoS) equipment. Customers for these products include engineering, procurement, and construction (EPC) contractors,

solar developers, and government agencies procuring equipment for large-scale projects. This segment plays a crucial role in reducing India's dependence on imported solar components and supports the government's Production Linked Incentive (PLI) schemes aimed at fostering domestic manufacturing capabilities. Strengthening the upstream manufacturing ecosystem is vital for achieving cost competitiveness, supply chain resilience, and long-term energy security in the solar sector.

3B.3 Global Solar Power Landscape

The global solar photovoltaic (PV) industry has entered a transformative phase, characterized by record-breaking capacity additions, declining costs, and growing geopolitical relevance. In CY2024, the global solar sector added 597 GW of new capacity—an increase of 33% year-on-year (YoY) over the 449 GW added in 2023—marking the highest annual addition in history and reinforcing solar PV as the dominant renewable energy source. Solar accounted for 81% of all new renewable energy capacity globally in 2024 and reached a cumulative installed capacity of 2.2 TW, doubling from 1.1 TW in 2022¹.

Market Size and Growth - The global solar photovoltaic (PV) industry has established itself as the cornerstone of the ongoing energy transition, driven by its unparalleled scalability, declining costs, and increasing adoption across both developed and emerging markets. In the calendar year 2024 (CY2024), global solar PV installations reached a new record of 597 GW, representing a robust 33% year-on-year (YoY) growth compared to the 449 GW installed in 2023. This remarkable expansion reaffirms solar's leadership in global renewable energy development and positions it as the fastest-growing power generation technology worldwide. The share of solar energy in the global electricity mix rose significantly to 6.9% in 2024, up from 5.6% in 2023, marking a 1.3 percentage point increase in a single year and nearly doubling from 3.2% in 2021. This equates to approximately 2,000 terawatt-hours (TWh) of solar electricity generation globally in 2024—roughly equivalent to the total annual electricity consumption of India.

The sector's cumulative capacity stood at 2.2 terawatts (TW) by the end of 2024, a milestone achieved just two years after crossing the first 1 TW threshold in 2022. This exponential growth—achieving in two years what previously took nearly seven decades—reflects not only technological advancements and cost reductions but also the accelerating global policy momentum toward decarbonisation and energy security.

Looking ahead, the industry is expected to maintain strong momentum, albeit with more moderate annual growth rates following the extraordinary surge in 2023. According to Solar Power Europe's Medium Scenario, annual installations are forecast to increase to 655 GW in 2025, representing a 10% growth from 2024. By 2029, global annual installations are projected to reach 930 GW, while the High Scenario anticipates the market surpassing 1.2 TW of new capacity annually by the end of the decade. These projections underscore the pivotal role of solar PV in meeting the COP28 target of tripling global renewable energy capacity to 11 TW by 2030, with solar expected to account for a majority share of the expansion¹.

Regional Highlights:

The global solar PV market in CY2024 witnessed robust regional activity, with growth dynamics varying significantly across geographies. While Asia-Pacific continued to dominate global installations, notable expansion was observed in the Americas and parts of Europe, even as the Middle East and Africa region lagged due to persistent structural and regulatory constraints.

a) Asia-Pacific (APAC)

The Asia-Pacific (APAC) region remained the epicentre of global solar PV deployment in 2024, contributing approximately 70% of the total new capacity added worldwide. This dominance was largely attributable to the scale and pace of installations in China, supported by rising activity in India and emerging Southeast Asian markets.

China, the global solar market leader, installed 329 GW of new capacity in 2024, accounting for 55% of global solar additions. This marked a 30% increase from the 253 GW added in 2023. With this, China's cumulative installed solar capacity reached 985 GW, representing approximately 44% of the global total. The country's continued leadership is underpinned by aggressive manufacturing expansion, large-scale utility deployments, and supportive policy frameworks aimed at achieving its climate and industrial targets.

India recorded a remarkable comeback in 2024, installing 30.7 GW of new capacity—an impressive 145% year-on-year growth. This performance positioned India as the third-largest solar market globally, after falling to fifth place in 2023. The resurgence was driven by commissioning of delayed utility-scale projects, improved grid infrastructure under the Green Energy Corridor initiative, and reinforced policy push via Renewable Purchase Obligations (RPOs). India's cumulative capacity stood at 121 GW by the end of 2024.

APAC excluding China also showed increased activity, with its share of global additions rising to 15%. Notably, emerging markets such as Uzbekistan and the Philippines achieved gigawatt-scale capacity additions for the first time in 2024, adding 1.4 GW and 1.1 GW, respectively. These developments highlight the increasing diversification of solar investments within the region¹.

b) America

The Americas emerged as the second-fastest growing solar PV region in 2024, contributing 82.9 GW of new capacity, which represented a 14% share of the global market and a 40% increase over 2023. Growth was spearheaded by the United States and Brazil, while smaller Latin American markets also showed progress.

The United States added a record 50 GW of solar PV capacity in 2024, a 54% year-on-year increase, bringing its total cumulative capacity to 223 GW. This surge was primarily attributed

to the full-scale implementation of clean energy incentives under the Inflation Reduction Act (IRA), coupled with increasing electricity demand from new industrial facilities and data centers.

Brazil, the region's second-largest market, installed 18.9 GW in 2024, up 21% from the previous year. This growth was notable despite macroeconomic headwinds and import tariffs, indicating strong underlying demand and resilience in distributed and utility-scale segments.

Other key markets included Chile (2.1 GW), Mexico (1.6 GW), and Colombia (1.6 GW). Notably, Colombia joined the gigawatt-scale club for the first time, driven by accelerated deployment of distributed PV systems and enhanced policy incentives¹.

c) Europe

Europe added 82.1 GW of new solar capacity in 2024, representing a 15% year-on-year growth and accounting for 14% of global additions. Despite breaking new installation records, Europe fell to fourth place globally in terms of regional market share, largely due to its slower growth relative to APAC and the Americas.

Germany continued to lead the continent, adding 17.4 GW in 2024 to reach a cumulative capacity of 101 GW. The market was supported by robust auction activity, a growing commercial and industrial (C&I) segment, and increased residential adoption.

Türkiye emerged as a regional outlier with exponential growth. The country installed 8.5 GW of solar capacity in 2024—a 394% increase over 2023—exceeding its 2025 national target of 18 GW one year ahead of schedule. This was driven by strong domestic manufacturing, regulatory support through the YEKDEM scheme, and rising rooftop adoption.

The EU-27 bloc contributed 65.3 GW, representing 80% of Europe's total additions. However, growth momentum in many member states slowed due to subsidy cuts, permitting delays, and grid bottlenecks. Nonetheless, 16 EU countries installed over 1 GW of capacity, indicating a more diversified market base compared to previous years¹.

d) Middle East and Africa (MEA)

The Middle East and Africa (MEA) region was the only major geography to experience a decline in annual solar installations, with 14.5 GW added in 2024, down 2% from the previous year. The slowdown was primarily attributed to regulatory delays, infrastructure limitations, and dependence on large-scale projects concentrated in a few countries.

Saudi Arabia emerged as the regional leader, installing 1.4 GW of solar capacity. However, this represented a 28% decline from 2023, when the massive 1.5 GW Sudair project had inflated the year's total. The 2024 capacity additions were mainly from two utility-scale plants—Al Rass 1 and Al Shuaibah PV 1.

South Africa, previously a strong performer, saw a steep 66% YoY decline, adding only 1.1 GW in 2024. The contraction followed a surge in 2023, which was spurred by regulatory reforms and widespread load-shedding that drove rooftop installations. In 2024, policy inertia and limited grid connectivity capacity constrained further growth.

While a few other markets such as Qatar and the UAE remain active, their contributions were not sufficient to offset the regional downturn, underscoring the need for broader policy and infrastructure development to unlock MEA's solar potential¹.

Technological Advancements:

The global solar PV industry continues to benefit from rapid and sustained technological innovation across the value chain, which has significantly contributed to the declining cost of solar electricity, improved project viability, and enhanced grid integration capabilities. Technological advancement remains a critical enabler of solar PV's competitiveness, especially as markets mature and face challenges such as grid curtailment, price cannibalisation, and land-use constraints. The three primary fronts of technological progress in recent years include module efficiency, digitalization, and energy storage integration.

- **Module Innovation and Efficiency Improvements:** Solar module technology has advanced considerably, leading to a step-change in conversion efficiencies and cost structures. Historically dominant monocrystalline PERC (Passivated Emitter and Rear Cell) technology continues to evolve, but the industry is now witnessing a strong transition towards next-generation high-efficiency cell architectures such as TOPCon (Tunnel Oxide Passivated Contact) and HJT (Heterojunction Technology). These new technologies offer higher energy yields per square metre, longer durability, better temperature coefficients, and lower degradation rates compared to previous-generation modules.

The ongoing migration to n-type silicon wafers in combination with these advanced cell architectures is enabling average commercial module efficiencies to reach the range of 22–23%, compared to 19–20% just a few years ago. This results in a significant reduction in the Levelized Cost of Energy (LCOE), particularly for large-scale utility projects, as more power can be generated from a smaller area using fewer balance-of-system (BoS) components. Furthermore, bifacial modules—now widely adopted—enhance energy output by capturing reflected light from the ground or adjacent surfaces, further improving project economics in appropriate geographies¹.

- **Digitalization and Data Analytics:** In parallel with hardware improvements, digital technologies are playing an increasingly vital role in the solar PV sector. Advanced digital tools are being used across the project lifecycle—from site selection and bankability assessment to operations and performance optimization. One of the most notable developments is the introduction of high-fidelity resource simulation platforms such as

Solargis Evaluate, which enables developers, investors, and lenders to access 30-year historical and forecasted solar resource datasets with high spatial and temporal resolution. These tools provide more accurate yield prediction models, reducing financial uncertainties and improving the credibility of energy production forecasts submitted to financial institutions during project due diligence. They also support dynamic system design, fault detection, remote monitoring, and maintenance optimization. As solar markets expand into increasingly complex geographies and grid environments, such simulation and analytics platforms are becoming indispensable for planning and executing viable projects, especially in markets with volatile irradiation profiles or grid variability¹.

- **Energy Storage Integration:** As solar PV penetration rises across global grids, the need for flexibility solutions has become paramount to ensure system stability, reduce curtailments, and manage intermittent generation. As a result, battery energy storage systems (BESS) are now being co-located or hybridized with solar PV installations at an accelerating pace, especially in mature markets such as the United States, China, and Australia.

Storage integration addresses multiple market challenges, including negative capture prices, where excess solar supply during peak generation hours leads to near-zero or negative pricing, and curtailment, where excess generation is forcibly shut off due to grid capacity limits. By storing excess solar output during the day and discharging during evening peaks, BESS enhances the dispatchability and revenue potential of solar projects.

Furthermore, advancements in battery chemistries (such as lithium-iron phosphate), falling battery prices, and supportive regulatory frameworks in several jurisdictions have significantly improved the cost-effectiveness of solar-plus-storage systems. In emerging economies, storage also enables islanded microgrids, supports energy access initiatives, and helps avoid costly grid upgrades, thereby expanding the reach and versatility of solar PV deployments¹.

3B.4 Indian Solar Power Sector

India has emerged as one of the world's most dynamic solar energy markets, driven by a convergence of policy ambition, cost competitiveness, and growing electricity demand. Recognised globally for its proactive clean energy transition, India has implemented large-scale solar deployment programs under the framework of the National Solar Mission and the updated renewable energy targets under its Nationally Determined Contributions (NDCs).

As of December 31, 2024, India's grid-connected cumulative installed solar capacity stood at 81.81 GW, with a robust project pipeline comprising 11.08 GW under implementation and another 71.47 GW under tendering through central government schemes such as CPSU Phase-II, ISTS-based tenders, and KUSUM². When factoring in rooftop, hybrid, floating, and off-grid systems, India's total operational solar capacity crossed approximately 121 GW, establishing it as the third-largest solar market in the world, trailing only China and the United States¹.

The Indian solar landscape is broadly diversified across utility-scale parks, commercial & industrial (C&I) rooftop projects, and decentralised installations in rural and peri-urban settings. This breadth, combined with supportive regulations and rapidly declining tariffs, has positioned solar power at the forefront of India's energy transformation strategy.

Market Size and Growth Trends

The Indian solar power market recorded its highest-ever annual installation in calendar year 2024, with 30.7 GW of new solar capacity added, a remarkable 145% year-on-year growth over the 12.5 GW added in 2023¹. This exceptional performance can be attributed to several reinforcing factors, including:

- The clearing of execution backlogs and pandemic-delayed projects.
- Accelerated commissioning of government-awarded utility-scale projects under SECI and NTPC tenders.
- Rapid expansion in the rooftop solar market, particularly under the Rooftop Solar Phase-II programme supported by the National Portal.
- Improved grid evacuation infrastructure under the Green Energy Corridor Phase-II.

As a result of these developments, India's cumulative installed solar capacity has reached a critical mass and now plays a central role in the country's power mix. As of March 31, 2025, solar energy accounted for approximately 17.5% of India's total installed electricity generation capacity, reflecting its rising prominence within the overall power sector².

Looking forward, the Government of India has committed to achieving 500 GW of non-fossil fuel-based power generation capacity by 2030, of which 280 GW is to be met through solar power². This trajectory is consistent with India's Long-Term Low Emission Development

Strategy (LT-LEDS) submitted to the UNFCCC and supports its broader targets of achieving net-zero emissions by 2070.

The Indian solar power sector is expected to continue growing at an accelerated pace, supported by declining costs, favourable policy incentives (including waivers on inter-state transmission charges), and increasing interest from both domestic and international investors in green infrastructure assets.

Market Segmentation and State-wise Trends

India's solar power sector is broadly segmented into utility-scale, rooftop, and off-grid solar systems, with each segment contributing differently to the overall solar ecosystem. As of March 31, 2025, the Indian solar market continued to be dominated by utility-scale solar projects, which accounted for approximately 87% of the total installed solar capacity². These projects typically range from tens to hundreds of megawatts and are deployed under central or state tender mechanisms, including SECI, NTPC, and state renewable energy agencies.

The rapid deployment of large-scale solar parks has been a defining feature of India's solar expansion strategy. These parks benefit from economies of scale, access to pre-cleared land, and dedicated grid connectivity through the Green Energy Corridor initiative, making them attractive for independent power producers (IPPs) and foreign investors. The integration of solar-wind hybrid projects and solar-plus-storage configurations is also being piloted at scale within this segment to enhance grid stability and dispatchability.

While utility-scale projects dominate capacity statistics, rooftop solar installations have shown strong growth momentum, especially in the commercial & industrial (C&I) segment, where consumers seek to lower electricity costs and meet sustainability targets. In the residential sector, growth is being driven by targeted capital subsidies offered under the Rooftop Solar Programme Phase-II, with installations facilitated through the National Portal for Rooftop Solar. This segment is poised for further acceleration with rising awareness, improved financing options, and state-level incentives.

State-wise Trends

As of March 31, 2025, the following five states led India in cumulative installed solar capacity²:

- **Rajasthan: 20.89 GW** - Rajasthan retained its position as the top solar state due to its high solar irradiation, availability of barren land, and robust policy environment. It is also home to several Ultra Mega Renewable Energy Power Parks (UMREPPs), including the Bhadla Solar Park.
- **Gujarat: 11.08 GW** - Gujarat's performance has been driven by both utility-scale and distributed solar deployment, supported by proactive policies such as the Gujarat Solar Policy 2021 and strong DISCOM participation in rooftop solar promotion.

- **Karnataka: 8.49 GW** - Karnataka has been an early mover in solar energy adoption, particularly through its solar-wind hybrid projects, and remains a leader in capacity despite some slowdown in recent auction activity.
- **Tamil Nadu: 6.31 GW** - Tamil Nadu has demonstrated consistent growth in solar capacity through a mix of utility and rooftop projects, while also addressing high renewable curtailment levels through enhanced grid management.
- **Telangana: 5.71 GW** - Telangana's solar development has largely been driven by state-led tenders and distributed solar promotion under the agriculture feeder solarisation model.

Emerging State Markets

While the western and southern states continue to dominate in utility-scale capacity due to favourable solar irradiation, land availability, and strong grid infrastructure, several northern states are emerging as key growth markets for rooftop and distributed solar:

- **Uttar Pradesh:** Growing rooftop adoption in urban clusters such as Lucknow and Noida, supported by residential subsidies and net metering reforms.
- **Punjab:** Strong uptake in agricultural and institutional rooftop installations, aided by its focus on solarisation of irrigation pumps and schools.
- **Delhi, Haryana, and Chandigarh:** These states/UTs are advancing in residential rooftop installations due to higher per capita income and grid proximity.

The regional distribution of solar capacity highlights the importance of customised policy frameworks, grid readiness, and land-use planning in scaling solar across diverse geographies. Moving forward, states that adopt integrated solar + storage + demand-response frameworks and enable open access procurement will likely emerge as leaders in the next phase of India's solar transition.

Solar Power Plants in India: Installed Capacity and Key Projects

India has rapidly expanded its solar power capacity through a structured approach led by the Ministry of New and Renewable Energy (MNRE) and supported by various centrally funded schemes. The country's solar energy infrastructure is highly diversified, consisting of large-scale solar parks, floating solar installations, hybrid systems, and distributed rooftop projects. This makes India one of the largest and most varied solar markets globally.²

Installed Capacity (as of February 2025):

- Utility-scale ground-mounted solar projects (including hybrid setups): ~79 GW
- Rooftop solar capacity: ~17 GW

- Hybrid and off-grid projects: ~7.5 GW³

India's utility-scale solar growth has been driven by policy mechanisms such as:

- Viability Gap Funding (VGF) for government institutions
- Inter-State Transmission System (ISTS) charge waivers
- Competitive auctions conducted by SECI, NTPC, and state DISCOMs
- Open Access Regulations benefiting commercial and industrial (C&I) customers

Ultra Mega Solar Parks and Large-Scale Projects: The Scheme for Development of Solar Parks and Ultra Mega Solar Power Projects, launched in December 2014, aimed to create large, centralized infrastructure for solar projects. The initial target was 25 parks totalling 20,000 MW, later increased to 40,000 MW across 12 states. By June 2023, about 37,990 MW had been sanctioned under this scheme. ⁴ Key Solar Parks include:

- Bhadla Solar Park, Rajasthan: World's largest solar park with 2,245+ MW capacity
- Pavagada Solar Park, Karnataka: ~2,050 MW
- Rewa Ultra Mega Solar Park, Madhya Pradesh: 750 MW, notable for record-low tariffs
- Kadapa and Ananthapuramu Solar Parks, Andhra Pradesh: Over 1.5 GW combined⁴

These parks provide ready land, transmission connectivity, water access, and streamlined clearances, reducing risks and costs for developers. ⁴

Central Public Sector Undertaking (CPSU) Scheme: Launched in 2015, this scheme promotes solar power generation by government producers using domestically manufactured modules under the Domestic Content Requirement (DCR). The scheme includes:

- Phase-I: 1 GW target
- Phase-II (2019 launch): 12 GW target supported by INR 8,580 crore VGF, to be completed by FY2025–26⁵

This scheme supports captive solar projects for PSUs, boosts domestic manufacturing, and lowers power procurement costs for government facilities. ⁵

Floating and Hybrid Solar Projects: To optimize land use and improve energy profiles, India has promoted:

- Floating solar projects, such as the 36 MW plant in Visakhapatnam, Andhra Pradesh
- Solar-wind hybrid projects primarily in Gujarat, Tamil Nadu, and Karnataka, offering better generation stability and lower variability.

4A. Market Dynamics – Crude Soybean Oil and De-Oiled Cake

The Crude Soybean Oil and De-Oiled Cake (DOC) industry plays a vital role in India’s edible oil ecosystem and animal feed value chain. The industry is experiencing sustained momentum, supported by favourable consumption trends, policy initiatives, and strong domestic and international demand. Both segments—edible oil and protein-rich feed—are being reshaped by shifting preferences, structural reforms, and evolving market dynamics.

Key Growth Drivers – Crude Soybean Oil and De-oiled Cake Industry

Growth Driver	Explanation	Impact on Crude Soybean Oil	Impact on De-oiled Cake
Rising demand for edible oils	Driven by population growth, urbanization, changing dietary habits, and health awareness.	High	Low
Government push for oilseed self-sufficiency	Includes national oilseed missions, MSP support, R&D, and import substitution focus.	High	Moderate
Growth in animal feed and poultry sectors	Rising demand for protein-rich feed in poultry, dairy, and aquaculture sectors.	Low	High
Export opportunities for non-GMO de-oiled cake	Indian DOC has competitive advantage in global markets due to non-GMO certification.	Low	High
Global price fluctuations and import dependency	International soy oil prices and supply disruptions impact domestic pricing dynamics.	High	Low
Technological improvements in processing and extraction	Advancements in solvent extraction and refining improve efficiency and oil recovery.	Moderate	Moderate

Emerging industrial applications (e.g., biofuels, oleochemicals)	Crude soybean oil increasingly used in biodiesel, lubricants, and industrial products.	Moderate	Low
Climatic risks affecting soybean cultivation	High dependency on monsoon rainfall leads to significant variability in production.	High	High
Changes in import duties and trade policies	Policy revisions impact price competitiveness and industry margins.	High	Moderate

The Crude Soybean Oil and De-oiled Cake industry is shaped by evolving demand patterns, supportive policy initiatives, and global market dynamics. While crude soybean oil benefits from growing edible oil consumption and government focus on self-reliance, de-oiled cake has strong prospects in the animal feed and export markets. However, challenges such as climate variability and import price volatility necessitate continuous investment in technology, improved seed quality, and resilient supply chain infrastructure to ensure sustained growth.

4A.3 Challenges and Risks

The Crude Soybean Oil and De-Oiled Cake (DOC) industry operates within a highly dynamic environment influenced by agro-climatic factors, international trade dynamics, policy interventions, and price volatility. While the sector offers significant growth potential, it is subject to a range of operational, financial, and structural risks that stakeholders must continuously monitor and manage.

Market Restraint	Explanation	Impact on Crude Soybean Oil	Impact on De-oiled Cake
Low domestic soybean yield	India's productivity is significantly below global standards due to poor seed quality, rainfed farming, and limited mechanization.	High	High
High dependence on imports for edible oil	Over 60% of edible oil demand is met through imports, creating pressure on domestic refiners and crushers.	High	Low - Indirect
Volatility in global prices and currency fluctuations	Fluctuating international prices and exchange rates impact input costs and margins.	High	Moderate
Lack of adoption of modern seed varieties and technology	Limited use of hybrid or GM seeds affects productivity and oil recovery.	High	High
Fragmented supply chain and smallholder farming	Inefficient logistics and scale limitations reduce competitiveness and traceability.	Moderate	Moderate
Limited investment in processing infrastructure	Many regions lack solvent extraction units or integrated refineries.	High	Moderate
Climatic vulnerability and erratic monsoons	Inconsistent rainfall patterns impact soybean crop output and quality.	High	High

Trade barriers and non-tariff restrictions in export markets	Exporters of DOC face challenges like quality certifications, contamination risks, and geopolitical restrictions.	Low	High
Inadequate warehousing and storage facilities	Leads to post-harvest losses, affecting quality and availability for crushing.	Moderate	Moderate

The Crude Soybean Oil and De-oiled Cake industry in India faces several structural and operational challenges that constrain its growth potential. Low domestic soybean yields, high import dependence, and limited adoption of modern technology continue to suppress the competitiveness of local production. Additionally, fragmented supply chains, inadequate processing infrastructure, and exposure to climatic risks further compound the industry's vulnerabilities. Addressing these constraints will require a coordinated approach involving policy support, investment in agricultural R&D, promotion of scalable farming practices, and enhancement of post-harvest infrastructure. Overcoming these bottlenecks is critical for unlocking the full potential of the soybean value chain and reducing India's reliance on edible oil imports.

4B. Market Dynamics – Solar Power

India’s solar power industry is witnessing robust growth, driven by an enabling policy environment, cost competitiveness, and increasing demand for clean and sustainable energy. With a national target of 292 GW of solar capacity by 2030, the industry is supported by central and state-level initiatives, including Production-Linked Incentive (PLI) schemes, infrastructure support, and regulatory reforms. Declining module and storage costs, rising corporate ESG commitments, and advances in solar-plus-storage technologies are further accelerating adoption across both utility-scale and rooftop segments. These growth drivers collectively position solar energy as a cornerstone of India’s transition to a low-carbon economy.

Key Growth Drivers – Solar Power Industry

Growth Driver	Explanation	Impact
Government policy support and renewable energy targets	National and state-level policies aim to expand solar capacity aggressively by 2030.	High
Falling cost of solar modules and storage	Module prices have declined sharply, improving project viability across scales.	High
Production-linked incentive (PLI) schemes and Make in India push	Encourages domestic solar manufacturing, reduces import dependency.	High
Corporate demand for clean energy (ESG/RE100 goals)	Industrial and commercial users are adopting solar for sustainability and long-term savings.	High
Favorable land availability in solar-rich states	Large tracts of low-cost land in high-irradiance zones support utility-scale expansion.	Moderate
Improved financing ecosystem and green bond access	Solar projects benefit from easier access to institutional finance, including ESG-linked capital.	High
Battery storage and hybrid system advancements	Enhances reliability and enables time-shifting of solar generation.	Moderate

Growing electricity demand and grid modernization	Urbanization, EV adoption, and smart grid rollout create a supportive demand environment.	Moderate
Supportive rooftop solar policies and net metering	Residential and MSME consumers benefit from decentralized energy incentives.	Moderate

The convergence of policy support, technological advancement, and investor interest is creating strong momentum in India’s solar sector. While utility-scale solar continues to dominate capacity additions, rooftop solar is gaining traction among industries and residential consumers due to favourable net metering policies and increasing cost parity. Going forward, the success of domestic manufacturing, grid integration of variable solar power, and widespread deployment of hybrid and storage-based systems will be critical in meeting long-term sustainability goals. With supportive reforms and market readiness, the Indian solar power industry is well-placed to lead the renewable energy transition in the coming decade.

4B.2 Challenges and Risks

Despite its rapid expansion, the solar power industry in India continues to face several structural and policy-level constraints that hinder its full potential. Key among these are the sector’s dependence on imported equipment, inconsistent regulatory frameworks, and infrastructure bottlenecks. While the government's push for domestic manufacturing and grid development is under way, many challenges remain, particularly for developers and investors navigating a complex and evolving ecosystem.

Market Restraint	Explanation	Impact
Dependence on imported solar modules and cells	High reliance on Chinese imports creates supply chain and pricing vulnerabilities.	High
Policy uncertainty and frequent regulatory changes	Inconsistent net metering policies, tariff revisions, and approval delays affect investor confidence.	High
Grid integration and transmission bottlenecks	Limited infrastructure for evacuating solar power, especially from remote areas.	High
Land acquisition and permitting delays	Utility-scale projects often face delays due to land disputes and slow clearance processes.	Moderate
Limited awareness and adoption in residential rooftop segment	Lack of consumer awareness, financing issues, and high upfront costs restrict adoption.	Moderate
Discom financial health and payment delays	Poor financial performance of state DISCOMs impacts project bankability and payment cycles.	High
Inadequate battery storage ecosystem	Storage remains expensive, limiting round-the-clock use of solar power.	Moderate
Domestic manufacturing challenges	Despite PLI schemes, local manufacturers face scale, quality, and cost disadvantages vs imports.	Moderate
Fluctuations in GST, import duties, and safeguard tariffs	Frequent changes in tax and duty structures disrupt cost planning and project execution.	High

5A. Regulatory and Policy Framework – Crude Soybean Oil and DE-Oiled Cake

The Crude Soybean Oil and De-Oiled Cake (DOC) industry in India is governed by a comprehensive regulatory framework encompassing agricultural development policies, trade regulations, environmental controls, and emerging renewable energy linkages. The government's policy interventions seek to enhance oilseed self-reliance, support sustainable processing, and strengthen global competitiveness.

1. Agricultural and Energy Policies

- **Oilseed Development and Production Support:** The Government of India promotes soybean cultivation through centrally sponsored schemes such as the *National Food Security Mission – Oilseeds and Oil Palm (NFSM–OS&OP)* and *Rashtriya Krishi Vikas Yojana (RKVY)*. These schemes provide financial assistance for high-yielding seed varieties, farm mechanisation, and farmer training.
- **Minimum Support Price (MSP):** Soybean is covered under the MSP mechanism, which aims to provide price assurance to farmers and incentivise oilseed production. Announced annually by the CACP, the MSP promotes stability in soybean availability for the crushing industry.
- **Edible Oil Mission Frameworks:** The broader goal of reducing edible oil import dependence is addressed through strategic missions like *NMEO–Oilseeds*, which support expansion in oilseed acreage, productivity enhancement, and processing infrastructure.

2. Renewable Energy Incentives

- **Byproduct Utilisation in Energy Generation:** Certain players in the soybean processing sector are eligible to benefit from renewable energy-linked schemes, particularly if they use DOC or other byproducts for biomass energy or industrial fuel. These initiatives align with India's push toward circular economy models.
- **Support under Energy-Efficient Operations:** Processors adopting energy-efficient technologies or waste heat recovery systems may qualify for fiscal incentives or capital subsidies under government-backed programs, contributing to reduced operating costs and sustainability.

3. Environmental Regulations

- **Compliance with Environmental Norms:** Solvent extraction and oil processing plants are governed by environmental regulations under the *Environment (Protection) Act, 1986*.

Units must obtain clearances from Central/State Pollution Control Boards and comply with standards relating to emissions, solvent recovery, and effluent treatment.

- **Mandatory Sustainability and Pollution Controls:** Regulatory oversight extends to storage, disposal of sludge, and safe handling of volatile compounds. Increasing emphasis is being placed on ESG (Environmental, Social, Governance) compliance, particularly for export-oriented processors.
- **Food Safety and Standards:** All edible oil intended for human consumption must comply with FSSAI regulations, including mandatory refining, labelling standards, trans-fat limits, and hygiene practices across the production chain.

4. Trade and Tariff Policies

- **Import Policy for Crude Soybean Oil:** Crude soybean oil imports are governed by tariff structures and quota allocations under the EXIM Policy. The government periodically adjusts import duties to balance domestic supply conditions and stabilise consumer prices.
- **Export Regulation of De-Oiled Cake:** DOC is classified as freely exportable under the *Open General Licence (OGL)* category. However, exports are subject to quality certifications, phytosanitary compliance, and traceability, particularly for shipments to premium global markets.
- **Commodity Market Access and Price Risk Management:** Soybean and its derivatives are traded on recognised commodity exchanges (NCDEX, MCX), offering processors hedging tools against raw material price volatility. These markets are regulated by SEBI to ensure transparency and risk protection.
- **Support from Export Promotion Bodies:** Exporters of DOC may avail assistance from APEDA for quality upgradation, certification, branding, and access to emerging international markets. This is particularly relevant for companies catering to feed manufacturers in Asia and the Middle East.

Key Budget Announcements Impacting the Soybean Sector

1. **Increased Allocation to the Ministry of Agriculture & Farmers' Welfare (MoAFW)** - The total Budget Estimate (BE) for FY2025–26 for MoAFW stands at ₹1,37,757 crore. This includes allocations to key schemes that directly support oilseed cultivation, processing, and infrastructure.
2. **Support under the National Mission on Edible Oils – Oilseeds (NMEO–Oilseeds)** - The Government continues its focus on reducing dependence on edible oil imports through this mission. The total mission outlay is ₹10,103 crore (over 5 years), with ₹11,040 crore

allocated in FY2025–26 for implementation, covering support for quality seeds, R&D, and cluster-based approaches in major soybean-growing regions.

- 3. Continuation of the Agri-Infrastructure Fund (AIF)** - The ₹1 lakh crore corpus under AIF remains operational, offering interest subvention and credit guarantee support. This fund supports the establishment and expansion of post-harvest infrastructure and oilseed processing units, including soybean oil mills and storage facilities.
- 4. Farmer Producer Organisation (FPO) Support Scheme** - A budget of ₹584 crore has been allocated for the promotion and strengthening of FPOs, which play a critical role in the aggregation, processing, and direct marketing of oilseeds. This enhances local value addition in soybean-producing regions.
- 5. Incentives for Bioenergy and Oilseed By-product Utilisation (MoPNG)** - Under the Ministry of Petroleum & Natural Gas (MoPNG), ₹250 crore has been earmarked for promoting biofuel and circular economy projects, facilitating the industrial use of De-Oiled Cake (DOC) and other soybean by-products in biomass and sustainable energy initiatives.
- 6. Export Promotion through APEDA and Market Access Initiative (MAI)** - The Agricultural and Processed Food Products Export Development Authority (APEDA) has received ₹2,250 crore, including ₹200 crore under MAI, for export certification, quality testing, and international promotion. This directly supports the export of DOC and refined soybean oil, especially to South-East Asia and the Middle East.

Source: *Union Budget FY2025–26, Press Information Bureau (PIB), and PRS Legislative Research.*

5B. Regulatory and Policy Framework – Solar Power

3A.4 Policy and Regulatory Support

The Indian government has implemented several policies to promote solar energy:

- The Government of India has waived Inter-State Transmission System (ISTS) charges for solar and wind power projects commissioned until June 30, 2025, to incentivize rapid deployment of renewable energy capacity¹.
- Starting June 2026, all grid-connected solar projects must incorporate photovoltaic (PV) modules assembled from domestically manufactured solar cells under the revised Approved List of Models and Manufacturers (ALMM) guidelines, promoting local manufacturing and reducing import dependence².
- Competitive tariff-based bidding protocols, guided by the Central Electricity Authority (CEA) and Ministry of New and Renewable Energy (MNRE), govern the procurement of grid-connected solar PV power, ensuring transparent and cost-effective project allocation³.

Government Initiatives and Investments

The Government of India has been proactive in harnessing this potential through various initiatives:

- Under the **Development of Solar Parks and Ultra Mega Solar Power Projects Scheme**, the government has sanctioned 50 solar parks across 12 states, amounting to a total sanctioned capacity of approximately 37,490 MW as of November 30, 2023. Of this, 19 parks with a cumulative capacity of 10,401 MW have been commissioned so far⁴.
- The **Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM)** Scheme, launched in 2019, aims to install 10 GW of decentralized grid-connected solar power plants (Component A) and achieve a total distributed solar capacity of 34.8 GW, which includes solar pumps and feeder-level solar projects, targeted by March 2026⁵. As of July 2025, Component A had 10 GW sanctioned with 638.99 MW installed. Additionally, over 8,40,947 standalone solar pumps and 5,89,526 feeder-level solar systems have been deployed across various states⁶.
- The **MNRE's Production Linked Incentive (PLI)** Scheme for High-Efficiency Solar PV Modules, with a total outlay of ₹24,000 crore, aims to boost domestic solar manufacturing and reduce import reliance. Implemented in two phases, Tranche-I

(₹4,500 crore, April 2021) awarded 8,737 MW capacity, while Tranche-II (₹19,500 crore, September 2022) selected 11 firms to set up 39,600 MW of integrated facilities⁷.

- To accelerate solar growth, the Government permits 100% FDI under the automatic route and has set up a dedicated Project Development Cell. Key enablers include continued waiver of ISTS charges and streamlined facilitation mechanisms to attract over USD 6.1 billion in FDI into the renewable energy sector between April 2020 and September 2023⁸.

Strategic Importance

Harnessing India's solar energy potential is crucial for:

- Enhancing energy security by reducing dependence on fossil fuel imports through accelerated domestic solar capacity addition.
- Aligning with India's Nationally Determined Contributions (NDC) to mitigate greenhouse gas emissions and support climate change commitments.
- Promoting inclusive economic growth and employment generation, particularly in rural regions via large-scale solar parks and distributed solar generation initiatives such as PM-KUSUM.
- Contributing to India's 2030 target of 500 GW from non-fossil fuel sources, renewable energy capacity has surpassed 203.18 GW as of October 2024, with solar energy accounting for 92.12 GW⁹.
- Under the Solar Parks and Ultra Mega Solar Power Projects scheme, the Government of India is accelerating infrastructure development to harness India's solar energy potential and enable large-scale, grid-connected capacity addition—37,990 MW has been sanctioned across 12 states as of June 2023¹⁰.

Opportunities for New Solar Power Developers

The current landscape offers several opportunities for companies entering the solar power sector:

- Solar Parks offer comprehensive infrastructure solutions including land, power evacuation, and pre-clearances, reducing project execution timelines and minimizing development risks.
- Central government schemes like PM-KUSUM and the PLI program provide financial incentives and policy certainty conducive to investment.
- Growing Corporate **Power Purchase Agreement (PPA)** demand from commercial and industrial (C&I) sectors creates expanding market opportunities.

- Emerging markets for hybrid solar-plus-storage and smart grid integration are gaining traction, driven by evolving regulatory requirements and grid stability goals.

6A. PESTEL Analysis – Crude Soybean Oil and De-Oiled Cake

A comprehensive PESTEL analysis helps understand the macro-environmental factors influencing the soybean industry.

Factor	Key Aspects
Political	<ul style="list-style-type: none"> - Implementation of the National Mission on Edible Oils – Oilseeds (NMEO–Oilseeds) incentivizes domestic soybean cultivation and crushing. - Government procurement and MSP policies directly impact soybean supply to crushing units. - Export policy liberalisation has facilitated higher DOC exports, especially to South Asia and the Middle East.
Economic	<ul style="list-style-type: none"> - Import dependency for crude soybean oil makes the sector vulnerable to global price shocks and freight cost fluctuations. - De-oiled cake (DOC) exports are a significant foreign exchange earner, contributing to trade balance. - Rising demand from livestock and poultry feed industries is driving domestic consumption of DOC.
Social	<ul style="list-style-type: none"> - Soybean oil is considered a low-cost cooking oil, widely accepted across Indian households and food service establishments. - Increased awareness of plant-based protein is boosting soymeal and DOC demand among dairy and poultry farmers. - Employment generation in rural areas through value chain activities like crushing, packing, and transport.
Technological	<ul style="list-style-type: none"> - Upgradation of solvent extraction plants and refining technologies has improved oil recovery rates and reduced operational losses. - Technological advancements in storage and logistics ensure longer shelf life of DOC and crude oil. - Use of digital trading platforms has improved DOC export visibility and price discovery.

<p>Legal</p>	<ul style="list-style-type: none"> - Compliance with FSSAI regulations is mandatory for edible crude oil refiners. - DOC exports must meet APEDA standards, particularly in terms of aflatoxin levels, moisture, and protein content. - Adherence to Environmental Protection Act and state-level pollution control norms for solvent recovery and effluent discharge from crushing units.
<p>Environmental</p>	<ul style="list-style-type: none"> - Soybean cultivation and oil extraction generate agro-industrial waste, creating a need for sustainable waste management and energy-efficient processing. - DOC is increasingly used in organic manure and biomass fuel, aligning with India's circular economy and net-zero goals. - Irregular monsoons and climate-related crop failures pose supply risks for crushing operations.

6B. PESTEL Analysis – Solar Power

A comprehensive PESTEL analysis provides a structured understanding of the macro-environmental factors influencing the solar power industry in India.

Factor	Key Aspects Specific to the Solar Power Industry
Political	<ul style="list-style-type: none"> - Strong policy support through schemes like PM-KUSUM, Rooftop Solar Programme, and Solar Park Scheme under the Ministry of New and Renewable Energy (MNRE). - Implementation of Production Linked Incentive (PLI) scheme for domestic manufacturing of solar modules and cells. - Clear political focus on achieving the 500 GW non-fossil fuel capacity target by 2030, as part of India's COP26 commitments.
Economic	<ul style="list-style-type: none"> - Falling solar tariffs have made solar power cost-competitive with coal and other thermal sources. - High initial capital costs remain a barrier for small developers; however, low operating costs provide long-term economic benefits. - PLI incentives, concessional financing, and FDI inflows are boosting manufacturing and large-scale project development.
Social	<ul style="list-style-type: none"> - Increasing public acceptance and awareness of clean energy, especially in rural and semi-urban areas. - Solar electrification is driving energy access and socio-economic development, particularly in remote regions. - Rooftop solar adoption is improving energy affordability for households, institutions, and MSMEs.
Technological	<ul style="list-style-type: none"> - Rapid advancement in PV efficiency, battery storage, and inverter technologies. - Growth in green hydrogen and hybrid solar-wind systems creating additional demand for solar power. - Smart grid integration and use of AI/IoT for performance monitoring and predictive maintenance of solar plants.

<p>Legal</p>	<ul style="list-style-type: none"> - Developers and EPC contractors must comply with grid code regulations, land acquisition laws, and state-specific renewable energy policies. - Solar Power Purchase Agreements (PPAs) are governed by the Electricity Act, 2003 and regulations issued by State Electricity Regulatory Commissions (SERCs). - Legal challenges include delays in land approvals and contract renegotiations in some states.
<p>Environmental</p>	<ul style="list-style-type: none"> - Solar power helps reduce carbon emissions and dependence on fossil fuels, aligning with India's NDCs and net-zero roadmap. - Land use for large solar parks may impact agriculture or biodiversity if not properly managed. - Focus on recycling and disposal of solar panel waste is gaining urgency, with draft rules proposed by the Ministry of Environment, Forest and Climate Change (MoEFCC).

7A. Competitive Landscape – Crude Soybean Oil and De-oiled Cake

7A.1 Indian Competitive Landscape

The Indian crude soybean oil and de-oiled cake industry operates within a highly fragmented and volume-driven market structure, marked by the presence of large integrated agri-processing companies, mid-sized solvent extractors, and regional cooperative units. The industry's competitiveness is shaped by factors such as raw material availability, processing efficiency, procurement scale, logistics, and downstream integration into edible oil refining and feed supply chains.

Key Industry Players

The Indian crude soybean oil and de-oiled cake industry comprises a mix of domestic agro-processing firms and subsidiaries of multinational agribusinesses. The following players constitute the key players in this segment:

- 1. Kirti Oil Industries Private Limited:** Kirti Oil Industries is engaged in solvent extraction and oil refining operations, primarily focused on soybean processing. The company has built a strong presence in central India, leveraging its proximity to major soybean cultivation regions. Its operations span across crude oil production and de-oiled cake manufacturing, catering to both domestic and export markets.
- 2. Kirti Agrovet Ltd:** An associated entity, Kirti Agrovet Ltd is involved in oilseed crushing and animal feed production. It focuses on value-added processing of soybeans, offering a range of products including crude oil and high-protein de-oiled cake. The company emphasizes efficient sourcing and consistent quality in serving feed manufacturers and oil refineries.
- 3. ADM Agro Industries Latur & Vizag Pvt Ltd:** A subsidiary of the global agribusiness giant Archer Daniels Midland (ADM), this company operates large-scale soybean processing facilities in Latur (Maharashtra) and Vizag (Andhra Pradesh). With strong backward and forward integration, ADM Agro Industries is a significant producer of crude soybean oil and DOC. The company benefits from ADM's global procurement, trading, and logistics network, and adheres to international quality and sustainability standards.
- 4. K N Agri Resources Ltd:** K N Agri Resources is an integrated agribusiness company engaged in soybean processing, oil refining, and de-oiled cake production. The company operates solvent extraction and oil refining units in Madhya Pradesh, with a focus on efficiency, scalability, and product diversification. Its DOC is exported to several countries, while its crude oil is supplied to refineries across India.

5. Rama Phosphates Limited: Rama Phosphates operates in both fertilizer and soybean processing sectors. The company produces crude soybean oil and de-oiled cake through its solvent extraction plant in Indore. It leverages synergies between its agri-input and agri-processing businesses, ensuring raw material access and operational flexibility. Its DOC is marketed under established feed-grade brands.

Integration of Renewable Energy - With increasing regulatory and sustainability pressures, several companies in the soybean oil and broader agribusiness sector are exploring clean energy alternatives:

- HPCL-Mittal Energy Limited (HMEL): Although primarily a refinery operator, HMEL has initiated steps to integrate green hydrogen and green chemical production through a partnership with NTPC Green Energy Ltd. These developments are indicative of a broader trend toward sustainability in Agri-processing and biofuel blending segments, which can influence the soybean oil value chain.
- Additionally, under government schemes like PM-KUSUM, oilseed processing and Agri-logistics operations are gradually incorporating solar-powered infrastructure, improving energy efficiency and reducing dependence on fossil fuels.

7A.3 Barriers to Entry

The crude soybean oil and de-oiled cake industry presents multiple entry barriers that deter new participants from easily establishing a foothold. These barriers span across operational, financial, regulatory, and market-related dimensions:

1. Capital-Intensive Operations

Setting up a solvent extraction plant and associated infrastructure for crude soybean oil and DOC production requires significant capital outlay. The investment includes land acquisition near key procurement zones, installation of processing units, oil storage tanks, effluent treatment facilities, and logistics networks. Additionally, establishing refining facilities to upgrade crude oil involves further capex.

2. Access to Raw Material

Soybean procurement is season-dependent and geographically concentrated in specific Indian states such as Madhya Pradesh, Maharashtra, and Rajasthan. Securing timely and high-quality raw soybeans at competitive prices is essential. New entrants without established procurement networks or long-term farmer or trader relationships face challenges in ensuring consistent input supply, impacting cost efficiency and capacity utilization.

3. Economies of Scale and Thin Margins

The industry operates on wafer-thin margins, especially for DOC where price volatility is high and largely influenced by international soymeal markets. Existing players benefit from economies of scale in procurement, processing, and logistics. Smaller or new entrants without such scale struggle to match pricing and profitability levels of established processors.

4. Technological Capabilities

Efficient extraction and recovery of oil from soybean seed require modern and specialized equipment. Technologies such as solvent recovery systems, enzyme-assisted extraction, and high-efficiency decanters demand skilled technical manpower and ongoing R&D investment. Inadequate technology or substandard processes can result in poor oil recovery, lower quality DOC, and non-compliance with regulatory standards.

5. Quality Assurance and Certification

Meeting national and international standards for crude oil and DOC is critical, especially for exporters. Compliance with FSSAI norms (for oil), APEDA registration (for DOC exports), and phytosanitary regulations in destination markets are essential. Lack of quality control laboratories, certification infrastructure, or regulatory knowledge can delay or block market entry.

6. Environmental and Regulatory Compliance

Soybean processing generates effluents and residues that require appropriate treatment before disposal. Regulatory agencies impose stringent norms related to air emissions, waste disposal, solvent loss recovery, and water usage. Acquiring clearances such as Environmental Impact Assessment (EIA), Consent to Establish (CTE), and Consent to Operate (CTO) from pollution control boards can be time-consuming and resource intensive.

7. Working Capital Requirements and Seasonality

Soybean is harvested during a short window (Kharif crop), but processing units run year-round. To ensure uninterrupted operations, processors must procure and store large volumes of soybean or soybean cake, locking up significant working capital. This creates high inventory and liquidity risks, especially for new entrants lacking access to favorable financing terms or credit lines.

8. Brand Reputation and Buyer Relationships

In both B2B edible oil and animal feed markets, buyer confidence in consistency, quality, and delivery timelines is paramount. Long-standing players have built strong relationships with edible oil refiners, feed manufacturers, and exporters. New entrants without proven track records often face hurdles in establishing credibility and securing long-term offtake agreements.

9. Price Volatility and International Competition

Soybean oil and meal prices are influenced by global commodity markets, including developments in Brazil, the U.S., and Argentina. Sudden shifts in global trade flows, import/export tariffs, or currency fluctuations can affect the competitiveness of Indian producers. Managing this volatility requires robust risk management systems, which may be beyond the reach of small or new operators.

7B. Competitive Landscape – Solar Power

7B.1 Indian Competitive Landscape

The Indian solar industry features a dynamic mix of large domestic players, joint ventures, and subsidiaries of international firms. These entities are actively engaged across the value chain, from project development and Engineering, Procurement, and Construction (EPC) services to component manufacturing.

Key Players in the Solar Power Industry

Company	Headquarters	Key Activities	Notable Highlights
Adani Green Energy	Ahmedabad	Utility-scale solar and wind project development	Acquired SB Energy India for US\$ 3.5 billion to strengthen its position in the renewable energy sector. Plans to expand solar manufacturing capacity to 10 GW by 2027.
Tata Power Solar	Mumbai	Solar module manufacturing, EPC services	Part of the Tata Group, with a focus on solar rooftop installations and utility-scale projects. Aims to have 80% of its total power come from clean energy by 2030.
ReNew Energy Global	Gurugram	Independent power producer (IPP) in solar and wind	Operates over 13.4 GW of renewable energy capacity, with plans to double its portfolio in the next five years.
Vikram Solar	Kolkata	Solar PV module manufacturing, EPC services	Manufacturing capacity of 4.5 GW. Recognized as India's only Tier 1 module manufacturer by BNEF in 2024.
Emmvee Group	Bengaluru	Solar module and cell manufacturing, EPC services	Total installed module manufacturing capacity of approximately 6.6 GW. Collaborated with Fraunhofer ISE for solar cell development.
Azure Power	New Delhi	Utility-scale solar project development and operation	Developed India's first utility-scale solar project in 2009. Total capacity exceeds 7 GW.
Mahindra Susten	Mumbai	EPC services for solar power projects	Part of the Mahindra Group, offering turnkey solutions for solar installations.
Waaree Energies	Mumbai	Solar PV module manufacturing	Leading the chart with 12,000 MW installed capacity as of March 2024.

7B.2 Barriers to Entry

The solar industry, despite its immense growth potential in India, presents several formidable barriers to entry that can limit participation by new market players.

- 1. Capital-Intensive Infrastructure:** One of the primary barriers is the requirement for substantial capital investments. Setting up utility-scale solar projects, particularly large-scale manufacturing facilities for solar cells, modules, and ingots/wafers, demands significant financial outlay. This poses a considerable hurdle for new or smaller players.
- 2. Regulatory and Policy Hurdles:** The evolving regulatory landscape introduces complexities. The uncertainty surrounding the Inter-State Transmission System (ISTS) charges waiver, the stringent Quality Control Orders (QCO 2025), and the Domestic Content Requirement (DCR) norms can significantly increase compliance costs and operational complexities for new entrants. Furthermore, land acquisition remains a persistent challenge for large-scale projects.
- 3. Technological Requirements and Know-How:** The modern solar industry is highly technology driven. New entrants must invest in acquiring or developing cutting-edge PV technologies, high-efficiency processing systems, robust quality assurance mechanisms, and expertise in integrating advanced solutions like energy storage and smart grids. The QCO 2025's mandated efficiency benchmarks further raise the technological bar for all participants.
- 4. Market Concentration and Supply Chain Control:** Established domestic players and large international firms often benefit from significant economies of scale, long-standing supply chain relationships, and established brand presence. New entrants may face considerable difficulty in securing competitive raw material procurement or establishing effective distribution channels without substantial time and marketing expenditure. India's historical reliance on Chinese imports also means that new domestic players must compete with established, cost-effective foreign suppliers.

While traditional barriers like capital and technology are significant, the Indian solar sector's competitive landscape is uniquely shaped by dynamic regulatory barriers. Policies such as DCR, QCO, and the evolving ISTS waiver, while aiming for self-reliance and quality, can increase costs and complexity for new entrants and even existing players. This creates a protected market for domestic manufacturers but also demands significant adaptability and financial strength from all participants. These "dynamic barriers" reflect a strategic intent by the government to foster a domestic solar ecosystem, aligning with the "Atmanirbharta" vision. By mandating local content and stricter quality standards, the government aims to reduce import dependence and build a robust local industry. However, this also means that new entrants or those heavily reliant on imports must navigate a more complex and

potentially costlier environment. Companies with strong financial backing, robust research and development capabilities, and expertise in regulatory compliance are better positioned to overcome these barriers. The policy environment thus acts as both a catalyst for domestic growth and a filter for market participants, favouring those who can align with the national strategic vision.

8A. Future Outlook – Crude Soybean Oil and De-Oiled Cake

The future outlook for the crude soybean oil and de-oiled cake (DOC) industry is underpinned by rising domestic consumption, evolving dietary trends, and increasing emphasis on sustainable agricultural and nutritional practices. Crude soybean oil, though primarily refined for edible consumption, is also witnessing growing demand across industrial segments such as biodiesel manufacturing, oleochemicals, paints, inks, and lubricants. As the push for renewable fuels gains momentum, the role of crude soybean oil in biofuel blending and industrial applications is expected to strengthen further.

In parallel, de-oiled cake is poised for sustained demand growth, especially from the livestock, poultry, and aquaculture sectors. As feed quality standards evolve and protein-rich inputs gain priority, DOC continues to be a preferred choice due to its nutritional value and cost efficiency. The ongoing formalization of India's dairy and animal husbandry ecosystem will likely enhance structured feed demand, further supporting the DOC market.

Moreover, increased mechanization and processing efficiency, coupled with supportive policy interventions aimed at boosting oilseed output and reducing edible oil import dependency, are expected to foster long-term growth. Investment in value chain integration, storage, and cold chain infrastructure is also anticipated to enhance supply-side resilience.

While global price volatility, climatic challenges, and input cost pressures remain key risks, the industry's long-term fundamentals remain robust. Rising health awareness, growing industrial applications of crude soybean oil, and the critical role of de-oiled cake in India's protein supply chain are expected to sustain industry momentum over the coming years.

8B. Future Outlook – Solar Power

The solar power industry in India is poised for robust growth, driven by strong policy backing, declining technology costs, and increasing investor interest in clean energy infrastructure. With a national focus on energy transition and climate commitments under the Paris Agreement, solar power is expected to remain a central pillar in India's renewable energy strategy.

Rapid adoption of utility-scale solar projects, along with expansion in rooftop and distributed solar systems, is expected to accelerate in the coming years. The government's production-linked incentives (PLI), solar park schemes, and favourable open-access regulations are likely to support the addition of new capacity across commercial, industrial, and residential segments.

Technological improvements in solar panel efficiency, battery storage, and hybrid systems (solar + wind + storage) are expected to improve project viability and grid stability. Additionally, the push for domestic manufacturing of solar modules and cells under the “Atmanirbhar Bharat” initiative is anticipated to reduce dependency on imports and strengthen the domestic solar value chain.

Despite challenges related to land acquisition, transmission infrastructure, and policy uncertainty in some states, the long-term growth outlook remains strong. Rising energy demand, corporate decarbonization goals, and the declining levelized cost of electricity (LCOE) from solar are likely to keep the sector attractive for long-term investors and developers.

The solar industry is expected to play a vital role in India's target of achieving 500 GW of non-fossil fuel capacity by 2030, contributing significantly to the country's sustainable development agenda and energy security.

9. Works cited

Section 1 – Global Macroeconomic Environment

1. IMF World Economic Outlook, April 2025.

Section 2 – Indian Macroeconomic Environment

1. IMF World Economic Outlook, April 2025.
2. MOSPI, first advance estimates of GDP 2024-25 released on January 7, 2025.
3. PIB, Press Release - India Becoming an Economic Powerhouse posted on June 16, 2025.
4. PIB, Research Unit - India becomes 3rd Most Powerful Nation in Asia, Surpasses Japan in Asia Power Index posted on September 24, 2025.
5. IMF Data Mapper, World Economic Outlook April 2025, India, GDP Per Capita at Current Prices <https://www.imf.org/external/datamapper/NGDPDPC@WEO/IND>
6. MOSPI, Second Advance Estimates of GDP 2024-25 dated February 28, 2025
7. MOSPI, Quick Estimate of Index of Industrial Production and Use-Based Index for the month of March 2025, dated April 28, 2025
8. Union Budget FY 2025-26 – Government of India.

Section 3A - Industry Overview – Crude Soybean Oil and De-oiled Cake

1. USDA World Agricultural Supply and Demand Estimates (WASDE), May 2025
2. DA&FW, UPAg - Unified Portal for Agricultural Statistics, 3rd Advance Estimates 2024-25
3. Directorate General of Commercial Intelligence and Statistics (DGCI&S), HS Code – 15071000
4. Directorate General of Commercial Intelligence and Statistics (DGCI&S), HS Code – 15079010
5. Directorate General of Commercial Intelligence and Statistics (DGCI&S), HS Code – 23040030

Section 3B – Industry Overview – Solar Power

1. Solar Power Europe, Global Market Outlook for Solar Power 2025–2029, May 2025.
2. Ministry of New and Renewable Energy (MNRE), Government of India, “Annual Report 2024-25,” February 2025.
3. Central Electricity Authority (CEA), “Installed Capacity Report,” February 2025.
4. Ministry of New and Renewable Energy (MNRE), “Development of Solar Parks and Ultra Mega Solar Power Projects,” June 2023.
5. Ministry of New and Renewable Energy (MNRE), “CPSU Scheme Phase-II,” March 2024.

Section 5A - Regulatory and Policy Framework – Crude Soybean Oil and De-oiled Cake

1. Union Budget FY2025–26, Press Information Bureau (PIB).

Section 5B - Regulatory and Policy Framework - Solar Power

1. Ministry of Power / Ministry of New and Renewable Energy (MNRE), Written reply, Government of India: Exemption of ISTS charges for renewable projects commissioned until June 30, 2025, 2024.
2. MNRE, Revised Approved List of Models and Manufacturers (ALMM) Guidelines, Government of India, 2023.
3. Central Electricity Authority (CEA) / MNRE, Guidelines for Tariff-Based Competitive Bidding for Grid-Connected Solar PV Power Projects, 2023.
4. PIB, Year End Review 2023 of Ministry of New & Renewable Energy.
5. MNRE, PM-KUSUM Scheme Implementation Status, May 2024.
6. MNRE, PM-KUSUM Component A, B & C Deployment Statistics, May 2024
7. MNRE, Production Linked Incentive (PLI) Scheme: National Programme on High Efficiency Solar PV Modules.
8. PIB, India's renewable energy sector has received FDI equity investment of \$ 6.1 billion during April 2020 – September2023.
9. PIB, India's Renewable Energy Capacity Hits New Milestone,2024.
10. MNRE, Development of Solar Parks and Ultra Mega Solar Power Projects

For Infomerics Analytics & Research Pvt Ltd

Uday
TG

Digitally signed
by Uday TG
Date: 2025.09.02
18:04:49 +05'30'

Uday TG
Director – Ratings
Place: Bangalore