INDUSTRY REPORT ON

ASSESSING THE MARKET POTENTIAL OF SELECT INDUSTRIAL DRIVE SOLUTIONS AND SOLAR PRODUCTS

SUBMITTED TO

Rotomag Enertec Limited

19th September 2025

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ABBREVIATIONS

Title	Abbreviations
APAC	Asia-Pacific
CAGR	Compound Annual Growth Rate
CPI	Consumer Price Index
CY	Calendar Year (January to December)
FTA	Free Trade Agreement
FY	Financial Year (April to March)
ME	Middle East
GDP	Gross Domestic Product
GVA	Gross Value Added
IMF	International Monetary Fund
IIP	Index of Industrial Production
MEIS	Merchandise Exports from India Scheme
MoSPI	Ministry of Statistics and Programme Implementation
Bn	Billion
Mn	Million
PMP	Phased Manufacturing Plan
PLI	Production Linked Incentive
EU	European Union
FDI	Foreign Direct Investment
GST	Goods and Services Tax
F&S	Frost and Sullivan
CAPEX	Capital Expenditure

DEFINITIONS

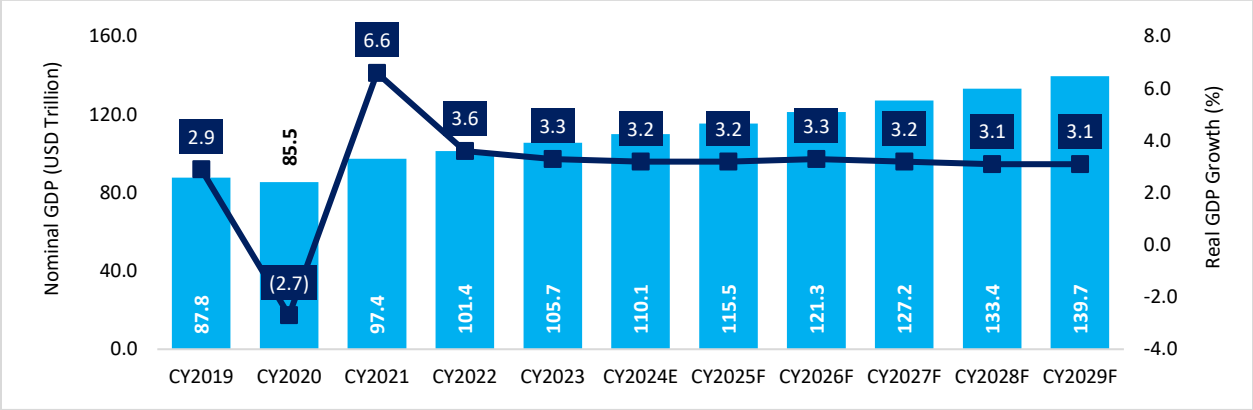
Title	Definition
Financial Year (FY)	The fiscal year in India is defined from April to March. For instance, FY24 refers to 1st April 2023 to 31st March 2024
Calendar Year (CY)	The calendar year is defined from January to December. For instance, CY23 refers to 1st January 2023 to 31st December 2023
Value	Market estimates by value mentioned in the report are based on the revenue.

Global Macro-Economic Overview

1.1. Macro-economic Trends of the Global Economy and Outlook of Global GDP Trends

Global economic growth saw a robust rebound in 2021, with real GDP expanding by 6.6%, driven by strong post-pandemic demand recovery and fiscal stimulus. Growth, however, moderated to 3.6% in 2022 and 3.3% in 2023, as the Russo-Ukrainian war intensified inflationary pressures, disrupted supply chains, and prompted aggressive monetary tightening.

Exhibit 1.1: Nominal GDP (in USD Trillion) and Real GDP Growth (%), Global, Calendar Year (CY)2019-CY2029F



Note: E: Estimate, F: Forecast, Global Nominal GDP, and Real GDP Growth are represented in calendar years
Source: International Monetary Fund (IMF): World Economic Outlook (WEO), October 2024, Frost & Sullivan

From 2025 to 2029, global nominal GDP is projected to grow at a CAGR of 4.9%, reaching approximately USD 140 trillion, with real GDP growth averaging 3.2% annually.

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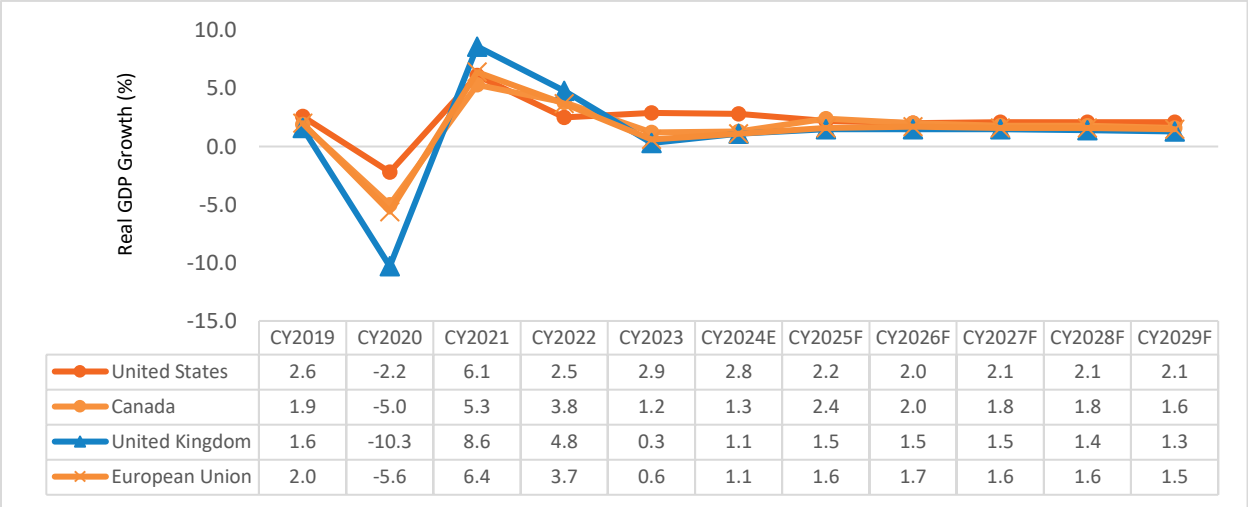
1.2. Outlook on Key Advanced Economies

Exhibit 1.2: Real GDP Growth (%), Key Advanced Economies, CY2019-CY2029F

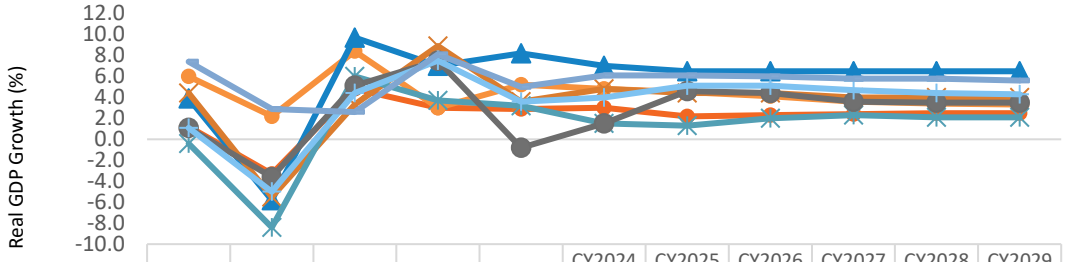


	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024E	CY2025F	CY2026F	CY2027F	CY2028F	CY2029F
United States	2.6	-2.2	6.1	2.5	2.9	2.8	2.2	2.0	2.1	2.1	2.1
Canada	1.9	-5.0	5.3	3.8	1.2	1.3	2.4	2.0	1.8	1.8	1.6
United Kingdom	1.6	-10.3	8.6	4.8	0.3	1.1	1.5	1.5	1.5	1.4	1.3
European Union	2.0	-5.6	6.4	3.7	0.6	1.1	1.6	1.7	1.6	1.6	1.5

Note: E: Estimate, F: Forecast, Real GDP Growth is represented in calendar years. Source: IMF: WEO, October 2024, Frost & Sullivan

1.3. Outlook on Key Emerging Markets

Exhibit 1.3: Real GDP Growth (%), Key Emerging Markets, CY2019-CY2029F



	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024 E	CY2025 F	CY2026 F	CY2027 F	CY2028 F	CY2029 F
Brazil	1.2	-3.3	4.8	3.0	2.9	3.0	2.2	2.3	2.4	2.5	2.5
China	6.0	2.2	8.4	3.0	5.2	4.8	4.5	4.1	3.6	3.4	3.3
India	3.9	-5.8	9.7	7.0	8.2	7.0	6.5	6.5	6.5	6.5	6.5
Malaysia	4.4	-5.5	3.3	8.9	3.6	4.8	4.4	4.4	4.0	4.0	4.0
Mexico	-0.4	-8.4	6.0	3.7	3.2	1.5	1.3	2.0	2.3	2.1	2.1
Saudi Arabia	1.1	-3.6	5.1	7.5	-0.8	1.5	4.6	4.4	3.6	3.5	3.5
United Arab Emirates	1.1	-5.0	4.4	7.5	3.6	4.0	5.1	5.1	4.7	4.4	4.3
Vietnam	7.4	2.9	2.6	8.1	5.0	6.1	6.1	6.0	5.8	5.8	5.6

Note: E: Estimate, F: Forecast, Real GDP Growth is represented in calendar years. Source: IMF: WEO, October 2024, Frost & Sullivan

India is set to become the fastest-growing major economy, driven by strong domestic demand and reforms. Rising from the 9th largest economy in 2010 (USD 1,676 billion) to 5th in 2024 (USD 3,889 billion), India is projected to rank 3rd by 2029 at USD 6,307 billion, surpassing Germany and Japan. This growth is powered by a demographic advantage (68% in the working age group) and CAPEX growing at a CAGR of 18.8% to USD 133.7 billion by FY2024-25. Key sectors like technology, infrastructure, defense, and a USD 2 trillion export target by 2030, are driving India's transformation and global leadership.

1.4. Growth of Capital Goods Sector – Global Scenario

The capital goods sector's growth is a crucial indicator of industrial development and economic expansion. It encompasses industries that produce machinery, equipment, and infrastructure for other sectors. The global capital goods sector has seen varying growth patterns in recent years, influenced by factors like post-pandemic recovery, supply chain dynamics, and macroeconomic conditions.

The demand for capital goods is being driven by increased investments in infrastructure, manufacturing, and automation, with sectors like construction, power, and transportation also contributing to this growth. The capital goods sector is positively impacted by strong growth in renewable energy equipment, rising demand for automation and smart manufacturing solutions, and increased investment in defense and aerospace manufacturing.

1.4.1. Capital Goods Sector – Key Economies Have the Strongest Growth Potential

The capital goods sector is predicted to experience robust growth in several economies in the coming years due to infrastructure investment, industrialization, and technological advancements.

Emerging economies like India, Vietnam, Brazil, Mexico, and Sub-Saharan Africa are expected to be the fastest-growing markets for capital goods due to their significant infrastructure needs and manufacturing growth. These countries are investing heavily in renewable energy, urbanization, and digital manufacturing technologies, resulting in a rise in demand for machinery, construction equipment, and industrial technologies.

India - Capital goods makers are projected to see a revenue increase driven by significant investments in railways, defense, conventional, and renewable sectors. Capital good players' revenue growth is expected to be bolstered by investments in PLI-driven schemes and emerging sectors like electric vehicles and data centers. Growth opportunities in automation, digitalization services, and charging networks could increase these sectors from 10% in fiscal 2024 to 25% by fiscal 2028.

1.5. Global Manufacturing Shift and Diversification Away from China and Europe

The global manufacturing landscape is undergoing a marked shift as businesses diversify from China, driven by demographic, economic, and geopolitical factors. China's population over 65 years is projected to rise to 17.4% by 2029, leading to a shrinking labour force, reduced productivity, and heightened fiscal pressures for pension and public healthcare reforms. Geopolitical tensions over Taiwan and the South China Sea amplify trade risks, while high corporate debt—particularly in the real estate sector—coupled with falling property prices, dampens economic growth and investor confidence. Financial inefficiencies further exacerbate the issue, with concentrated loans in state enterprises and inconsistent government interventions undermining economic stability.

Many European businesses are struggling with rising energy costs and weakening consumer spending as households allocate more to energy expenses. Energy-intensive industries are under pressure, disrupting operations and profitability. This disparity in energy prices is driving some industries to consider relocating to India, offering a potential boost to India’s manufacturing sector. Trade relations with key markets such as the EU, the U.S., and Japan are expected to wane, prompting companies to explore alternative manufacturing destinations.

India has emerged as a significant beneficiary of this shift, leveraging fiscal incentives and a burgeoning semiconductor manufacturing sector, with three plants under development and policies encouraging ancillary industries. India also plans to replicate China’s eCommerce integrated pilot zones near airports to streamline customs processes, a step toward achieving its ambitious USD 1 trillion goods export target by 2030.

1.5.1. India’s Strategic Advantage: Emerging as a Key Beneficiary of the China+1 and EU+1

Strategic Position in Global Supply Chains: India is emerging as a key player in the global China+1 and Europe+1 strategies.

Focus on High-Value Industries: The India Semiconductor Mission, with INR 760 billion in funding and INR 1.5 trillion in private investments, showcases India's focus on high-value industries. Supporting policies like the Design Linked Incentive scheme and **Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors** are driving growth in aerospace, electrical machinery, and pharmaceuticals.

Geopolitical Challenges and Opportunities: Geopolitical tensions involving Russia have disrupted supply chains in industries like automotive and steel. Rising raw material costs have pressured profitability. However, India's diversification of energy imports and renewable energy investments under Atmanirbhar Bharat are enhancing resilience and creating opportunities in export-driven sectors.

Policy and Workforce Strengths: Initiatives, like Make in India, cost-competitive labour, and a rapidly upskilling workforce, are transforming India into a reliable manufacturing hub.

Future-Ready Economy: With a diversified economy, strategic policies, and sustainability-focused practices, India is well-positioned to meet global market demands. Its emphasis on ease of doing business and robust manufacturing capabilities offers significant opportunities for global investors, cementing its place in global supply chains.

1.6. Global – Growing Environmental Regulations and Sustainability Focus

As the globe confronts the growing threat of climate change, there is a pressing need for action to shift to sustainable energy sources. The global search for sustainable energy alternatives is both an environmental and economic imperative..

A. Global Push for Renewable Solutions

Government policies and incentives are crucial in promoting sustainable energy solutions, with many countries setting ambitious targets and offering various incentives for clean energy technology development. Renewable energy technologies, including solar, wind, hydropower, and geothermal, are rapidly gaining popularity as clean, reliable, and cost-effective alternatives to fossil fuels. Solar energy has experienced significant growth due to advancements in technology, reduced costs, and government incentives. It is now an affordable energy source, with large-scale solar farms being built globally. Rooftop solar panels are also popular among homeowners and businesses. Advanced solar storage solutions, like batteries, enable excess energy to be stored and used during high-demand periods, making solar energy more reliable and flexible.

B. Regulations mandating manufacturers to focus on producing energy-efficient solutions

Global regulations are increasingly mandating manufacturers to focus on producing energy-efficient solutions, aiming to reduce energy consumption and mitigate environmental impacts. Countries worldwide are setting renewable energy targets to reduce carbon emissions and promote sustainability The European Commission has unveiled a comprehensive five-year plan to enhance the competitiveness of European industries. Central to the plan is the "Clean Industrial Deal," aiming to simplify business rules, expedite investments, and support the decarbonization of energy-intensive industries. The EU's Eco-design Directive establishes a framework for setting mandatory ecological requirements for energy-using and energy-related products. The directive obliges manufacturers to reduce energy consumption and other negative environmental impacts at the design stage.

C. Climate Goal of Key Countries

Countries worldwide are setting ambitious climate goals to address the pressing issue of climate change. These targets, often outlined in Nationally Determined Contributions (NDCs) under the Paris Agreement, reflect each nation's commitment to reducing greenhouse gas emissions and promoting sustainable practices. The European Union aims for net-zero emissions by 2050, while China aims for carbon neutrality

by 2060, focusing on expanding renewable energy capacity. India aims to decrease GDP emission intensity by 33-35% by 2030 and achieve 40% of its electric power installed capacity from non-fossil fuel-based energy resources by the same year.

D. Energy Transition Projects - Capital availability between public and Private sector

Governments worldwide are leveraging public and private capital to accelerate the energy transition, with substantial funding inflows into projects in recent years. To achieve net zero emissions by 2050, a significant increase in capital-intensive clean energy assets like wind, solar PV, electric vehicles, and hydrogen electrolyzers is needed. Public and private investments are crucial for delivering clean energy at the required scale. Access to low-cost financing is crucial, especially in emerging and developing economies.

E. Increasing Demand for Clean and Sustainable Energy Sources

Switching to eco-friendly energy sources offers significant benefits for both businesses and the environment. It helps companies reduce energy costs, meet regulatory requirements, access new markets, boost brand reputation, and attract green investments. Globally, it curbs emissions, reduces pollution, conserves resources, and enhances energy security, supporting sustainable economic growth.

Globally, renewable power capacity reached 3,870 GW by the end of 2023, led by solar energy at 1,418 GW, followed by hydropower (1,268 GW) and wind energy (1,017 GW). Solar energy saw a significant rise from 492 GW in 2018 to 1,418 GW in 2023 a 24% growth driven by increasing demand for clean energy. In 2023 alone, global solar capacity grew by 345 GW, with Asia contributing over 60% of the new installations. According to IRENA, renewables could supply 65% of global electricity by 2050 and generate over 30 million clean energy jobs by 2030. By the end of 2023, global renewable power capacity reached 3,870 GW, with solar energy leading to 1,418 GW, followed by hydropower (1,268 GW) and wind energy (1,017 GW). Solar capacity grew significantly from 492 GW in 2018 to 1,418 GW in 2023, a 24% increase driven by rising demand for clean energy. In 2023 alone, solar energy capacity rose by 345 GW, with Asia contributing over 60% of the new installations.


Domestic Macro-Economic Overview

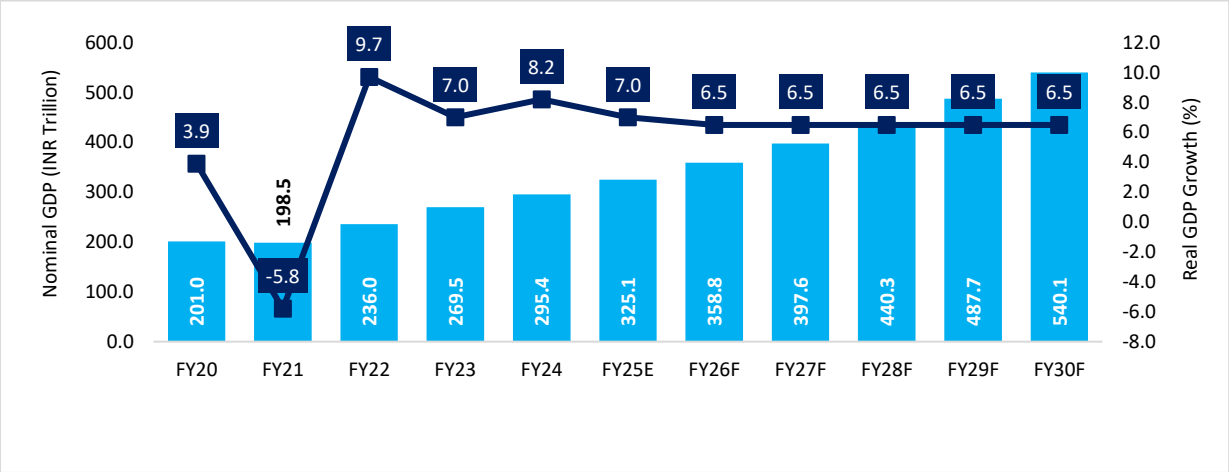
2.1. Macro-economic Overview of the Indian Economy

Indian economic growth in FY24 outperformed many other major economies and was the least impacted by the inflationary pressures globally. The government has been promoting structural reforms, such as a focus on disinvestment and higher FDI limits, while also working on a national logistics policy to promote India's economic growth post-pandemic.

In CY2019, the Indian government set a target of becoming a USD 5 trillion economy and a global powerhouse by FY25. As a result of the COVID-19 pandemic, the government revised the original timeline by 18–24 months. India crossed the USD 3 trillion mark in FY2022, and India is on the verge of surpassing a USD 4 trillion GDP by FY2025. In a realistic scenario, India needs another 2-3 years to cross the USD 5 trillion mark.

2.2. Real and Nominal GDP Growth in India: GDP Growth Trends

Exhibit 2.1: Nominal GDP (in INR Trillion) and Real GDP Growth (%), India, Fiscal Year (FY) 2020 to FY2030F



Source: IMF: WEO, October 2024, Frost & Sullivan.

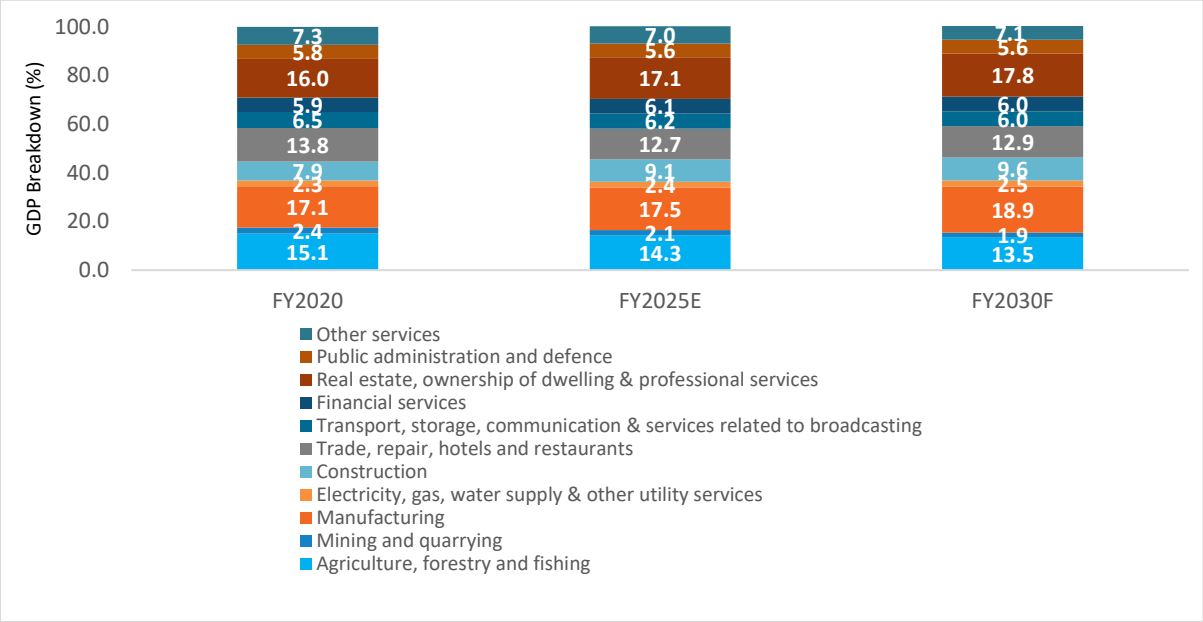
India's real GDP displayed resilience with a strong rebound of 9.7% in FY2021-22, following a sharp contraction of 5.8% in FY2020-21 due to COVID-19, and maintained steady growth at 7.0% and 8.2% in FY2022-23 and FY2023-24, respectively. Nominal GDP surged by 46.9% from FY2019-20 to FY2023-24, reaching INR 295.4 trillion, reflecting rising economic activity. Projections indicate sustained growth momentum with nominal GDP projected to reach INR 540.1 trillion by FY2029- 30, driven by a robust consumer base, competitive labor costs, and government-led CAPEX. Structural reforms, increasing digitalization, and expanding global trade integration further position India as a key player in the global economy, underscoring its potential to exceed USD 7.0 trillion in nominal GDP within the next decade.

2.3. GDP Breakdown by Key Sectors

Manufacturing

India's sectoral GDP composition reflects a dynamic shift towards a combination of industrialization and services-led growth. India's manufacturing sector has accounted for 17%-18% of the total Gross Value Added (GVA) over the past decade. In Over the medium term, the share of manufacturing is poised to grow, driven by production-linked incentive schemes across 14+ sectors, including pharmaceuticals, textiles, medical devices, auto components, and white goods (electronic items such as refrigerators and televisions), among others.

Exhibit 2.2: GDP breakdown by key sectors (%), India, FY2019-20, FY2024-25E & FY2029-30F



Source: Ministry of Statistics and Programme Implementation (MOSPI) – India, Frost & Sullivan

Agriculture

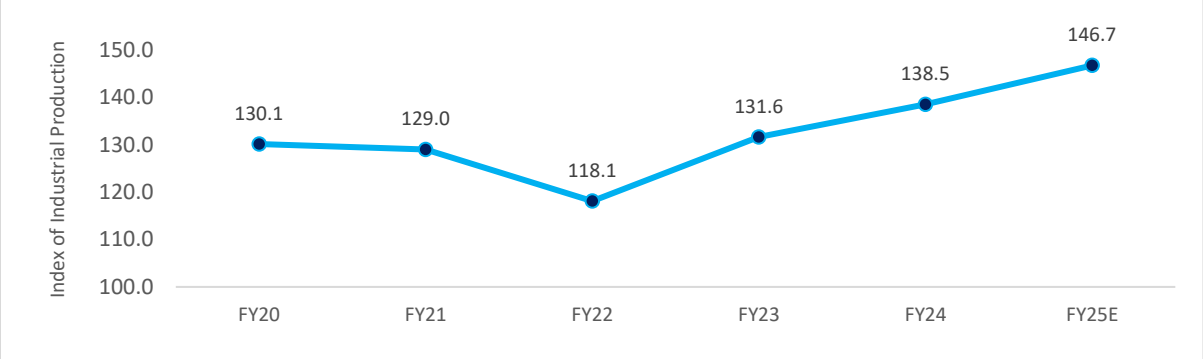
The agricultural and allied sector is expected to have good performance, mainly attributable to government initiatives aimed at increasing crop and livestock productivity, guaranteeing stable returns for farmers through price support, encouraging crop diversification, and enhancing market infrastructure by incentivizing the establishment of farmer-producer organizations and investments in infrastructure through the Agriculture Infrastructure Fund. By FY30, the agriculture, forestry, and fishing sectors are projected to decline to 13.5% of GDP, down from 14.3% in FY25, reflecting a gradual structural shift. However, their critical role in rural employment and food security persists.

However, in FY2023 and FY2024, production in agriculture and allied sectors witnessed a record jump, mainly attributed to foodgrain production. Key demand-side drivers such as population growth and export market expansion, as well as supply-side drivers such as ideal climate, technologically advanced irrigation infrastructure, the Green Revolution in Eastern India, an increase in climate-smart agricultural practices,

and policy and infrastructure support such as the "Krishi Nivesh" portal, Paramparagat Krishi Vikas Yojana, Pradhanmantri Gram Sinchai Yojana, and Sansad Adarsh Gram Yojana, along with the Kisan Rath app, 200+ Kisan Rails, and Krishi Udaan Scheme for produce transportation, are worth noting in agricultural production boost in recent years.

2.4. Industrial Activity Growth – Increase in IIP

Exhibit 2.3: Index of Industrial Production (IIP), India, FY2019-20 to FY2023-25E



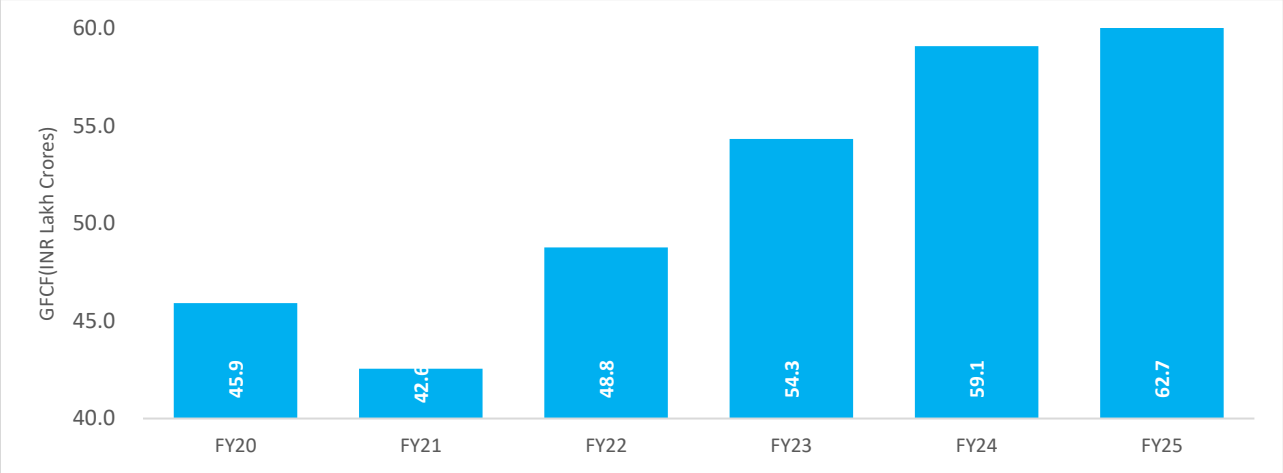
Source: MOSPI – India, Frost & Sullivan.

Between FY2019-20 and FY2024-25, India's IIP grew at a steady CAGR of 2.4%, driven by initiatives like the PLI scheme, Make in India, and Atmanirbhar Bharat, which boosted domestic manufacturing and innovation. Key sectors such as automotive, electronics, and pharmaceuticals have thrived on strong consumer demand and export opportunities, highlighting India's evolving industrial ecosystem and its growing role in global manufacturing and trade. Macro factors like GDP growth, inflation, and landmark policies, along with micro drivers such as skilled labor, infrastructure, and technological advancements, have bolstered industrial activity. Improved logistics and targeted resource policies further strengthen India's growth-oriented industrial framework, paving the way for sustained economic expansion.

2.5. Historic Trends and Outlook of Gross Fixed Capital Formation

Gross Fixed Capital Formation (GFCF) in India has shown a significant upward trend over the past decade. At constant 2011-12 prices, GFCF increased from ₹32.78 lakh crore in 2014-15 to ₹54.35 lakh crore in 2022-23. The government's capital expenditure increased 28.2% YoY in 2023-24, reaching ₹9.5 lakh crore, 2.8 times the level of FY20. GFCF by private non-financial corporations increased by 19.8 percent in FY23.

Exhibit 2.4: Gross Fixed Capital Formation (in INR), India, FY2020 to FY2025



Note: Gross Fixed Capital Formation at Constant (2011-12) Prices (Rs. Crore) *Source: pib.gov.in, mospi.gov.in, Frost & Sullivan*

India's gross fixed capital formation (GFCF) climbed to 30.8% of GDP in FY24, up from an average of 28.9% between FY15-19 (pre-pandemic). The government's strong capex push, together with household investment in real estate (dwellings, other buildings, and services), has contributed to the improvement in GFCF. In summary, while the private sector has been the predominant contributor to India's GFCF, recent government initiatives in capital expenditure have significantly bolstered overall investment levels. This collaborative dynamic between government spending and private investment is pivotal for sustaining and enhancing India's economic growth trajectory.

2.6. Overview of the Agriculture Sector in India

The agriculture sector forms a large part of the Indian economy. The agricultural and allied industries have shown robust performance in recent years, mainly attributable to government initiatives aimed at increasing crop and livestock productivity, guaranteeing stable returns for farmers through price support, encouraging crop diversification, and enhancing market infrastructure by incentivizing the establishment of farmer-producer organizations and investments in infrastructure through the Agriculture Infrastructure Fund.

The Indian government has launched the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM KUSUM) scheme to promote the use of solar-powered irrigation pumps. The scheme aims to reduce farmers' dependence on diesel, lower irrigation costs, and enhance water and energy security. The government provides central financial assistance of 30% of the benchmark cost or tender cost, with state governments offering an additional 30% subsidy. The farmer bears the remaining 40% loan.

The KUSUM scheme has positively impacted the agricultural sector by improving energy access, reducing costs, promoting sustainability, and providing economic opportunities for farmers. It also aligns with India’s broader goals of clean energy transition and rural development.

2.7. Agriculture - Major employment contribution sector in India

Agriculture is a vital sector in India's economy, employing 43-45% of the workforce and remaining the largest employment sector despite a decline in its GDP share. Rural India heavily relies on agriculture, with millions engaged in farming and related activities. Despite employing nearly half of the workforce, agriculture contributes a smaller proportion to GDP, indicating low productivity compared to other sectors. Government initiatives like PM-KISAN, MSP (Minimum Support Price), and rural development schemes aim to improve farmers' incomes.

Key Challenges include low productivity compared to global standards, fragmented land holdings, reliance on monsoons, limited mechanization, and price volatility affecting farmer earnings.

Table 2.1: Comparison of Agriculture Workforce of Major Economies, CY2023

Country	% of the workforce in agriculture	% of GDP Contribution in agriculture (Range)	Remarks
India	43 -45%	15 -18%	High Employment and Low Productivity
China	24 -26%	7 -8%	Higher Mechanization and Government support
USA	~1.5 -2%	1%	Highly mechanized, extremely productive
Brazil	9 -10%	5 -6%	Large sector with high exports
Germany	~1%	~0.8%	Advanced Agritech

Source: World Bank, Statista, Frost & Sullivan

India's agriculture sector employs a significant portion of the population but lags in productivity compared to major economies. To improve productivity, India should focus on mechanization, modern farming techniques, improved market access, and rural industrialization.

Table 2.2: Comparison of Agriculture GDP of Major Economies, CY2023

Country	Agriculture share of GDP%
India	16.0%
Indonesia	12.53%
China	7.12%
Brazil	6.24%
Turkey	6.16%
Argentina	5.93%

Source: World Bank, Statista, Frost & Sullivan

Agriculture's share in the global GDP has decreased to about 4% in recent years, with India's sector still accounting for a larger portion of its GDP. In contrast, the United States, Western European countries, and emerging economies like China have seen a decline in agriculture's share due to rapid industrialization. China's agriculture accounts for 7.12% of its GDP in 2023. In absolute terms, it is one of the largest agricultural producers globally.

2.8. Key schemes focusing on agriculture

Key schemes by the Government include the Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Rashtriya Krishi Vikas Yojana (RKVY), Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM), and Agriculture Infrastructure Fund (AIF)

Budget allocation for key government schemes:

A few critical agricultural sector initiatives taken by the Government are:

Rashtriya Krishi Vikas Yojana (RKVY) is designed to encourage states to increase public investment in agriculture and allied sectors, ensuring holistic development. It has seen significant budget allocations to promote sustainable agriculture and enhance food security in India.

Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiya (PM-KUSUM) aims to enhance the financial and water security of farmers by promoting the installation of solar pumps and grid-connected solar power plants. The PM-KUSUM scheme, launched in March 2019 and expanded in January 2024, aims to provide energy and water security to farmers, enhance their income, de-dieselize the farm sector, and reduce environmental pollution. The scheme comprises three components: installation of 10,000 MW of solar capacity through small solar power plants, installation of 20 lakh standalone solar-powered agriculture pumps, and solarization of 15 lakh grid-connected agriculture pumps. However, the scheme faces challenges such as land availability, affordable financing, and delays in state fund disbursements. To address these issues, the government issued revised guidelines in January 2024 and included all components under the Agricultural Infrastructure Fund.

Agriculture Infrastructure Fund (AIF): Operating from 2020-21 to 2032-33, the AIF offers a 3% interest subvention and credit guarantee support for post-harvest management infrastructure and community farm assets. With ₹1 lakh crore allocated until 2025-26, the scheme has sanctioned ₹13,681 crore for over 18,133 projects.

The Pradhan Mantri Krishi Sinchai Yojana (PMKSY) aims to enhance farm productivity by expanding cultivable areas under assured irrigation, improving on-farm water use efficiency, and promoting water-saving technologies. Launched in 2015, it has been extended for 2021-2026, with a total allocation of ₹93,068.56 crore. The scheme includes components like the Accelerated Irrigation Benefit Program, PDMC, and Watershed Development.

2.9. Challenges in the Growth of Agriculture in India

Agriculture in India is a significant sector, employing nearly half of the workforce. However, it faces several challenges, particularly in electricity supply.

Key factors impacting Agriculture:

1) Unreliable and irregular power supply disrupts irrigation schedules and affects crop yields.
2) Limited rural electrification limits mechanization in remote areas.
3) Heavily subsidized agricultural electricity tariffs strain DISCOM finances, resulting in revenue losses, delayed infrastructure upgrades, and increasing uncertainty in rural power reliability.
4) Dependence on subsidies often leads to the overuse of groundwater due to excessive pumping. Uncontrolled access to electricity for tube wells causes severe groundwater depletion.

5) Lack of infrastructure and modernization, such as outdated transmission lines and transformers, causes power losses and inefficiencies.

6) Slow adoption of renewable energy, such as solar-powered irrigation pumps, is slow due to high initial costs.

7) Electrification and power supply quality vary considerably across Indian states — for instance, Punjab offers a relatively reliable agricultural power supply, while states like Bihar, Jharkhand, and those in the North-East continue to face significant gaps in both coverage and quality

To address these challenges, potential solutions include improving rural grid infrastructure, promoting smart metering and energy pricing, expanding solar-based irrigation systems, and ensuring timely subsidies and better financial health of DISCOMs. Addressing these electricity-related challenges will significantly improve agricultural productivity and sustainability in India.

2.10. India – Growing Focus on Clean Energy and Sustainability

India is focusing on reducing its reliance on fossil fuels through various strategies. These include expanding its renewable energy capacity, improving energy efficiency through initiatives like the Perform, Achieve and Trade scheme and Energy Conservation Building Code, diversifying energy sources through clean and low-carbon technologies like electric vehicles, green hydrogen, and clean cooking solutions, and promoting afforestation and reforestation. India also plans to adopt electric vehicles on a large scale, with policies promoting production, charging infrastructure, and incentives for consumers.

However, India faces challenges such as a growing population, rapid urbanization, and reliance on coal for energy. To balance development with climate goals, India emphasizes the need for finance and technology transfer from developed countries, climate-resilient agriculture and adaptation strategies, and international cooperation to address the disproportionate impact of climate change on developing nations. India's commitment to the Kyoto Protocol and Paris Agreement reflects its role as a major developing nation in global climate governance.

India’s Key Initiatives for Carbon Footprint Reduction

India is embracing solar energy-based irrigation and rooftop electricity generation to reduce carbon footprints and transition towards sustainable energy solutions.

India has approximately 17.5 lakh sq. km of arable land, the largest in the world. Much of this land relies on groundwater pumps for irrigation, primarily powered by the electricity grid or diesel. Transitioning to solar-powered irrigation, through solar pumps and drip irrigation systems, can support the country’s climate goals while providing farmers with accessible and cost-effective energy solutions. In line with this vision, the government launched the PM-KUSUM scheme, aiming to add 34.8 GW of solar power capacity by FY2026, backed by ₹34,400 crore in central financial assistance.

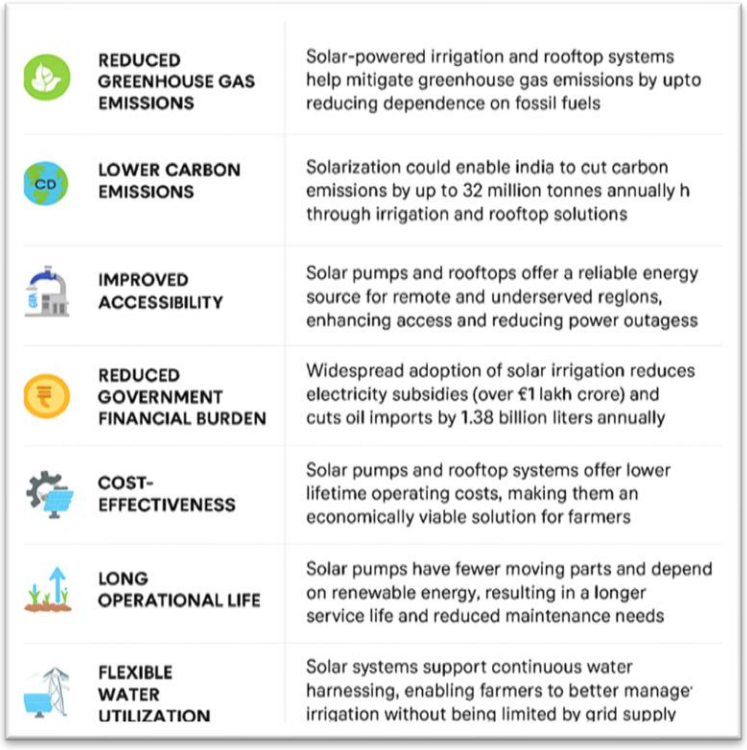
Solar Energy-Based Irrigation

Traditional irrigation systems in India rely on diesel-powered pumps and grid electricity, leading to high costs, inefficiency, and environmental damage. Solar-powered irrigation systems offer a sustainable alternative, reducing diesel and grid electricity dependency. The National Mission on Solar Irrigation (PM-KUSUM) scheme aims to provide solar pumps to farmers, encouraging solar energy adoption in rural areas. Benefits include cost reduction, sustainability, and energy independence, as solar power reduces carbon emissions and environmental pollution, reducing farmers' dependence on expensive fossil fuels or unreliable grid power.

Rooftop Solar Electricity Generation

India has significant potential for rooftop solar energy generation due to its high sunlight levels. By installing solar panels, individuals, businesses, and institutions can generate their electricity, reducing their reliance on grid power. The Indian government has introduced various incentives to promote rooftop solar installations, such as subsidies under the National Solar Mission. Net metering allows homeowners and businesses to sell excess power back to the grid, making it a viable investment. Benefits include energy savings, grid stability, and reduced carbon emissions compared to conventional power generation.

Advantages of Solarization of Irrigation and Rooftops



Rooftop solar is an emission-free, cost-effective energy solution that supports India’s climate goals. It can reduce electricity bills by up to 50%, with households saving ₹15,000–18,000 annually and businesses over ₹2 crore. The PM-Surya Ghar: Muft Bijli Yojana aims to provide free electricity (300 units/month) to 10

million homes. With a lifespan of over 25 years, minimal maintenance, and no moving parts, rooftop solar is ideal for both urban and remote communities. GOI plans to integrate power generation with storage, scale residential BESS, and build a strong market ecosystem.

India aims to achieve 500 GW of non-fossil fuel capacity by 2030, with a significant portion coming from solar energy, to reduce its dependence on coal and other carbon-intensive energy sources.

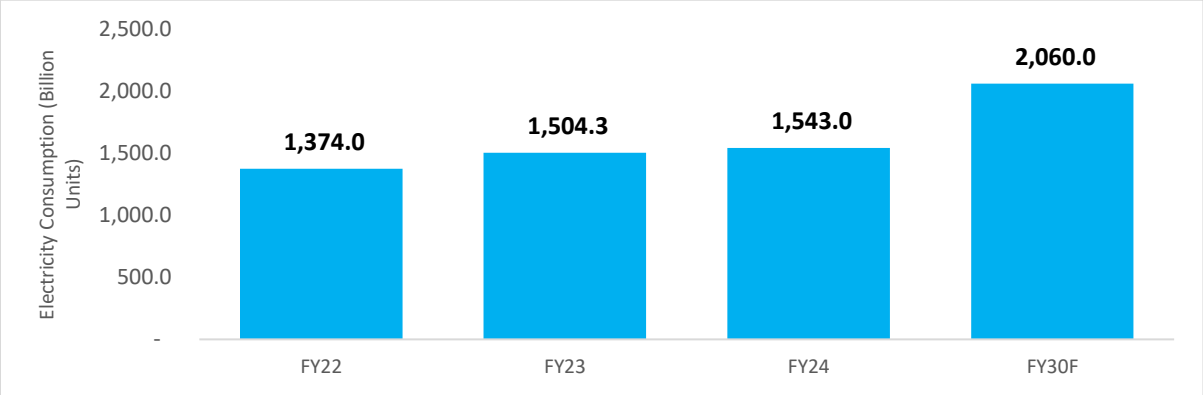
2.11. Overview of India's Power Consumption Trends

The global power demand is expected to rise at a faster rate, an average of 3.4% annually, through 2026. India is expected to experience the fastest growth in global electricity demand through 2026. This growth is driven by strong economic activity and expanding air conditioner ownership. India's electricity demand is expected to be equivalent to the UK's consumption over the next three years. Renewables are expected to meet half of this growth, while one-third will come from rising coal-fired generation.

2.11.1. Total Power Consumption in India

India's power consumption has seen a significant increase in the past two decades, primarily due to economic expansion, population growth, and urbanization. India's power consumption has seen substantial growth in recent years, with projections indicating continued rises through 2030 due to economic development, industrialization, and increased electrification. From 2023-24 to 2029-30, the CAGR of the electrical energy requirement is expected to be 4.9%.

Exhibit 2.5: Total Power Consumption, India, FY2022 to FY2024 to FY2030

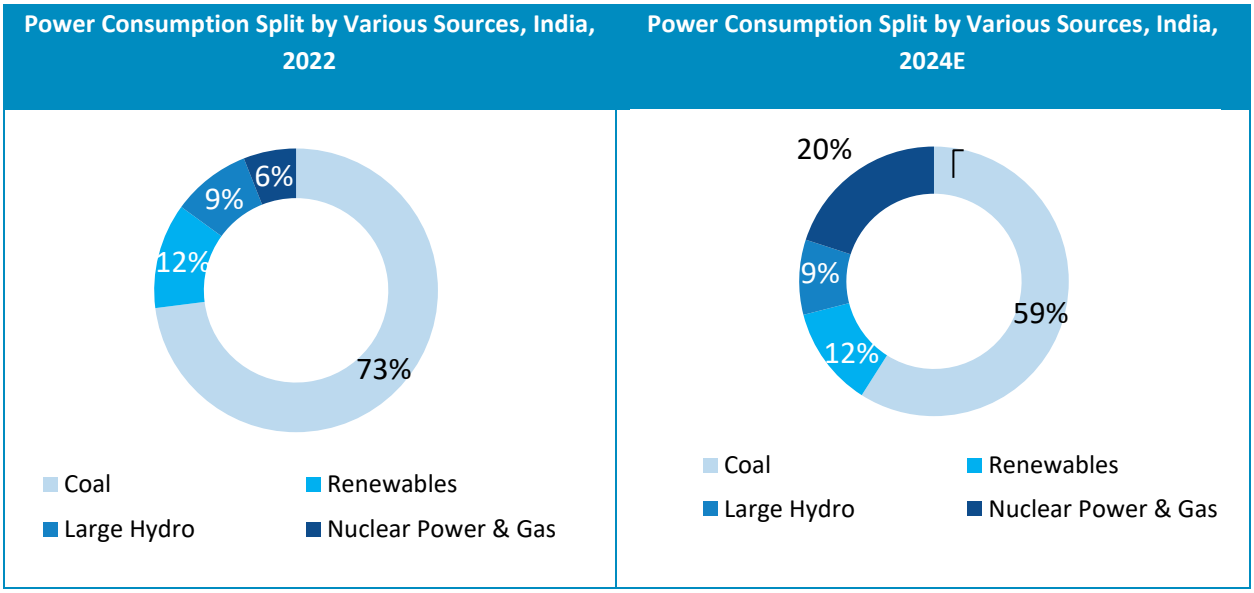


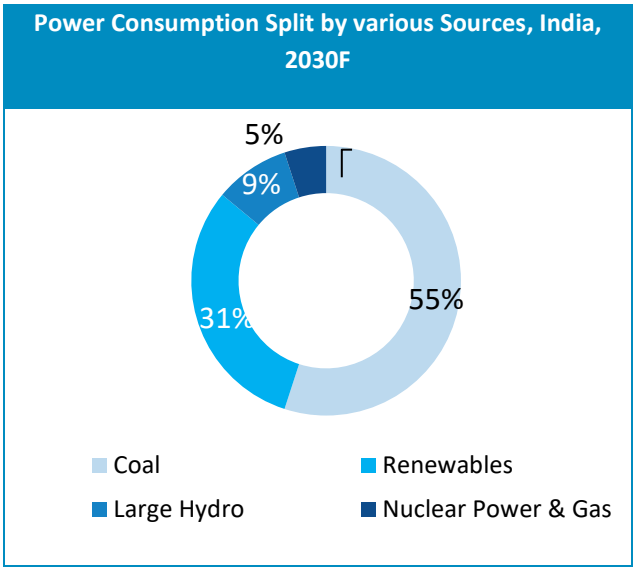
Note: F: Forecast *Source: beeindia.gov.in, CEA, Frost & Sullivan*

India's power demand is expected to rise by 5% annually from 2018 to 2040, driven by economic growth, urbanization, and increased adoption of energy-intensive technologies like air conditioning and electric vehicles. Key drivers of increased energy demand include India's expanding economy, population growth, technological adoption, government policies aimed at improving energy access and promoting economic development, and climate change, which can lead to increased use of cooling systems and higher electricity demand.

2.11.2. India - Power Consumption Split by Various Sources

Exhibit 2.6: Power Consumption Split by various Sources, India, FY2022 to FY2024 to FY2030





Note: Renewables include Solar, Wind, Biomass and Small Hydro Source: Business Standard, iced. niti, Frost & Sullivan

India's power generation has primarily relied on coal, but there is a growing trend towards renewable energy sources. The projections show a significant increase in renewable energy capacity, with solar and wind energy expected to quadruple by 2030. However, coal's absolute generation is predicted to rise by 13% between 2023 and 2030 due to increasing power demand.

2.11.3. India - Power Consumption Split by Grid vs off-Grid

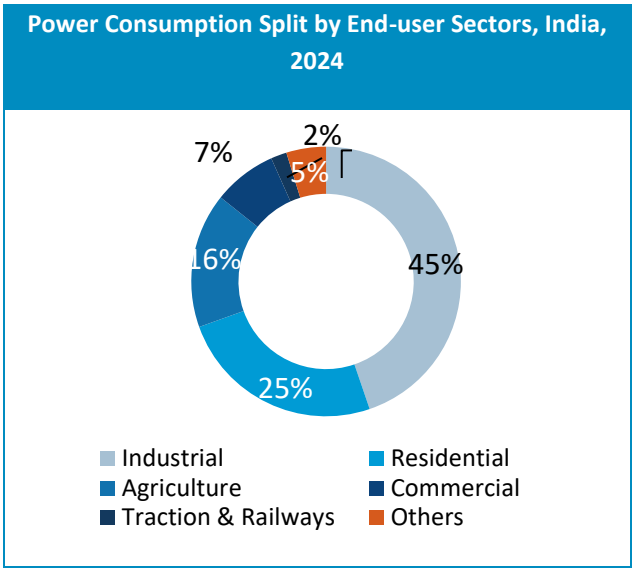
India's majority of households (87%) have grid-connect electricity access, while 13% use non-grid sources or do not use electricity at all. 62% of non-grid customers are agricultural, with only 4% of households

currently lacking access to grid-based electricity. India's electricity consumption is primarily supplied by the central grid, with off-grid sources like solar home systems, microgrids, and diesel generators playing a secondary role in remote and rural areas. The country's energy landscape is constantly evolving, promoting renewable energy adoption.

India aims to increase its renewable energy capacity to 500 GW by 2030.

2.11.4. India - Power Consumption Split by End-user Sectors

Exhibit 2.7: Power Consumption Split by End-user Sectors, India, FY2024



Source: Mospi, CEA, Frost & Sullivan

The industrial sector is expected to lead in electricity consumption, with significant growth in residential and commercial segments. Emerging industries like electric vehicles and data centers are also expected to contribute significantly. In 2030's the Industrial sector is expected to contribute a significant market share.

2.12. India – Irrigation Pumps led by coal and Diesel Sources

India is the largest user of irrigation pumps globally, operating approximately 32 million pumps powered by a mix of grid electricity, diesel, and solar energy. Agricultural irrigation pumps account for nearly 25% of the country's total electricity consumption, utilize around 85 million tons of coal annually, and consume about 12% of India's total diesel usage equivalent to over 5.52 billion liters each year.

After transportation, agriculture is India's second most significant consumer of diesel. Among 32 million conventional agricultural pumps in India, ten million run on diesel. As a result, harnessing solar energy for irrigation is critical to achieving 'diesel-free' farms. Ministry of Power announced plans to eliminate diesel in the agriculture sector by transitioning to renewable energy. The announcement is consistent with India's objective of reaching net zero by 2070. It will also lower India's crude oil imports, which totaled USD 132.4 billion in fiscal year 2023-24.

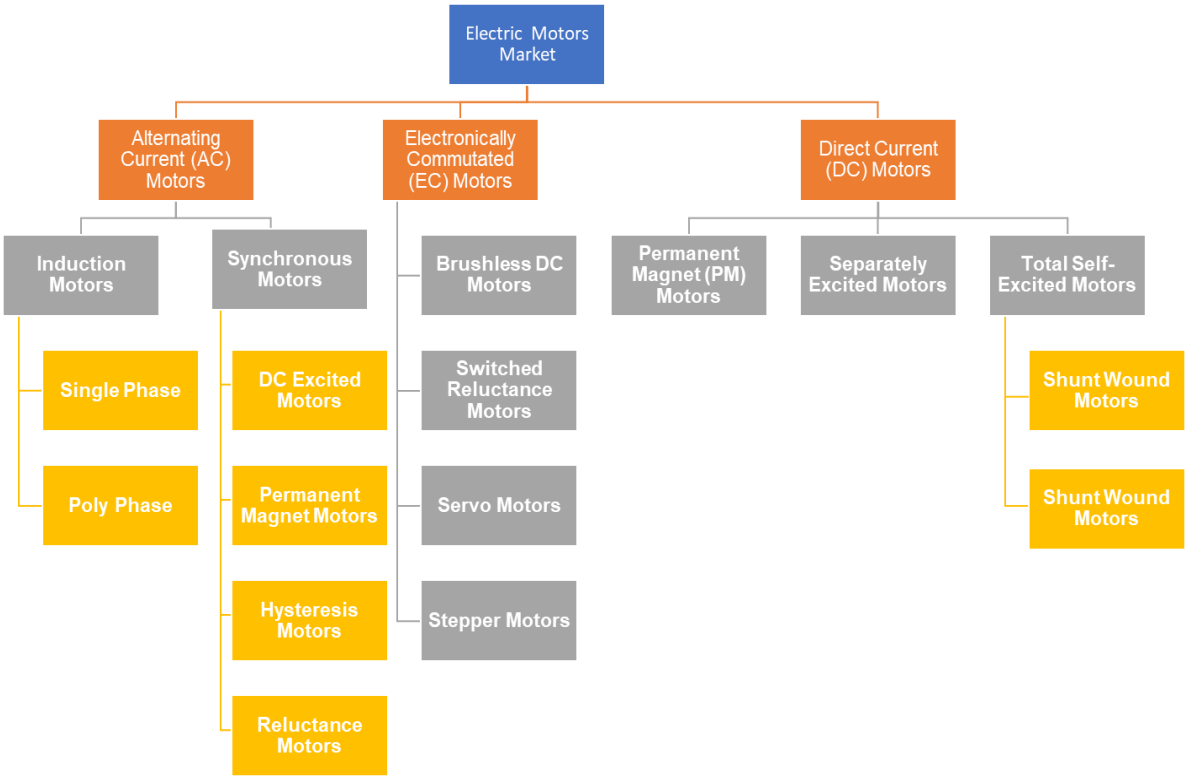
Global and Domestic Industrial Electric Motors Market

3.1. Global Industrial Electric Motors – Overview

Electric motors are essential components of many industries, powering machinery and systems in manufacturing, transportation, energy, and automation. These motors transform electrical energy into mechanical motion and are available in various configurations, including AC motors, DC motors, and servo motors, each tailored for a specific industrial application. The global industrial electric motor market has grown significantly, due to increased industrial automation, rising need for energy-efficient solutions, and the expansion of manufacturing sectors globally. The global industrial electric motor market is predicted to expand further due to technical developments, rising demand for smart motors, and ongoing investment in automation and renewable energy. The transition to Industry 4.0, the Internet of Things (IoT), and AI-powered industrial solutions will improve motor efficiency and performance.

3.1.1. Description of Various Types of Electric Motors

Exhibit 3.1: Global Industrial Electric Motors Market, Product Classification



Source: Frost & Sullivan Analysis

A) Alternating Current (AC) Motors

Alternating Current (AC) Motors—An AC motor is an electric motor that uses alternating current (AC) to produce mechanical power. It works by converting the electrical energy from AC into rotational mechanical energy through the principles of electromagnetic induction.

1) Induction Motors/ Asynchronous Motors

Induction motors, also known as **asynchronous motors**, are widely used in industrial and commercial applications due to their robustness, efficiency, and simple construction. They operate on the principle of electromagnetic induction, where the current required to produce torque is induced in the rotor rather than supplied externally.

Types of Induction Motors and their applications

Single Phase – Sub types: Shaded Pole, Permanent Capacitor, Resistant start, etc.

Applications*:* household appliances, industrial machinery, and small farming tools.

Poly Phase – Sub types: Squirrel Cage, Wound rotor (Slip Ring)

Applications: squirrel-cage induction motors are widely used as industrial drives. Wound rotors are used in Heavy machinery, Power plants, Industrial facilities, etc.

Unbalanced/Vibratory Motors

AC Vibratory Motors are three-phase or single-phase induction motors used in heavy-duty industrial machinery like feeders, screens, and compactors. DC Vibratory Motors are used in small-scale applications like mobile phones, medical devices, and automotive seats, running on low-voltage DC power and offering easier control over speed and vibration intensity.

2) Synchronous Motors

A **synchronous motor** is an AC electric motor in which the rotation of the rotor is synchronized with the frequency of the supply current. This means that the rotor's speed remains constant and matches the speed of the rotating magnetic field generated by the stator.

Types of Synchronous Motors and their applications

a) Non-Excited Synchronous Motors

b) DC Excited Synchronous Motors

Non-Excited Synchronous Motors - These motors use external magnetic fields to magnetize a steel rotor, achieving synchronization without additional electrical excitation.

Permanent Magnet Synchronous Motors (PMSM): It uses permanent magnets embedded in or attached to the rotor to create a constant magnetic field. Unlike induction motors, which rely on induced currents in the rotor, PMSMs achieve synchronous speed without slip, making them highly efficient and precise.

Key application areas**:** Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs), Industrial Automation & Robotics, HVAC Systems (Heating, Ventilation, and Air Conditioning), Wind Energy and Renewable Energy Systems, CNC Machines and Servo Drives, Aerospace & Marine Applications. It is also used in super-efficient IE5/IE6 industrial applications which demand motors with superior efficiency.

Hysteresis and Reluctance Motors: Types of non-excited synchronous motors that use different principles (hysteresis losses and magnetic reluctance) to achieve and maintain synchronous speed. Hysteresis and reluctance motors find application in various areas, including industrial automation, electric vehicles, HVAC systems, and household appliances.

DC Excited Synchronous Motor -These motors need a DC supply to the rotor windings to generate the magnetic field and often use damper windings to start as induction motors before reaching synchronous speed.

B) Electronically Commutated (EC) Motors

EC Motors – They are synchronous motors powered by direct current (DC) electricity and controlled by electronic circuits, eliminating the need for mechanical commutators and brushes. This design enhances efficiency, reliability, and longevity. It is used in HVAC Systems (fans, blowers), Home appliances, and the Automotive Industry.

1) Brushless DC Motors (BLDC)

It is powered by a direct current (DC) electric power supply. Unlike traditional brushed motors that use mechanical brushes and a commutator, BLDC motors utilize an electronic controller to switch DC currents to the motor windings, producing magnetic fields that effectively rotate in space and which the permanent magnet rotor follows.

Applications: Automotive (Electric vehicles, cooling fans, power steering systems), Aerospace (Drones, UAVs), Home appliances (Washing machines, AC), handheld power tools (Drills, Cordless tools)

2) Servo & Stepper Motors

Servo motors and stepper motors are both widely used in applications requiring precise control of motion. Servo motors are those with either AC input or DC input that have a position feedback circuit consisting of a sensor and encoder; this feedback circuit allows precise motion and position control. Stepper motors are motors that rotate in discrete steps.

Servo Motor Applications: Servo motors are utilized in applications demanding high speed, high torque, and precise control. Ex. Industrial automation, Robotics, Aerospace, Renewable energy, etc.

Stepper Motor Applications: Stepper motors are favored for their ability to provide precise positioning and repeatable movements without the need for feedback systems. E.g., Textile Machinery, Robotics, CNC Machines, Medical Equipment, Printing equipment.

3) Switched Reluctance motor

An electric motor like an SRM (switched reluctance motor) runs through reluctance torque. Different from the types of common brushed DC motor, power can be transmitted to windings within the stator instead of the rotor. It is widely used in textile machinery like towel looms, rapier looms, electric vehicles, Oilfield machinery like beam pumps, vertical pumps, well testing machinery, etc.

C) Direct Current (DC) Motors

Direct Current (DC) Motors—A direct current (DC) motor is a type of electric machine that converts electrical energy into mechanical energy. DC motors take electrical power through direct current and convert this energy into mechanical rotation

1) A Permanent Magnet DC (PMDC) motor is a type of direct current motor that utilizes permanent magnets to create the magnetic field required for its operation, eliminating the need for field windings.

Applications: Automotive Systems (windshield wipers, electric windows, and seat adjusters), Household Appliances (vacuum cleaners and electric toothbrushes), Industrial Equipment (such as conveyor belts, small robotics, scubbers, and AGVs), portable battery-powered tools, battery-operated appliances and equipment.

2) A **separately excited motor** is a type of **DC motor** where the field winding is powered by a separate external source rather than being connected to the armature circuit. This allows independent control of the field current and armature current, making it highly flexible for applications requiring precise speed and torque control.

Applications: Electric Vehicles, Industrial machinery, Electric Traction systems, Variable speed drives

3) A **self-excited DC motor** is a type of **DC motor** in which the same source powers the field winding as the armature winding. This means the field coils are "self-excited" rather than being separately powered. Three types are motor shunt wound, Series wound, and Compound wound.

Applications: Lathes, Conveyors, Blowers, Electric Trains, Cranes, Elevators, Rolling Mills

3.2. Key Growth Drivers – Global Industrial Electric Motors Market

A) Increased Focus on Energy Efficiency: The global motors market is significantly driven by the increasing emphasis on energy efficiency. Governments and regulatory bodies worldwide are implementing stringent energy consumption standards and regulations to reduce environmental impact. This trend is pushing manufacturers to innovate and produce high-efficiency motors that can operate at lower energy costs without sacrificing performance.

B) Rapid Industrialization and Urbanization: As emerging economies continue to industrialize and urbanize, the demand for motors in infrastructure development, manufacturing, and consumer products is growing. This is especially evident in regions like Asia-Pacific, which is witnessing substantial economic growth and development activities.

C) Technological Advancements in Motor Design: Technological innovations such as the development of ultra-efficient motor drives and the integration of IoT (Internet of Things) capabilities into motor systems are pivotal growth drivers. These advancements enable precise control and monitoring of motor operations, leading to better performance, and reduced downtime, and maintenance costs.

D) Growth in Renewable Energy Installations: The expansion of renewable energy sources, such as wind and solar, necessitates the use of high-performance motors for energy generation and distribution systems. The shift towards greener sources of energy is fostering the development of new motor technologies that are compatible with renewable energy applications.

E) Automotive Electrification: The surge in electric vehicle production is a critical driver for the motors market. Motors are essential for electric vehicles, from propulsion to controlling various functions. As the automotive industry moves towards electrification, the demand for highly efficient and reliable motors is expected to increase dramatically.

F) Energy-Efficient Motors for Manufacturing: The aerospace industry is experiencing a shift towards electric propulsion and hybrid-electric aircraft, increasing the demand for high-efficiency motors. High-performance motors are needed for giga factories and assembly lines in manufacturing. The textile industry is experiencing a surge in demand for high-speed spinning and weaving machines, energy-efficient motors, automation and digitalization, and sustainability.

3.3. Threats and Challenges – Global Industrial Electric Motors Market

The worldwide industrial electric motors market faces many threats and challenges that could affect its growth and profitability.

Technological Disruptions and Alternative Innovations - Advancements in solid-state motors, smart motor technologies, variable frequency drives (VFDs), and other energy-efficient systems are rapidly evolving. These innovations could render traditional electric motors obsolete, pressuring manufacturers to invest heavily in R&D to stay relevant. Additionally, the rise of IoT-enabled smart motors introduces cybersecurity risks that must be proactively managed.

Competitive Pressure from Low-Cost and Emerging Alternatives - Established brands face pricing pressure from low-cost manufacturers offering cost-efficient alternatives. Simultaneously, the growing preference for renewable energy systems and advanced motor technologies is shifting market demand away from traditional motor solutions, further intensifying competition.

Increasing Regulatory and Environmental Compliance Burdens- Stricter energy efficiency norms, carbon emission mandates, and environmental regulations across global markets demand significant investment in product innovation, manufacturing upgrades, and retrofitting of existing systems. While these regulations promote sustainability, they also increase compliance costs and pose challenges to profitability and timely product adoption.

3.4. Global Industrial Electric Motors – Key Industry Trends across End-user Segments

Advancements in technology, energy efficiency regulations, and evolving industry demands drive the evolution of industrial electric motors. Industry-specific customization, such as explosion-proof motors for oil & gas and lightweight motors for electric vehicles, is on the rise. Electrification trends in mining, automotive, and renewables are boosting demand for industrial electric motors.

Automotive: The rise of electric vehicles (EVs) is driving the adoption of high-efficiency electric motors, particularly PMSMs and induction motors. Automakers are also focusing on lightweight, high-torque-density motors to enhance vehicle efficiency. Advances in motor controllers and battery management systems are also improving performance.

Industrial Machinery: The global energy standards, driven by stricter regulations, are replacing conventional motors with high-efficiency models. Governments are focusing on energy efficiency by enforcing IE3 and IE4 efficiency standards, which is driving a surge in demand for high-efficiency motors. The utilization of servo and stepper motors is on the rise in robotics and CNC machinery. Industry 4.0 is promoting IoT-enabled electric motors for predictive maintenance and automation.

Renewable Energy (Solar & Wind): The adoption of gearless wind turbine motors is increasing to attain higher efficiency, while solar-powered DC motors are expanding for solar water pumps and off-grid applications. However, grid integration challenges require variable frequency drives for power generation stability.

Oil & Gas: The demand for explosion-proof motors is increasing due to strict safety regulations in hazardous location applications. Companies are shifting towards electric motors in drilling and pumping applications to reduce diesel reliance.

Metals & Mining: Heavy-duty motors are increasingly being utilized for crushing, grinding, and conveyors due to their durability and high torque. The shift towards battery-electric and hybrid mining vehicles is being implemented to electrify mining equipment.

Aerospace and Defense: The defense sector is focusing on investing in advanced motor technologies for UAVs, drones, and hybrid-electric aircraft for lightweight and high-torque solutions.

Agriculture and Robotics: Electric motors are being increasingly used to replace traditional hydraulic and combustion-based systems in tractors, irrigation pumps, and harvesting equipment. AI-driven agricultural robots, equipped with electric motors, enhance efficiency in crop planting, harvesting, and health monitoring.

Other applications: Electric motors are essential in:

- Floor Care: Powering vacuum cleaners and polishers for efficient cleaning.
- Stairlift and Mobility: Driving stairlifts and wheelchairs for safe, independent movement.
- Material Handling: Enabling conveyors and forklifts for streamlined material transport.

3.5. Global Electric Motors – Key Product and Technology Trends

A) EC Motors

EC motors sales are expected to continue the upward growth trend. Increasing awareness about the need for energy-efficient motors and advantages such as noiseless operation will be the driving factors.

B) PMSM Motors

Sales of PMAC (Permanent Magnet AC) motors are expected to increase at the global level because of their advantages, such as high-power density and higher energy efficiency of synchronous motors. High-

torque and high-speed (>3,200 rpm) PMAC motors will be increasingly adopted. It is widely used in Electric vehicles, Robotics and CNC machines, Wind turbines, and HVAC systems.
IE5 Permanent Magnet Synchronous Motors (PMSMs) achieve top-tier efficiency with permanent magnet rotors, offering a compact, high-torque design and precise VFD control across a 0.37–315 kW range. They save up to 50% energy, reduce size and weight significantly, and ensure sustainability with low emissions and rare-earth-free options. With high torque, low noise, and reliable, low-maintenance operation, they excel in HVAC, pumps, fans, and automotive applications.

C) Variable-speed Motors

The adoption of variable-speed motors (with in-built drives to control) is likely to increase. The advantages of these motors such as ease of installation and programming will drive their growth, robust ingress protection (in harsh environments), and lesser space footprint.

D) Connected Motors

The adoption of connected motors (motors with embedded sensors to monitor condition parameters and analyze/ transmit the data) is expected to increase further, starting with proof-of-concept implementations.

Other Key Technology/ Industry Trends:

A) Growing Preference for New Age Motors: The preference for new-age industrial electric motors is increasing due to advancements in efficiency, sustainability, and smart technology. Key factors driving this trend include energy efficiency, smart and connected motors, the rise of electric vehicles (EVs), and e-mobility applications. Governments and industries are prioritizing energy-efficient motors to reduce power consumption, with ultra-premium efficiency technologies like IE4 and IE5 motors gaining traction. The rise of EVs is pushing R&D in high-performance electric motors, with a focus on lightweight, high-power-density motors for e-mobility applications. Growth in robotics, automation, and factory electrification fuel demand. Industrial applications and evolving sectors are also driving demand for advanced electric motors in HVAC, water treatment, and renewables.

B) Growing presence for integrated solutions — motor, gearbox, and controller VFD as an integrated product

The demand for integrated motion solutions, which combine a motor, gearbox, and variable frequency drive or controller, is on the rise. This single package simplifies installation and wiring, reducing compatibility issues. It also reduces space and weight, making it ideal for compact machinery and mobile applications. It also reduced downtime and improved reliability by reducing components and minimizing failure points, with some features including condition monitoring and predictive maintenance capabilities built into the system.

Market Adoption in Key Industries: Material Handling: Plug-and-play motion control is useful for AGVs, conveyors, and robots. Packaging and processing require compact, high-performance motion control in a fast-paced environment.

3.6. Global Industrial Electric Motors Analysis

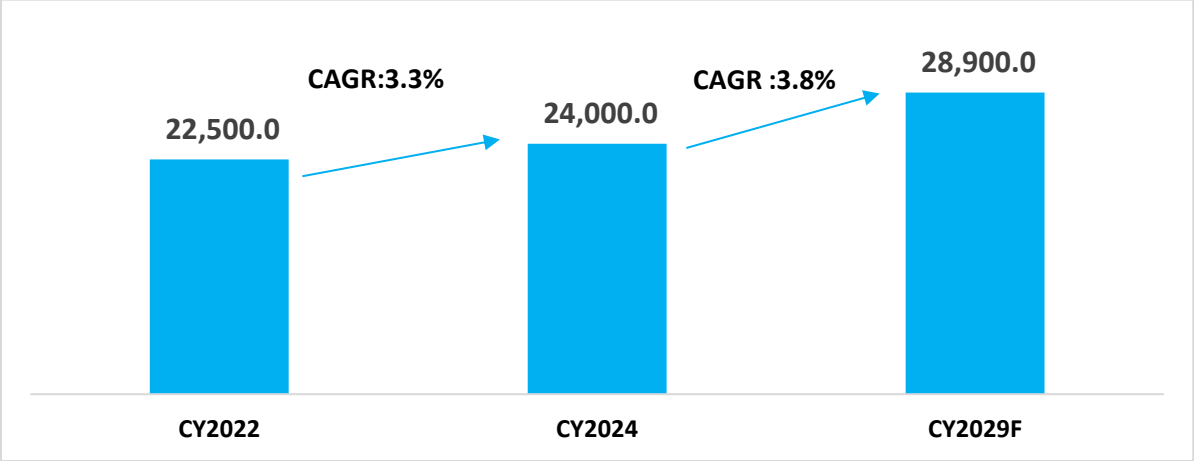
3.6.1. Industrial Electric Motors - Market Size and Growth Outlook

The global motors market is witnessing strong growth, fueled by significant technological advancements, increased industrial automation, and a rising emphasis on energy efficiency. As the motors market continues to evolve, several emerging trends are poised to shape its trajectory over the coming years. Incorporating AI and ML technologies in motor systems sets the stage for smart, self-diagnosing motors that can predict failures and optimize performance in real-time. This evolution is particularly significant in sectors that demand high reliability and operational efficiency, such as aerospace and industrial automation.

Developing new materials such as advanced composites and superconducting materials is expected to revolutionize motor efficiency and performance. These materials can significantly reduce the weight and energy consumption of motors while enhancing their power output and longevity.

The market was valued at US$24,000.0 million in CY2024, and it is projected to experience a compound annual growth rate (CAGR) of 3.8% over the forecast period, reaching US$28,900.0 by CY2029.

Exhibit 3.2: Global Industrial Electric Motors, CY2022 - CY2024- CY2029F, USD Million



Source: Frost & Sullivan Analysis

The increasing adoption of automation in industries like manufacturing, automotive, and electronics is driving the demand for electric motors. Governments and regulatory bodies are enforcing stricter energy efficiency standards, encouraging industries to switch to high-efficiency electric motors. Advancements in motor technologies, such as IoT-enabled motors, enhance performance and adoption. The growth of robotics and industrial equipment is driving demand for reliable electric motors. Industries are moving towards lightweight and compact motors with high power output. The adoption of Industry 4.0 and smart manufacturing processes is pushing demand for intelligent and connected electric motors.

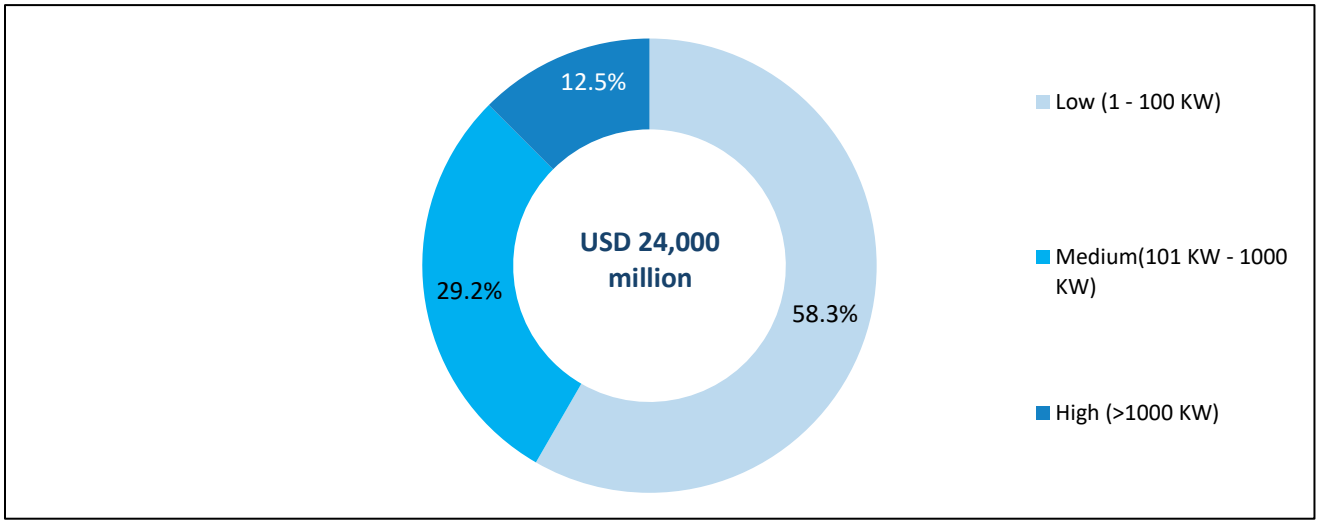
3.6.2. Global Industrial Electric Motors - Market Split by Power Rating

Low-power motors (1-100 KW) are integral to a myriad of sectors, marking their dominance by occupying 58.3% of the global motors market share with a revenue of US$ 14,000.0 million. In the industrial sector, these motors drive the functionality of machines, small pumps, and conveyors—applications that demand

reliability and consistent performance at lower operational voltages. In commercial and residential buildings, low-power motors are primarily utilized in HVAC systems, elevators, and other building services where safety and energy efficiency are paramount. The automotive industry relies on low-power motors for various manufacturing processes, particularly in assembly lines where precision and control are crucial.

Medium-power (101-1000 KW) and High-Power motors (> 1000 kW), although smaller in market share, are essential in sectors requiring high power outputs and robust motor solutions. Medium Power motors, which account for 29.2% of the market with revenues amounting to US$ 7,000.0 million, are predominantly used in demanding industrial environments such as oil and gas, where they power offshore drilling rigs and refinery processes. They are also vital in water and wastewater treatment facilities and mining operations, driving large pumps, blowers, and heavy-duty machinery necessary for extracting and processing minerals.

Exhibit 3.3: Global Industrial Electric Motors, Split by Power Rating, CY2024, USD Million

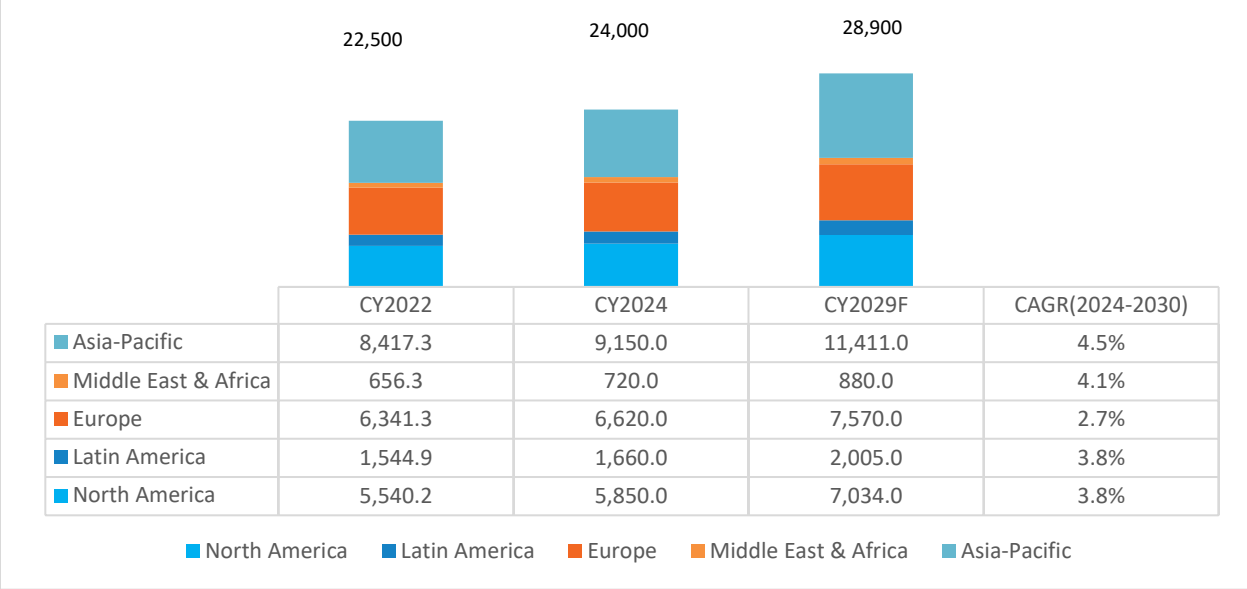


Source: Frost & Sullivan Analysis

High-power (HT) motors, making up 12.5% of the market, are crucial in power generation and heavy manufacturing. They operate within power plants—including coal, hydroelectric, and nuclear facilities—and drive large-scale infrastructure projects, such as steel mills and large water pumps for flood control and irrigation. Together, Medium and high-power motors are pivotal in applications where durability, high torque, and the capacity to handle large-scale operations are indispensable.

3.6.3. Global Industrial Electric Motors - Market Size by Regions

Exhibit 3.4: Global Industrial Electric Motors, Market Split by Regions, CY2022 - CY2024- CY2029F, USD Million



	CY2022	CY2024	CY2029F	CAGR(2024-2030)
Asia-Pacific	8,417.3	9,150.0	11,411.0	4.5%
Middle East & Africa	656.3	720.0	880.0	4.1%
Europe	6,341.3	6,620.0	7,570.0	2.7%
Latin America	1,544.9	1,660.0	2,005.0	3.8%
North America	5,540.2	5,850.0	7,034.0	3.8%

Source: Frost & Sullivan Analysis

The Asia-Pacific region is emerging as the most promising market for motors, driven by rapid industrialization and urbanization. Countries like China and India are leading this growth, with substantial investments in infrastructure development and manufacturing. The region's commitment to energy efficiency and the increasing adoption of electric vehicles further contribute to the high demand for motors.

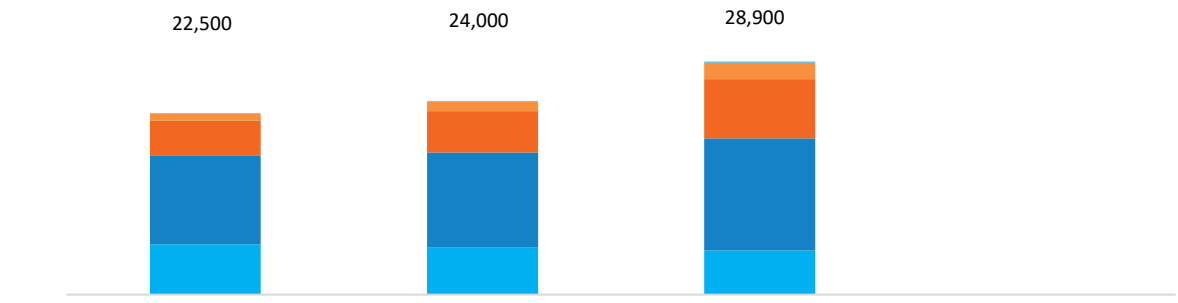
Additionally, North America and Europe continue to show robust growth, supported by advancements in automotive technologies and the renewable energy sector. These regions are also seeing a surge in the adoption of smart motors, which are equipped with sensors and connectivity technologies that enable predictive maintenance and enhanced operational efficiency.

3.6.4. Global Industrial Electric Motors - Market Size by Motor Efficiency (by Value)

IE2

The market for IE2 motors is declining due to the increased adoption of energy-efficient models like IE3, IE4, and IE5, driven by stricter energy efficiency regulations and the push for more sustainable solutions. Governments often provide subsidies, tax benefits, or incentives for upgrading to IE3 or IE4 motors, making IE2 motors less appealing. The EU's Eco-design Regulation 2019/1781 mandates IE3 or higher motors for new industrial vehicles, phasing out IE2 models; similar policies are in place in the US and China.

Exhibit 3.5: Global Industrial Electric Motors, Market Split by Motor Efficiency, CY2022 - CY2024- CY2029F, USD Million



	CY2022	CY2024	CY2029F	CAGR(2024-2029)
IE6	22.5	48.0	173.4	29.3%
IE5	900.0	1,200.0	2,023.0	11.0%
IE4	4,297.5	5,112.0	7,340.6	7.5%
IE3	11,025.0	11,760.0	13,872.0	3.4%
IE2	6,255.0	5,880.0	5,491.0	-1.4%

Source: Frost & Sullivan Analysis

IE3, IE4, IE5

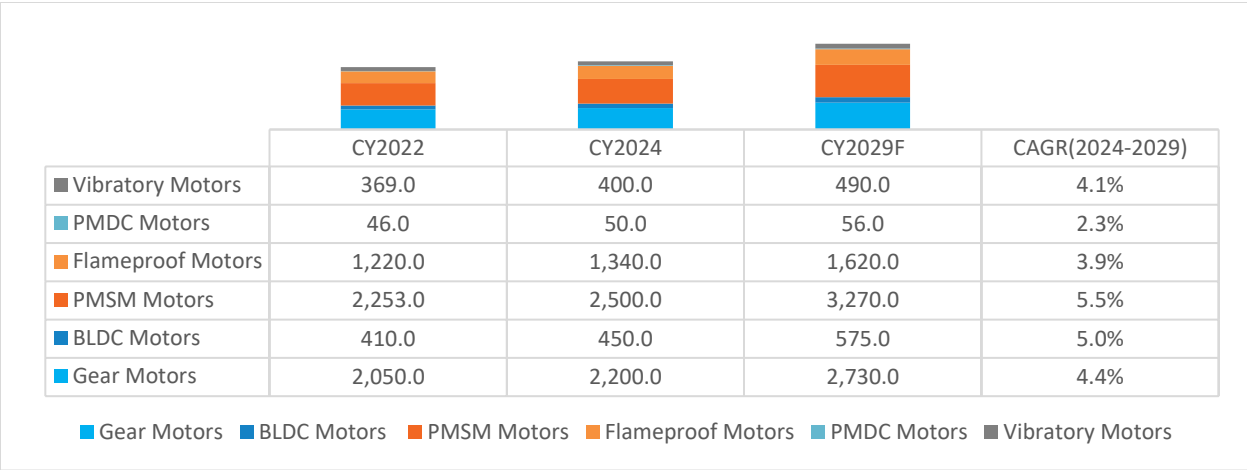
The EU, US, and India are implementing higher energy efficiency requirements, with IE3 and IE4 motors becoming the standard in industrial applications. Advancements in permanent magnet synchronous motors, synchronous reluctance motors, and high-efficiency induction motors are enhancing the availability and viability of IE4 motors. They are beneficial in HVAC systems, pumps, compressors, and conveyor systems. IE5 motors are gaining popularity due to their ultra-premium efficiency, helping industries reduce energy consumption and meet environmental regulations.

IE6

IE6 motors are advancing in energy-efficient technology, aiming for ultra-high-efficiency solutions. As industries prioritize sustainability and cost savings, they will play a crucial role in reducing global energy consumption in the next 5 years.

3.6.5. Global Industrial Electric Motors - Market Size by Specific Type of Motors (by Value)

Exhibit 3.6: Market Split by Specific Motor Types, CY2022 - CY2024- CY2029F, USD Million



	CY2022	CY2024	CY2029F	CAGR(2024-2029)
Vibratory Motors	369.0	400.0	490.0	4.1%
PMDC Motors	46.0	50.0	56.0	2.3%
Flameproof Motors	1,220.0	1,340.0	1,620.0	3.9%
PMSM Motors	2,253.0	2,500.0	3,270.0	5.5%
BLDC Motors	410.0	450.0	575.0	5.0%
Gear Motors	2,050.0	2,200.0	2,730.0	4.4%

Source: Frost & Sullivan Analysis

The growth potential of motor types depends on factors like industry demand, technological advancements, regulatory trends, and electrification efforts. BLDC and PMSM motors are experiencing high growth due to the increasing adoption of EVs, automation, and electrification. Gear and vibratory motors have medium growth, driven by steady demand in industrial automation and material handling. PMDC and flameproof motors face low growth due to efficiency concerns and regulatory constraints, limiting their expansion.

3.7. India Industrial Electric Motors Analysis

Key Growth Drivers:

1. **Industrial Automation and Industry 4.0 Adoption**
   The Indian industrial landscape is undergoing a significant transformation with the increasing adoption of automation and smart manufacturing practices. Sectors like automotive, steel, cement, FMCG, and textiles are integrating automated machinery and robotics, all of which rely heavily on electric motors. The push towards Industry 4.0 is also fueling the demand for high-efficiency motors (IE2, IE3, and IE4), which offer improved performance, better control, and energy savings.
2. **Government Initiatives and Infrastructure Growth**
   Policies such as “Make in India,” the Production Linked Incentive (PLI) schemes, and massive infrastructure investments are driving the establishment of new industrial units across the country. Projects related to smart cities, metro networks, industrial corridors, and logistics hubs are boosting demand for electric motors used in HVAC systems, pumps, conveyors, and material handling equipment.
3. **Rising Focus on Energy Efficiency**
   The Indian government, through the Bureau of Energy Efficiency (BEE), is encouraging the adoption of energy-efficient motors to reduce industrial power consumption. As a result, industries are gradually replacing outdated motors with IE-rated efficient models to meet regulatory standards and cut operating costs. This shift is expected to create a sustained demand for premium-grade motors in the coming years.

4. **Urbanization and Construction Boom**

Rapid urban development is pushing the demand for motors used in elevators, escalators, HVAC systems, and water supply mechanisms in commercial and residential buildings. With growing construction activity in metros, airports, and housing developments, the demand for electric motors is expected to remain strong.

5. **Growth of Renewable Energy and Electric Vehicles (EVs)**
   Electric motors play a key role in renewable energy installations such as wind turbines and solar trackers. Additionally, as India expands its EV infrastructure, there is increasing demand for motors in EV chargers, traction systems, and auxiliary applications. Local manufacturing of EV components is also adding momentum to the motor manufacturing sector.
6. **Export Opportunities and Localization**
   India is becoming a favorable destination for global OEMs seeking cost-effective motor suppliers. As domestic manufacturers scale up, the country is emerging as a reliable exporter of industrial motors. Simultaneously, efforts to localize motor production are reducing dependency on imports and enhancing competitiveness.

Threats and Challenges

1. Price Sensitivity of the Indian Market -Many Indian buyers, especially SMEs, focus on upfront cost rather than long-term efficiency, slowing the adoption of high-efficiency motors and limiting demand for premium models.
2. Fragmented and Unorganized Industry -The market is crowded with unorganized players offering low-cost, low-quality products, affecting the overall perception of domestic brands and challenging quality-focused manufacturers.
3. Limited Awareness Among SMEs -SMEs in smaller cities often lack awareness of the benefits of energy-efficient motors, resulting in slower modernization and missed opportunities for cost savings.
4. Raw Material Cost Volatility -Dependence on materials like copper and aluminum exposes manufacturers to global price fluctuations, impacting production costs and pricing strategies.
5. Lagging Technological Advancement- Some domestic manufacturers are slow to adopt new motor technologies, making it hard to compete in specialized segments that require innovation and precision.
6. Dependence on Imports for Specialized Motors -India still imports high-end motors due to limited local expertise, which affects cost, lead time, and efforts toward self-reliance in critical motor technologies, however the QCO orders of the Government pertaining to IS 12615 ensures that only the motors with ISI mark are permitted to be used in India. Hence it is now not possible to import fully finished Asynchronous motors.

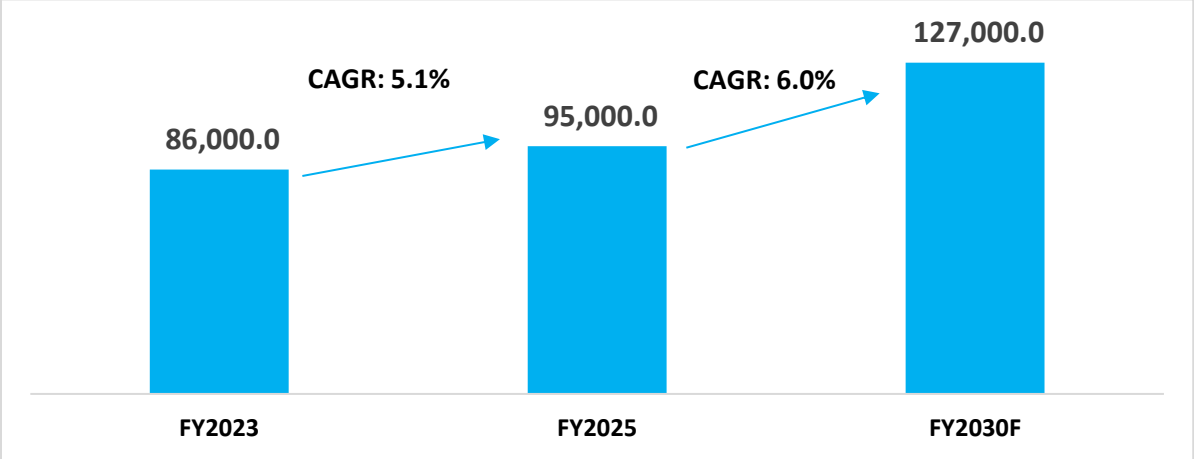
3.7.1. Domestic Industrial Electric Motors - Market Size and Growth Outlook

The motors market in India is set for rapid expansion, bolstered by strategic governmental policies, a shift towards sustainable energy sources, and infrastructural developments across urban and rural areas. As the country continues to emphasize innovation and efficiency in technology adoption, the demand for

advanced and reliable motors is expected to soar, playing a crucial role in India's industrial and economic growth.

In FY2025, the Indian market for Industrial Electric motors was valued at INR 95,000.0 million, and it is projected to experience a compound annual growth rate (CAGR) of approximately 6.0% over the forecast period, reaching INR 127,000.0 million by FY2030.

Exhibit 3.7: Domestic Industrial Electric Motors, FY2023 - FY2025- FY2030F, INR Million

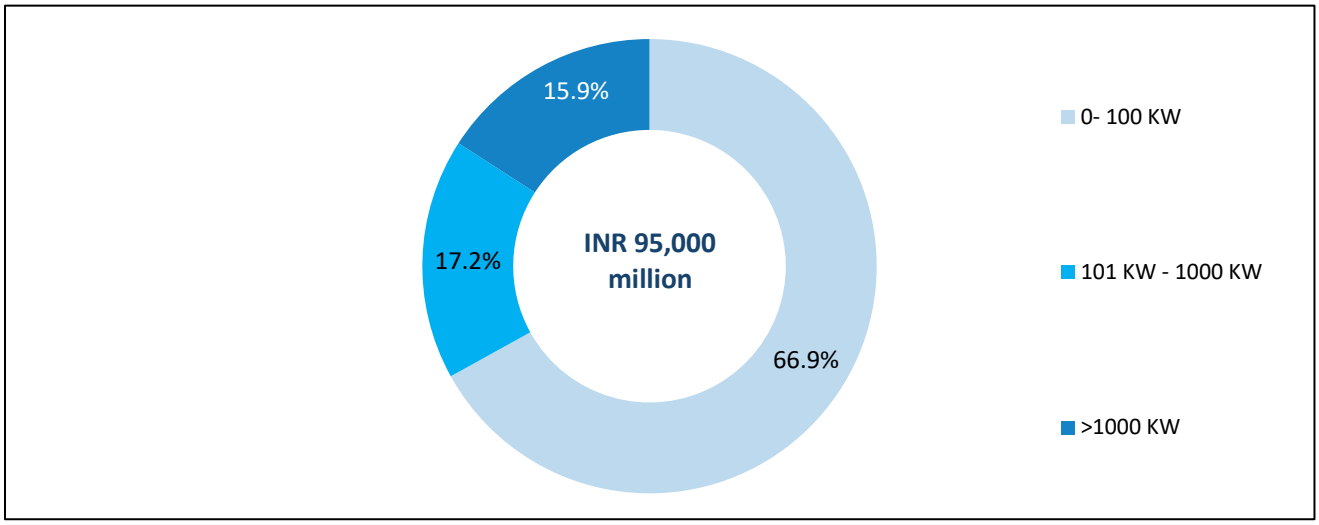


Source: Frost & Sullivan Analysis

3.7.2. India Electric Motors - Market Split by Power Rating

In India, low and medium-kW motors (typically ranging from 0 kW to 1000 kW) have high demand due to the following factors. Government mandates are driving the demand for energy-efficient motors in the low and medium-power segments, leading to industries replacing old motors with IE3 & IE4-compliant models. Low and medium-kW motors are cost-effective, readily available, and easy to repair, making them attractive to businesses and farmers. Low-kW motors are increasingly used in irrigation pumps due to government subsidies, which encourage their widespread adoption. AC Induction Motors, DC Motors, and Traction Motors are utilized to power cranes, lifts, HVAC systems, and water pumps in various structures, including buildings, roads, and metro projects.

Exhibit 3.8: India Industrial Electric Motors, Split by Power Rating, FY2025, INR Million

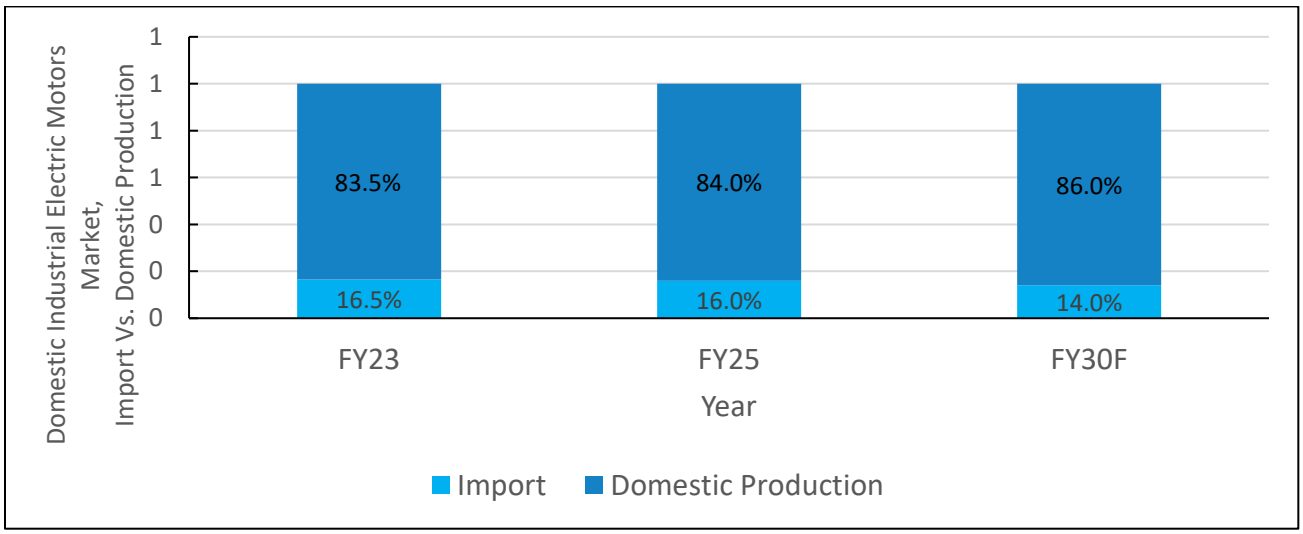


Source: Frost & Sullivan Analysis

Motors with power ratings higher than 750kW are mostly custom-designed for very specific industrial applications. Low power is primarily used in OEM applications. In contrast, medium power combinations (up to 500-1000 kW) are predominantly preferred in end-user sectors, such as oil and gas, power, metals, and mining.

3.7.3. Domestic Industrial Electric Motors – Market Split by Import Vs. Domestic Production

Exhibit 3.9: Domestic Industrial Electric Motors, Market Split by Import Vs. Domestic Production , FY2023 - FY2025- FY2030F



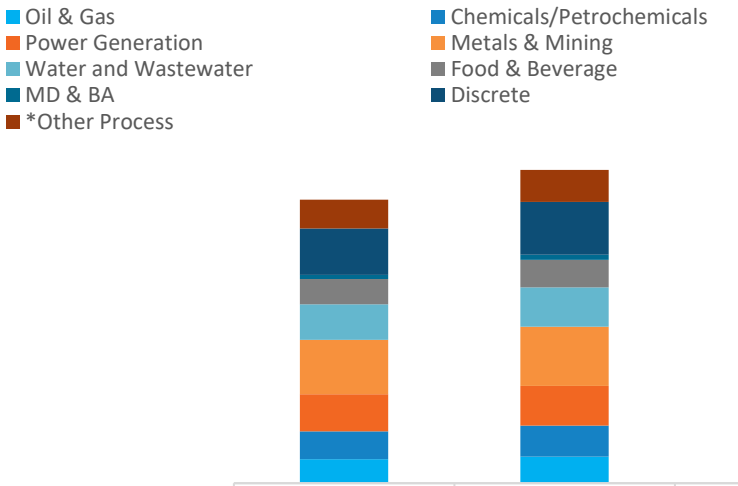
Source: Frost & Sullivan Analysis

India's electric motor manufacturing industry is strong, supplying both local and international markets, with imports playing a significant role in specific motor types and components. Domestic manufacturers are utilizing advanced technologies like variable-speed drives and permanent magnet synchronous motors to meet the increasing demand. Indian manufacturers face competition from imported motors, especially

from China, which offers cost advantages, forcing local producers to improve efficiency while maintaining quality standards. The Indian industrial electric motors market is expected to grow due to government policies, technological advancements, and increasing demand across sectors. Balancing imports with domestic production is crucial for sustainable industrial development.

3.7.4. India Industrial Electric Motors - Market Size by End-user Industries

Exhibit 3.10:India Industrial Electric Motors, Market Split by End-user Industries, FY2023 - FY2025-FY2030F, INR Million



	FY2023	FY2025	FY2030F	CAGR(2025-2030)
*Other Process	8,775.8	9,700.0	12,960.0	6.0%
Discrete	13,987.6	16,000.0	21,990.0	6.6%
MD & BA	1,312.7	1,500.0	1,938.5	5.3%
Food & Beverage	7,615.1	8,425.0	12,000.0	7.3%
Water and Wastewater	10,769.5	11,900.0	15,903.7	6.0%
Metals & Mining	16,567.5	18,000.0	24,000.0	5.9%
Power Generation	11,227.5	12,000.0	15,000.0	4.6%
Chemicals/Petrochemicals	8,470.0	9,400.0	12,508.0	5.9%
Oil & Gas	7,274.4	8,075.0	10,700.0	5.8%

MD&BA – Medical Devices and Building Automation

Source: Frost & Sullivan Analysis

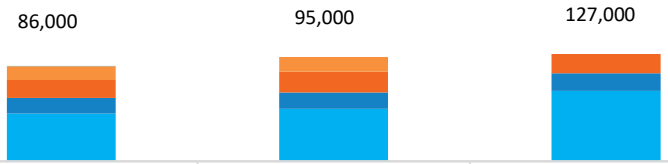
Motors form the backbone of India's industrial framework, playing a crucial role in sectors that are vital to the country's economy, such as oil & gas, chemicals, food processing, water management, power generation, and mining. These industries depend heavily on robust motor systems to power a variety of processes, including extraction, agitation, fluid transfer, and load handling. India's ongoing push for industrialization, combined with initiatives to enhance manufacturing capabilities, is propelling the demand for motors that are not only cost-effective but also align with the country’s focus on reducing carbon footprints and improving energy security. In India, motors play a pivotal role in the functionality of pumps across various key sectors. Industrial applications include extensive use in oil refineries, petrochemical plants, and manufacturing facilities, where pumps are essential for operations like fluid

transfer, heat exchange, and waste management. In agriculture, which is a cornerstone of the Indian economy, motor-driven pumps are crucial for irrigation systems, significantly impacting crop yields and farming efficiency. Infrastructure developments such as urban water supply and sewage treatment rely on robust pumping systems to manage water resources. In India, the role of motors in electric vehicle (EV) components is becoming increasingly significant as the country embarks on its journey toward the electrification of transportation.

In India's railway segment, AC traction motors predominantly drive electric motor growth. These motors, particularly three-phase AC induction motors and permanent magnet synchronous motors (PMSMs) are favored for their high efficiency, precise control, and suitability for high-speed trains, metro systems, and electric locomotives. The shift to 100% railway electrification and the demand for energy-efficient, high-power-density motors (typically in the 200–400 kW range) further solidify their dominance.

3.7.5. India Industrial Electric Motors - Market Size by Motor Efficiency (by Value)

Exhibit 3.11: India Industrial(Asynchronous) Electric Motors, Market Split by Motor Efficiency, FY2023 - FY2025- FY2030F, INR Million



	FY2023	FY2025	FY2030F	CAGR(2025 -2030)
IE6	0	0	254	0.0
IE5	250	400	700	11.8%
IE4	25,042	28,050	42,000	8.4%
IE3	32,500	37,100	52,296	7.1%
IE2	28,208	29,450	31,750	1.5%
Total	86,000	95,000	127,000	6.0%

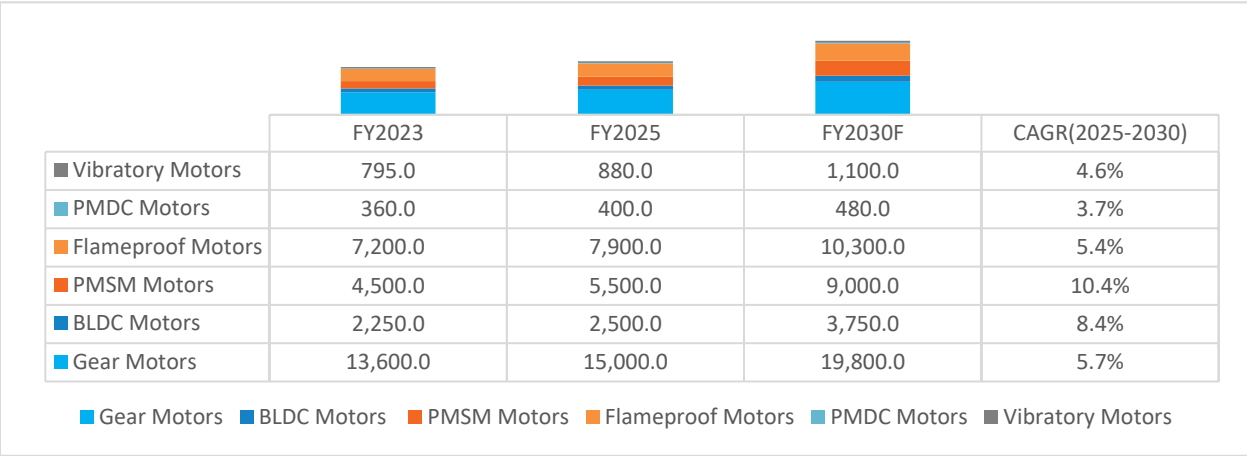
Total IE2 IE3 IE4 IE5 IE6

Source: Frost & Sullivan Analysis

IE3 motors have become the dominant choice in the Indian industrial electric motor market, holding the highest segmental market share of 39.0% in FY2025. This is due to their high energy efficiency and growing emphasis on sustainability in various sectors. IE3 motors are widely used in HVAC systems, pumps, industrial machinery, and fans, where energy savings and reduced operational costs are critical. The Indian government's initiatives, such as the Star Labeling program and ABB India's IEC Low Voltage IE4 cast iron super premium efficiency motors, have accelerated the adoption of high-efficiency motors. The Indian industrial electric motor market is shifting towards more energy-efficient solutions, with IE3 motors currently leading the market and growing interest in IE4 motors.

3.7.6. India Electric Motors - Market Size by Specific Type of Motors (by Value)

Exhibit 3.12: Market Split by Specific Motor Types, India, FY2023 - FY2025- FY2030F, INR Million



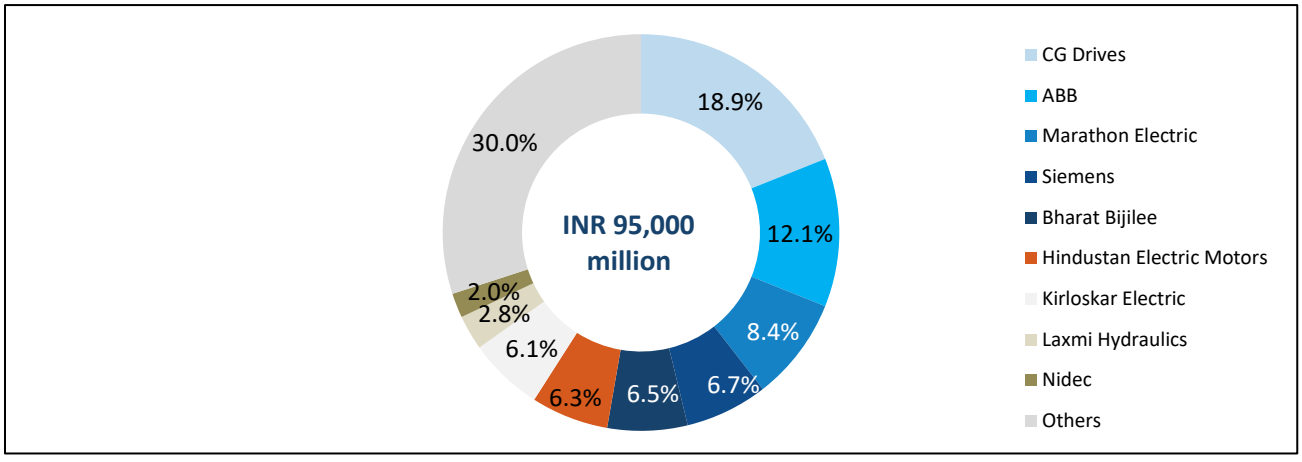
	FY2023	FY2025	FY2030F	CAGR(2025-2030)
Vibratory Motors	795.0	880.0	1,100.0	4.6%
PMDC Motors	360.0	400.0	480.0	3.7%
Flameproof Motors	7,200.0	7,900.0	10,300.0	5.4%
PMSM Motors	4,500.0	5,500.0	9,000.0	10.4%
BLDC Motors	2,250.0	2,500.0	3,750.0	8.4%
Gear Motors	13,600.0	15,000.0	19,800.0	5.7%

Source: Frost & Sullivan Analysis

The Brushless DC (BLDC) motor market in India is experiencing significant growth due to increasing demand in the automotive, home appliances, and industrial automation sectors. The market is expected to grow at a CAGR of over 8.4% in the next five years, driven by the demand for energy-efficient solutions and the adoption of electric vehicles and smart home appliances. India's commitment to enhancing energy efficiency and minimizing operational costs has resulted in a surge in the widespread use of IE4 PMSMs across various industries. PMSMs are gaining popularity in various industries due to their high efficiency and reliability. BLDC and PMSM motors are in high demand in EVs, automation, and energy-efficient applications. Gear and flameproof motors are growing due to industrial automation and regulatory requirements. Vibratory motors have niche demand in material handling and mining, while PMDC motors are declining.

3.8. Competitive Landscape of Domestic Industrial Electric Motors

Exhibit 3.13: Domestic Industrial Electric Motors, Market Share by Key Players, FY2025



Source: Company Website, Annual Report, Filings, Primary Research, Frost & Sullivan Analysis

The Indian Industrial electric motor landscape features a mix of multinational corporations and domestic manufacturers. The top five players account for around 53.1% of the total market share.

Indian-origin companies account for approximately 75.0% of total sales in India, while MNCs contribute the remaining 25%

In India, the leading suppliers of Industrial electric motors are are CG Drives (18.9%), ABB (12.1%), Marathon Electric (8.4%), Siemens (6.7%), Bharat Bijilee (6.5%), Hindustan Electric Motors (6.3%), and Kirloskar Electric (6.1%). The other notable players are Laxmi Hydraulics, Nidec, Rotomag Enertec Limited, etc. **Rotomag Enertec Limited** is one of the key players in the Indian industrial electric motors market, known for its specialization in DC and AC motors. The company offers a wide range of motor solutions catering to applications across solar pumping, industrial automation, machine tools, and electric mobility. With a strong focus on innovation, distinctive product design, extensive use of lightweight materials, reliability, and customization, Rotomag Enertec Limited has built a reputation for delivering motors that meet diverse performance and durability standards. Its presence in both domestic and export markets further reinforces its position as a trusted and competitive motor manufacturer in the industrial electric motors segment.

Domestic Industrial Gearbox Market Overview

4.1. Industrial Gearboxes – Definition

An industrial gearbox is a mechanical device that transmits power and torque from a motor to a driven machine. It consists of gears arranged in a specific configuration to modify speed, torque, and direction of rotation. Gearboxes are essential in industrial machinery for efficient power transmission and operational stability.

Low torque gearboxes (Industrial gearboxes with a torque rating below 10 kNm) are intended for applications that demand a lower torque output while maintaining efficiency, precision, and durability. These gearboxes are widely employed in robotics, medical devices, automation systems, and small machinery that operate under high-speed, low-load conditions. Industrial gearboxes with a torque rating below 10 kNm are also utilized in various applications like conveyors, mixers, pumps, and small-scale machinery.

4.1.1. Types of Industrial Gearboxes (up to 10 kNm)

Gearbox Type	Description	Key Application Areas
Worm Gearboxes	High torque, compact, self-locking, high reduction (5:1–100:1), lower efficiency due to friction.	Conveyor systems, cranes, elevators, robotics, tractors, crushers, winches, wind turbines, solar trackers, textile machinery.
Bevel Gearboxes	Right-angle power transmission, low torque (<10 kNm), compact, high load capacity.	Automotive, agriculture, conveyors, marine, robotics, wind turbines, pumps, cranes.
Bevel Gearboxes	Right-angle torque transfer, space-efficient, high torque.	Manufacturing (conveyors, robotics), crushers, mixers, pumps, marine propulsion, wind turbines, and mining.
Helical Gearboxes	High efficiency, high torque (≤10 kNm), smooth power transmission.	Mixers, hoists, pumps, wind & solar energy, automation, textiles, agriculture, conveyors.
In-line Helical Gearboxes	Quiet, smooth, high torque, handles heavy loads.	Harvesters, crushers, ship propulsion, wind turbines, conveyors, mixers, robotics, and CNC machines.
Cycloidal Gearboxes	Compact, high torque, even load distribution, and durable.	Robots, AGVs, aerospace, CNC machines, surgical robots, EVs, packaging, and solar tracking.
Planetary Gearboxes	High torque, compact, reduction ratio (3:1–10:1).	Construction, mining, ship propulsion, wind turbines, hydraulic drives, conveyors, extruders, cranes.

4.2. Key Growth Drivers – Domestic Industrial Gearboxes Market

A) Increasing focus on energy efficiency and asset utilization

There is an increasing demand for OEM equipment, such as material handling and processing machinery, across end-user sectors due to an enhanced focus on automated equipment. Low-torque gearboxes, when combined with efficient motors, can significantly reduce energy consumption in industrial applications, particularly in the food processing and packaging industries, ensuring smooth operation and minimal product damage.

B) Significant planned investments in Renewable Energy (Solar, Wind, and Hydroelectric Power)

Growing investment in solar, wind, and hydroelectric energy projects drives up gearbox demand in the power generation segment. India's push for sustainable energy and favorable policies for renewable energy development further support this trend.

C) Growing demand in automation and robotics applications across key end-user industries

In India, across various key industries like manufacturing, logistics, healthcare, and even agriculture, there is a rapidly growing demand for automation and robotics applications, driven by the need to improve efficiency, reduce costs, enhance productivity, and address labor shortages. Low-torque gearboxes are crucial for precise motion control in robotic arms and automated systems, where delicate movements are required without excessive force.

D) Increasing need for precise motion control in lightweight machinery

India has rapidly emerged as a significant player in global electronics and medical devices manufacturing. India has been investing in electronics and medical device manufacturing through a variety of policies and incentives, including the PLI scheme. Low-torque gearboxes are increasingly being utilized in industries like electronics manufacturing and medical devices due to their compact, lightweight design for controlled power.

E) Growth in Industrialization and Infrastructure Development

Rapid urbanization and industrial expansion in India are boosting the demand for industrial gearboxes in sectors like power, steel, and manufacturing. India's growing industrial base, supported by programs like "Make in India," is driving up gearbox demand in industries including automotive, steel, textiles, food processing, etc. Increasing investments in infrastructure projects (railways, metros, smart cities) are fueling market growth.

F) Increasing investments in Warehouse and automated Solutions

India is rapidly expanding its warehousing and e-commerce infrastructure to meet the surge in online shopping, fueled by rising consumer demand, supportive government policies, and the need for efficient last-mile delivery. This growth is driving the development of modern warehouses and increasing demand for automated warehouse systems, including material handling equipment like conveyors, AGVs, and shuttles, which depend on low-torque gearboxes for precise movement.

4.3. Threats and Challenges – Domestic Industrial Gearboxes Market

Increasing competition and increasing production costs affect margins.

Rising production costs for gearbox manufacturers stem from higher raw material prices, supply chain delays, energy and labor costs, regulatory compliance, and increased R&D for customization. These pressures, combined with intense competition, are reducing profit margins, especially for catalog products. Manufacturers face price sensitivity from customers, limiting their ability to pass on costs, and must explore value-added products to maintain profitability.

Delays in project execution

Few end-user industries in India have faced delays in the execution of projects over the past few years. Longer delays in project execution led to lower demand in the specific year and increased the chances of cancellations due to cost overruns in the future. The delays in project execution are expected to be reduced during the forecast period.

Declining demand for worm gear technology

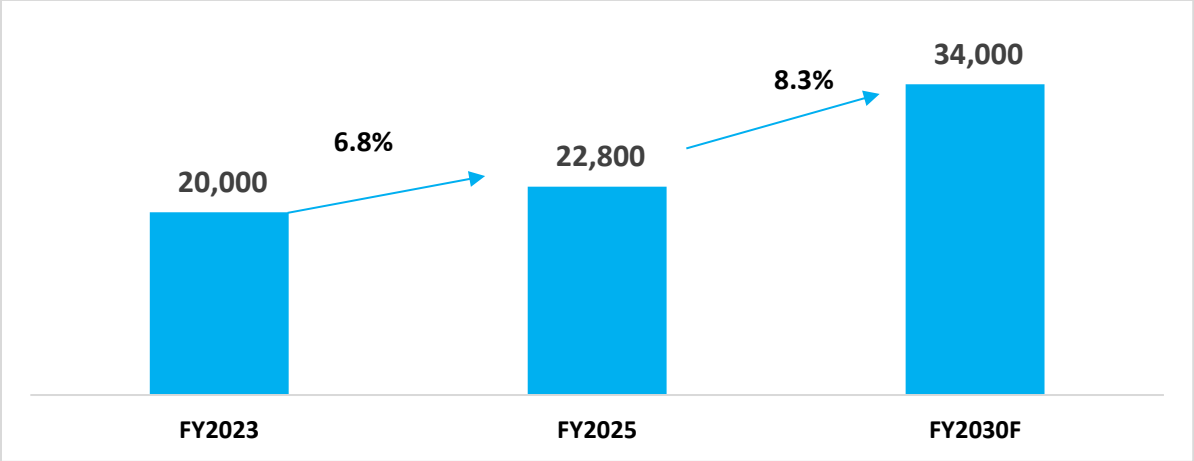
Technological inefficiencies are expected to result in the replacement of worm gear technology by helical/bevel-helical, planetary units, and other competing substitute technologies. Technology is highly mature but suffers from various technical disadvantages, which result in lowered adoption rates.

Threat of replacement by alternative technologies

End users' changing preference for alternative technologies, such as variable speed motors, poses a threat to the growth of the gearboxes and geared motors market. This substitute eliminates the need for a gearbox, with the electric motors being controlled precisely by electric AC drives. This is likely to result in a sizeable revenue loss for the geared motors market.

4.4. Domestic Industrial Gearbox Market - Market Size and Growth Outlook

Exhibit 4.1: Domestic Industrial Gearboxes (<10 kNm) , FY2023 - FY2025- FY2030F, INR Million



Source: Frost & Sullivan Analysis

The India Industrial Gearbox market (torque up to 10 kNm) was estimated to be worth INR 22,800 million by FY2025. The market is expected to grow at a 8.3% CAGR and generate INR 34,000 million in sales during the forecast period (FY2025-FY2030).

Key drivers for the growth of Industrial Gearbox (<10 kNm) in the Forecast period

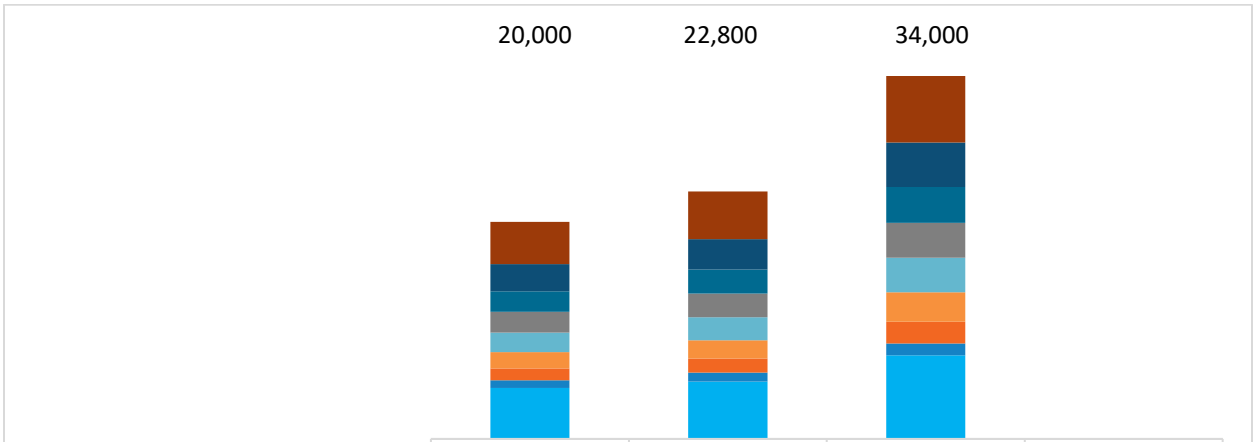
The market for gearboxes with torque ratings below 10 kNm is driven by growth drivers and emerging trends in industries like industrial automation, robotics, Precision engineering, and renewable energy. The demand for precision gearboxes in robotics, CNC machines, and automated production lines, along with the growth of collaborative robots and AGVs, is expected to drive market growth. As industries continue to demand lightweight, efficient, and customizable solutions, the market for these gearboxes is expected to expand further.

4.5. Domestic Industrial Gearbox Market – Market Size by End-user Industries

Material Handling holds the largest share of the Gearboxes market. Gearboxes are widely used in cranes, hoists, conveyors, forklifts, and automated storage & retrieval systems (AS/RS), making material handling one of the largest end-users of gearbox technology.

Marine, Aerospace, and defense are expected to achieve high growth in the forecast period

Exhibit 4.2: Domestic Industrial Gearbox (<10 kNm) , Market Size by End-user Industries, FY2023 - FY2025- FY2030F, INR Million



	FY2023	FY2025	FY2030F	CAGR (FY2025 - FY2030)
Material Handling	3,900	4,400	6,700	8.8%
Chemical & Pharma	2,500	2,800	4,100	7.9%
Food and Beverage	1,900	2,200	3,300	8.4%
Mobile Machinery*	1,900	2,200	3,200	7.8%
Robotics & Automated Machineries	1,800	2,100	3,200	8.8%
Marine, Aerospace & Defense	1,500	1,700	2,700	9.7%
Machine Tools & CNC Machines	1,100	1,300	2,000	9.0%
Textiles	700	800	1,100	6.6%
Others	4,700	5,300	7,700	7.8%

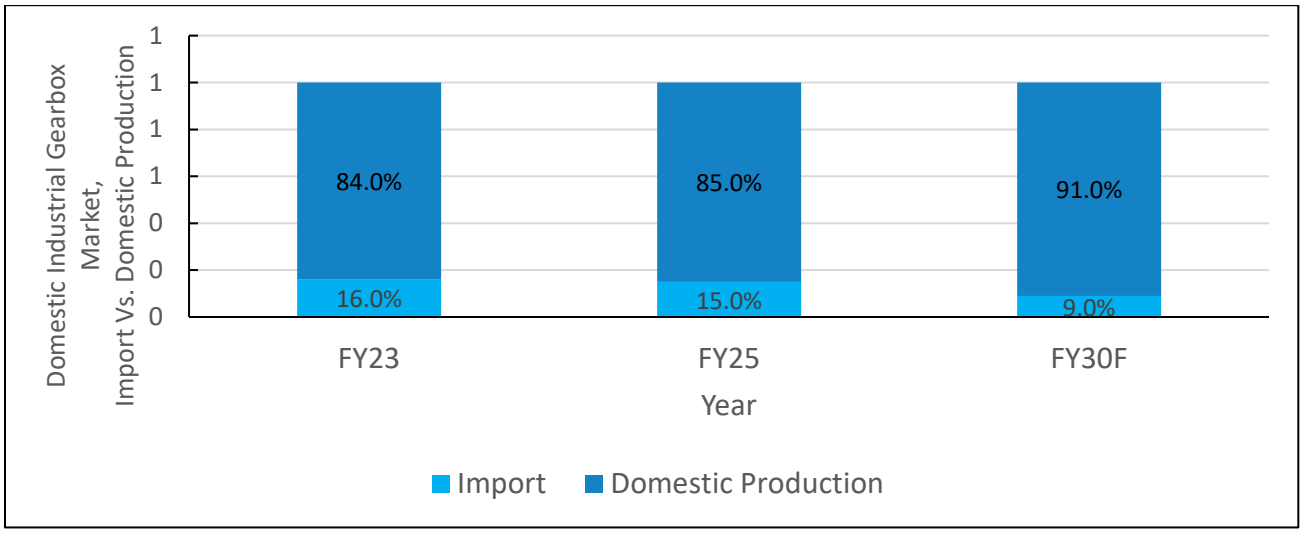
Source: Frost & Sullivan Analysis

Note: Mobile Machinery includes Construction, Mining, and Agricultural Machineries
"Others" include Automotive & EVs, Power - Renewable Energy, Cement, Sugar, Plastics, Pulp & Paper, Dairy, Rubber / Tyre.

India is moving towards domestic production of machine tools and components to reduce dependence on imports. More Indian manufacturers are producing custom gearboxes tailored for CNC and machine tool applications. This will have a positive impact on the gearbox market growth in the forecast period.

4.6. Domestic Industrial Gearbox Market – Market Split by Import Vs. Domestic Production

Exhibit 4.3: Domestic Industrial Gearbox (<10 kNm), Market Split by Import Vs. Domestic Production , FY2023 - FY2025- FY2030F



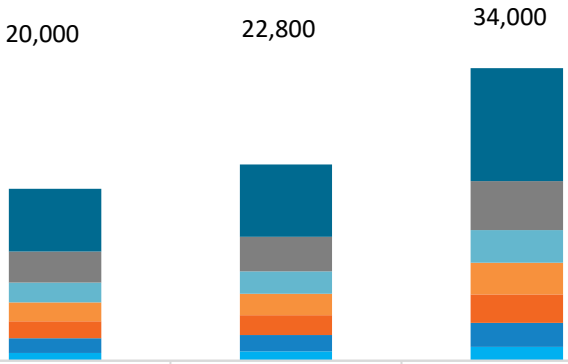
Source: Frost & Sullivan Analysis

Note: Imports include CKD / semi-knockdown units.

Increased penetration by local manufacturers and growth in the number of MNCs establishing their manufacturing operations in India have led to a higher level of local manufacturing in the forecast period.

4.7. Domestic Industrial Gearbox Market – Market Split by Gearbox Type

Exhibit 4.4: Domestic Industrial Gearbox (<10 kNm) , Market Size by Gearbox Type, FY2023 - FY2025-FY2030F, INR Million



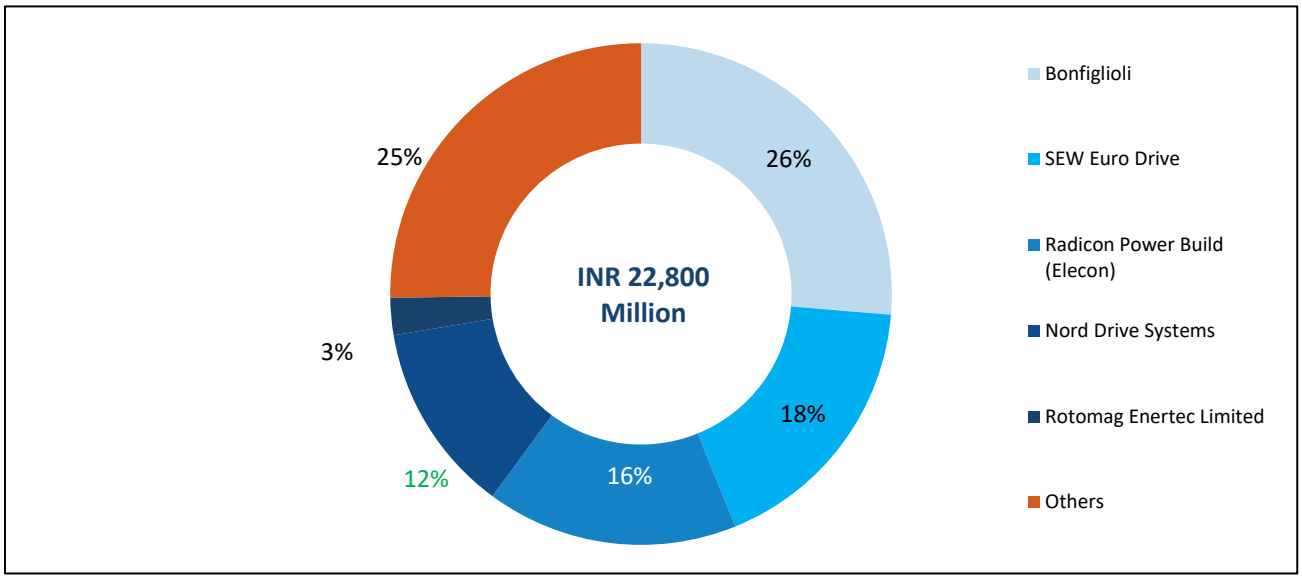
	FY2023	FY2025	FY2030F	CAGR (FY2025 - FY2030)
Helical Gearboxes	7,300	8,400	13,100	9.3%
Worm Gearboxes	3,600	4,000	5,700	7.3%
Bevel Helical Gearboxes	2,300	2,600	3,800	7.9%
In-line Helical Gearboxes	2,200	2,500	3,700	8.2%
Bevel Gearboxes	2,000	2,300	3,300	7.5%
Planetary Gearboxes	1,700	1,900	2,800	8.1%
Cycloidal Gearboxes	900	1,100	1,600	7.8%

Source: Frost & Sullivan Analysis

Helical, Worm, Bevel-Helical, and In-line Helical gears are expected to dominate the market due to their widespread usage across key OEM equipment. Helical gears are preferred for higher efficiency and horsepower applications, while planetary gearboxes are used in applications that have higher bearing loads. The mining and automotive industries are increasingly adopting worm gear reducers for their machinery, contributing to market expansion. Traditionally, worm and a combination of worm and helical, planetary gear motors are most preferred in the agro machinery sector, while price and delivery time are key selection factors. Technological inefficiencies are expected to result in the replacement of worm gear technology by helical/ bevel-helical, planetary units, and other competing substitute technologies. Cycloidal gearboxes are gaining traction in India due to their high precision, durability, and efficiency, making them ideal for applications in robotics, automation, aerospace, and industrial machinery. Cycloidal gearboxes are increasingly used in wind turbines and solar tracking systems, benefiting from India's push toward renewable energy.

4.8. Competitor Landscape of Domestic Companies in the Industrial Gearbox (up to 10 kNm)

Exhibit 4.5: Domestic Industrial Gearbox (<10 kNm), Market Share of Key Players by Value, FY2025



Source: Company Website, Annual Report, Filings, Primary Research, Frost & Sullivan Analysis-

The India Domestic Industrial Gearbox market is consolidated, with around 15 players actively operating in the market.

In India, the leading suppliers are Bonfiglioli (26.0%), SEW Euro Drive (18.0%), Radicon PowerBuild (16.0%), Nord Drive Systems (12.0%) and Rotomag Enertec Limited (3.0%). The other notable players are Top Gear Transmission, MGM Varvel, Bauer, Rossi, Kavitsu, SMD Gearbox, Hylo Transmission, Agnee Transmission, etc.

These companies achieved their market position due to their broad product portfolio, Strong regional and global presence, brand equity, customer support, strong customer base with a high retention ratio, and the capacity to design solutions to meet unique customer needs. The diversified end-user segments in the country, comprising different tiers of companies with varying requirements, enable gearbox manufacturers to carve a niche for themselves at the product, industry, or regional levels.

Rotomag Enertec Limited is one of the key players in the Indian industrial gearboxes and gear motors market, offering a comprehensive portfolio of solutions tailored for various industrial applications. The company specializes in integrated gear motors combining robust gearboxes with energy-efficient electric motors, widely used in sectors such as material handling, packaging, textile machinery, and solar tracking systems. Known for its engineering precision, customization capabilities, and reliability, Rotomag Enertec Limited continues to strengthen its market position by delivering cost-effective, application-specific solutions across both domestic and international markets.

Chapter 5: Overview of EV Drivetrain Solutions Market for India

Overview of EV Drivetrain Solutions Market for India

5.1. Overview of Domestic Electric Vehicles (EV) Industry

Electrification will significantly contribute to the transformation of the mobility industry, offering significant opportunities for all vehicle segments. However, the pace of this change will vary depending on factors such as regulatory changes, government support, infrastructure development, consumer behavior, and technological advancements. The electric vehicle industry is at a nascent stage; as of today, it stands at 7.0% of total vehicle sales. However, it has the potential to grow multifold over the next 5–10 years.

At present more than 3 million electric vehicles are plying on Indian roads, 95.0% of them being 2-wheelers and 3-wheelers. The industry volumes fluctuate, mostly depending on the incentives offered by the government. Key players (Ola, Ather, Hero, Tata, Mahindra, etc.) are continuing with the mission and trying to enforce positive change in the industry. The industry is on the brink of significant growth, and the launch of the EMPS (Electric Mobility Promotion Scheme) 2024, extending incentives for two- and three-wheelers, is expected to accelerate its upward trajectory further. The Government of India has been supporting the EV industry through schemes such as FAME and EMPS, along with the increased focus on charging infrastructure. The country sees a huge opportunity with EVs in reducing the carbon footprint and dependence on crude oil imports, creating jobs, and building a new technology knowledge hub in India.

5.1.1. Key Growth Drivers for the Domestic EV Market

A) Strong Government Push – Incentivization and Subsidies

Incentivization, such as tax credits and subsidies, makes EVs more attractive and affordable for car buyers. Various incentives and subsidies are provided under the FAME schemes by the Government. The Government provides various state-level incentives and waives registration fees across most states.

B) Air Pollution and GHG Emissions

Vehicular emissions account for 23% of greenhouse gas emissions, and 63 Indian cities are among the world's 100 most polluted cities. EVs emit 50% less greenhouse gas (GHG) than petrol or diesel vehicles. Extremely low emissions by electric vehicles are the best bet to tackle the hazardous air pollution levels in choked cities in India. EVs can improve this scenario by reducing local concentrations of pollutants in cities.

C) Falling Battery Prices

Battery prices have significantly influenced the economics of EV adoption. Battery accounts for about 40-50% of the total EV cost. From 2010 to 2024, battery prices saw a massive drop. The increasing scale economics are expected to push the prices further down to US$90 - 100 over the next 4 - 5 years. In addition to the reduction in prices, the advancements in battery design have improved their performance in terms of lower charging time and power-to-density ratio (trimmed size and weight of batteries). This sharp fall in battery costs directly enhances the Total Cost of Ownership (TCO), making EVs more financially attractive for consumers and fleet operators.

D) Setting up of Local Manufacturing units

Production-linked incentive schemes will boost domestic manufacturing, drive innovation, and accelerate the EV ecosystem. Leading global manufacturers of lithium-ion batteries have started exploring the opportunities to initially build battery pack assembly units and eventually transition to large-scale lithium-ion cell manufacturing in the country.

5.1.2. Potential Trends Impacting the EV Market Growth

Exhibit 5.1: EV Market Growth in India – Potential Trends and its Implications

	Details	Implications
Growing efforts to address charging incompatibility	India has approved 4 charging standards—Bharat DC-001, Bharat AC-001, CCS, and CHAdeMO—making the charging market incompatible and fragmented.	The market should focus on universal charging solutions (e.g., Bolt). For example, Earth Pro provides charging solutions for all types of vehicles.
Need for EV companies to source components locally	India's FAME scheme insists on local component sources for at least 50% of the vehicle's total components.	EV participants must refund subsidies to the government for non-adherence, which will result in improved local production capacity in the future.
Rapid urbanization and deteriorating air quality	Urbanization increases the need for vehicles for commuting while increasing pollution.	Local state governments impose EV policies to reduce vehicular emissions and focus on public–private partnerships to develop charging infrastructure.
Scaling up the Tier I OEM component supplier base	EV companies will focus on scaling up their OEMs to increase EV production.	Scaling will help EV companies mass produce at comparatively lower prices than before, helping achieve cost parity against ICE vehicles.
Advancement in Li-ion batteries	Apart from high-power Li-ion batteries, technical expertise is developing in advanced technologies such as sodium-ion and solid-state batteries (e.g., GODI India).	Progress in battery technology and vehicle compatibility with advanced technologies will fast-track EV growth.

Image source: Getty Images

Source: Frost & Sullivan Analysis

5.1.3. Key Threats and Challenges for the Domestic EV Market

A) High Cost of Technology and Limited Range

The cost of an electric vehicle is 25-50% higher than that of a conventional vehicle due to the high cost of technology (in terms of battery, motors, onboard chargers, and power electronics) which remains the key deciding factor on the consumer end. Electric range on a single charge is limited to 300-400 kms in a premium segment vehicle; however, 150-200 kms is the current range on mass market vehicles, while the expectation is 400-500 kms.

B) Lack of Charging Infrastructure

CPOs (CHARING POINT OPERATORS) - High costs associated with rent/ land cost, equipment, and installation act as the major challenge with low returns. Customers are keen to charge as quickly as they can refuel a petrol tank, which is not feasible with the current charging technologies. Integrating surging EV demand into the existing grid poses a challenge.

C) Total Cost of Ownership (TCO) and Limited Model availability

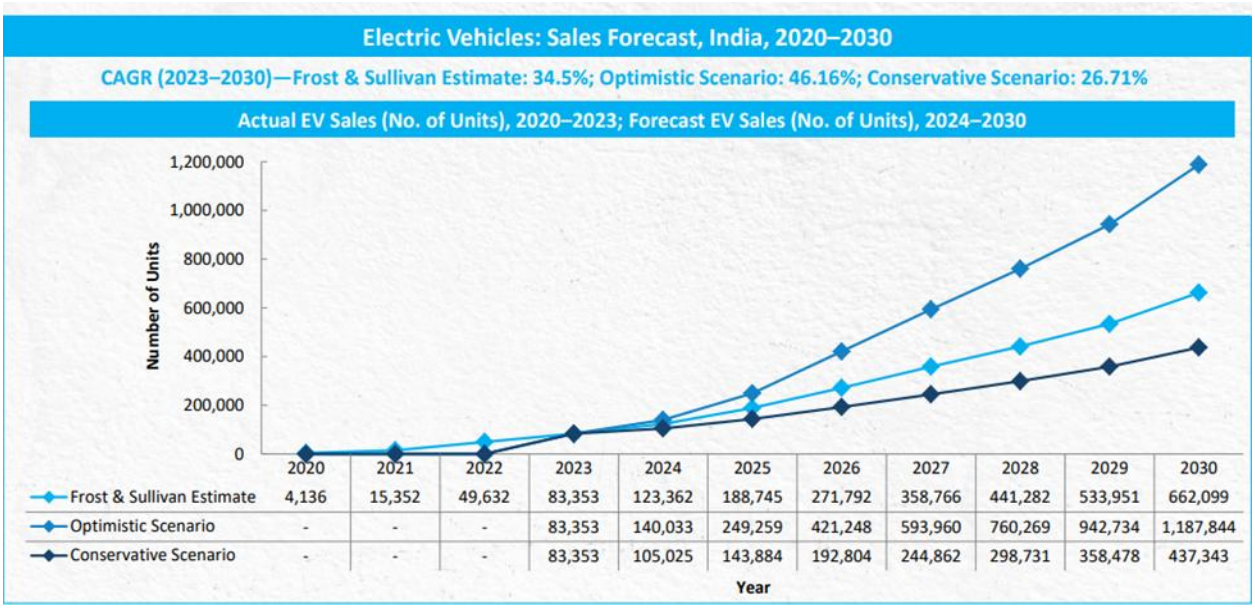
While electric two- and three-wheelers are becoming more cost-effective, the TCO for passenger vehicles and heavy commercial vehicles remains unattractive compared to their ICE counterparts. The high upfront cost of batteries, along with uncertainties about their long-term lifespan and resale value, poses significant challenges. The Indian market has fewer EV models compared to global markets, limiting consumer choices. This restriction is especially significant in the passenger vehicle segment.

D) Underdeveloped Local manufacturing and supply chain

India's EV industry is heavily reliant on imported components, especially batteries and other critical components. The lack of a robust local supply chain increases costs and hinders the scale of manufacturing. Technological Gaps - India lags in research and development compared to global leaders like China, Japan, and South Korea. Substantial investments in R&D and skilled workforce development are required.

5.2. Domestic EV Market Analysis

Exhibit 5.2: Domestic Electric Vehicles Market, Sales Forecast, India, FY2020-2030

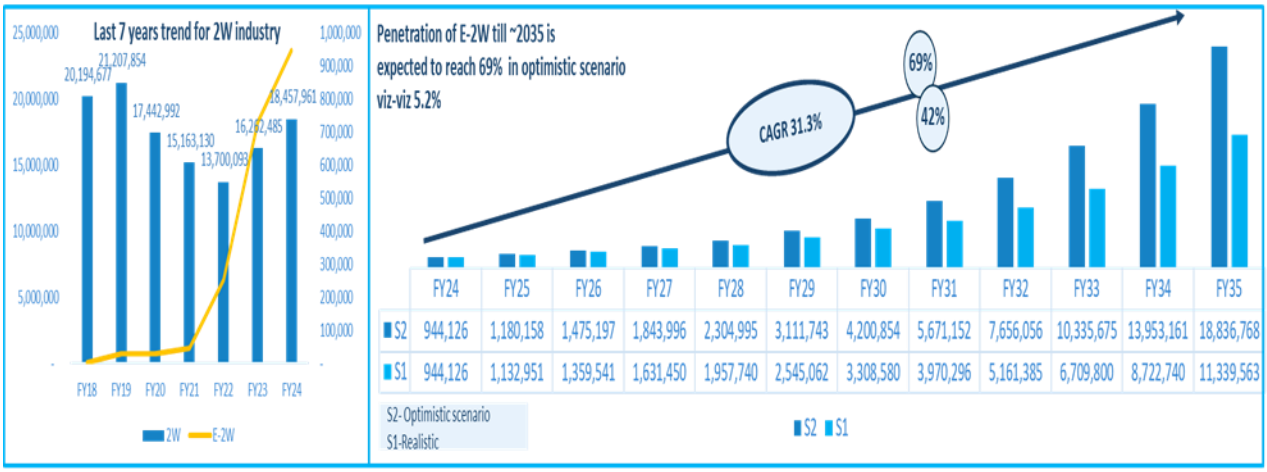


	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Frost & Sullivan Estimate	4,136	15,352	49,632	83,353	123,362	188,745	271,792	358,766	441,282	533,951	662,099
Optimistic Scenario	-	-	-	83,353	140,033	249,259	421,248	593,960	760,269	942,734	1,187,844
Conservative Scenario	-	-	-	83,353	105,025	143,884	192,804	244,862	298,731	358,478	437,343

Source: Frost & Sullivan Analysis

5.2.1. Electric Two-Wheeler Analysis

Exhibit 5.3: Domestic Electric Vehicles Market, 2W, Sales Forecast, India, FY24-FY35



	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
S2	944,126	1,180,158	1,475,197	1,843,996	2,304,995	3,111,743	4,200,854	5,671,152	7,656,056	10,335,675	13,953,161	18,836,768
S1	944,126	1,132,951	1,359,541	1,631,450	1,957,740	2,545,062	3,308,580	3,970,296	5,161,385	6,709,800	8,722,740	11,339,563

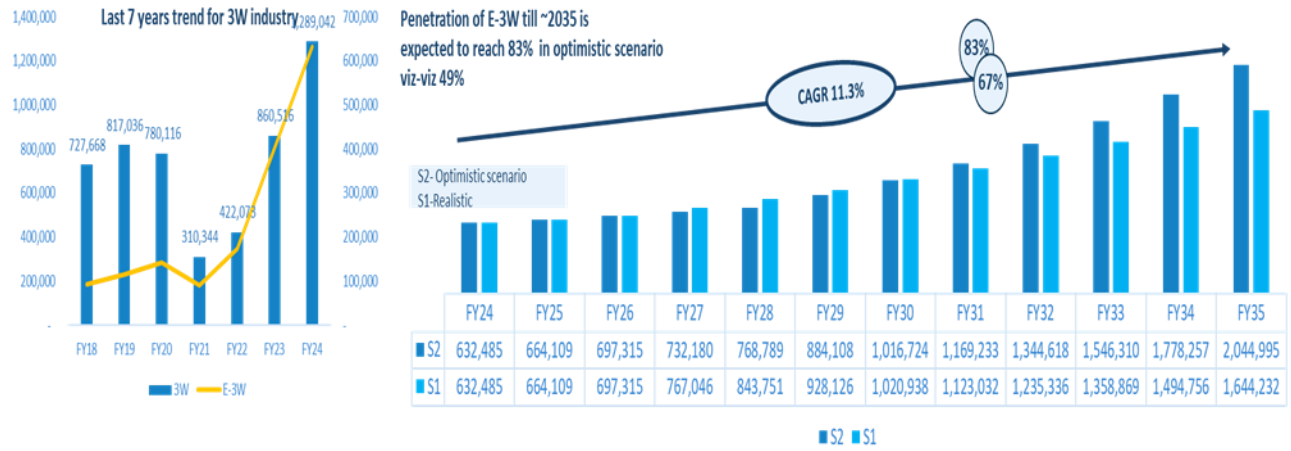
Source: Frost & Sullivan Analysis

Several new companies, including Honda, Suzuki, Yamaha, Gogoro, and BMW, are entering the Indian E2W market by introducing high-speed electric two-wheelers over the coming years. Over the last two years, start-ups in the segment have raised more than INR 48,000 million (US$ 6000 million) in investment. By FY'35, over 50% of 2Ws sold in India are envisaged to be electric.

5.2.2. Electric Three-Wheeler Analysis

In FY23, over 400,000 E-3Ws were sold in India, accounting for 46% of all 3W sales. In FY'24, the sales rose to 632,000 E-3Ws, accounting for over 49% of all 3W sales, growing at over 1.5x. It is estimated to reach over 1 million in sales by FY'30, growing at a CAGR of over 11%.

Exhibit 5.4: Domestic Electric Vehicles Market, 3W, Sales Forecast, India, FY24-FY35



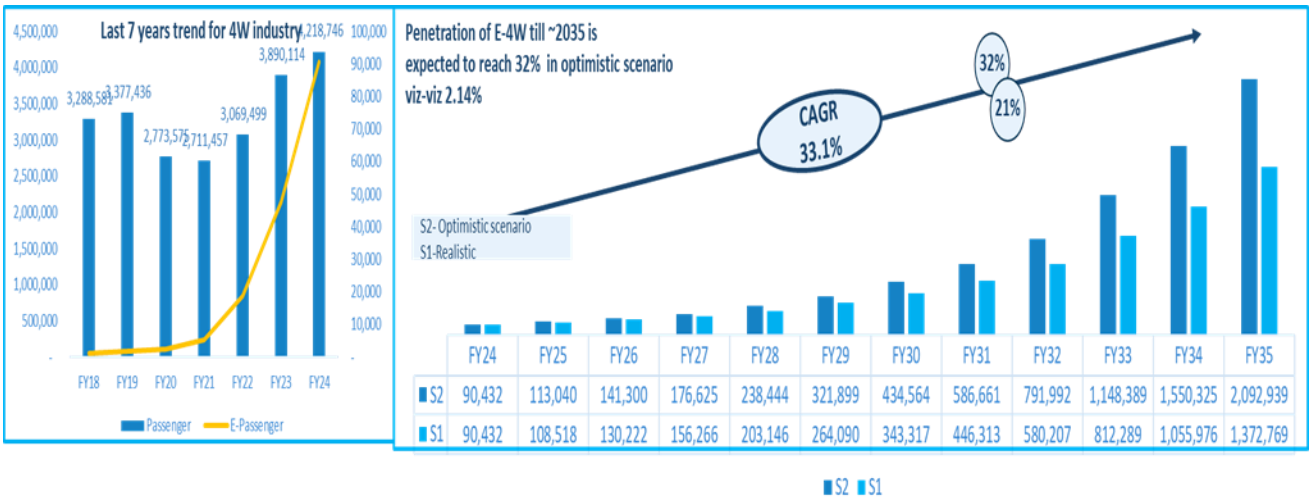
	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
S2	632,485	664,109	697,315	732,180	768,789	884,108	1,016,724	1,169,233	1,344,618	1,546,310	1,778,257	2,044,995
S1	632,485	664,109	697,315	767,046	843,751	928,126	1,020,938	1,123,032	1,235,336	1,358,869	1,494,756	1,644,232

Source: Frost & Sullivan Analysis

The E3W cargo segment is forecast to grow faster as the last-mile delivery ecosystem grows significantly, creating many growth opportunities for E3W commercial applications. Many established OEMs (e.g., Mahindra Electric, Piaggio) and start-ups are entering the cargo fleet business and supporting the growing demand for last-mile services in India, boosting the E3W market. The latest technological and digitalization trends, along with emerging platforms and accessible, cost-effective financing solutions, are set to accelerate the growth of India's electric three-wheeler (E3W) market. New start-ups are emerging with the help of venture capitalists, leading to a highly competitive market.

5.2.3. Electric Passenger Car(4W) Analysis

Exhibit 5.5: Domestic Electric Vehicles Market, 4W – Passenger Cars, Sales Forecast, India, FY24-FY35

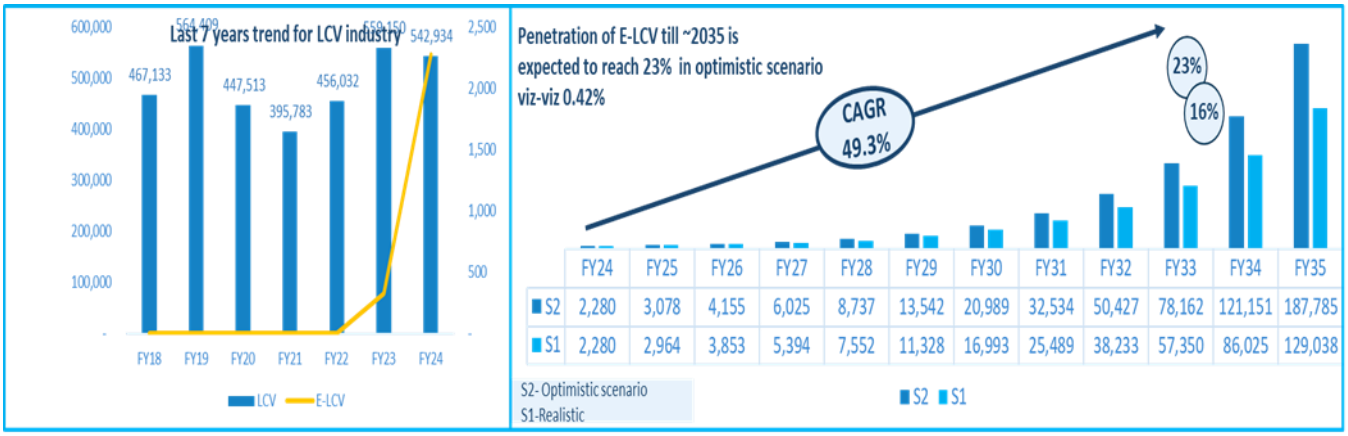


Source: Frost & Sullivan Analysis

In FY'23, close to 47,500 e-Passenger Cars were sold, comprising 1.2% of all Passenger Car Sales for the year. In FY'24, sales of e-Passenger Cars reached over 90,000, accounting for over 2% of all Passenger Car sales, nearly doubling in sales.

5.2.4. Electric LCV and MHCV Analysis

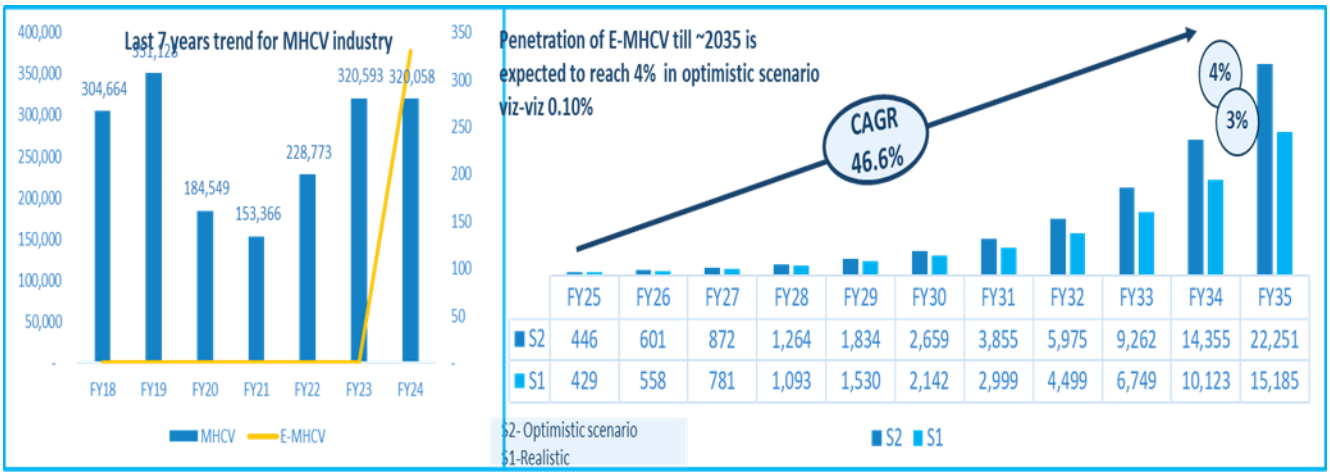
Exhibit 5.6: Domestic Electric Vehicles Market, 4W – LCV, Sales Forecast, India, FY24-FY35E



	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
S2	2,280	3,078	4,155	6,025	8,737	13,542	20,989	32,534	50,427	78,162	121,151	187,785
S1	2,280	2,964	3,853	5,394	7,552	11,328	16,993	25,489	38,233	57,350	86,025	129,038

Source: Frost & Sullivan Analysis

Exhibit 5.7: Domestic Electric Vehicles Market, 4W – MHCV, Sales Forecast, India, FY24-FY35E



	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
S2	446	601	872	1,264	1,834	2,659	3,855	5,975	9,262	14,355	22,251
S1	429	558	781	1,093	1,530	2,142	2,999	4,499	6,749	10,123	15,185

Source: Frost & Sullivan Analysis

Light Commercial Vehicles (LCV) Segment < 7.5T and Medium and Heavy Commercial Vehicle (MHCV) Segment 12-16T and > 16T will observe electrification in the domestic commercial vehicles market. The penetration of E-LCVs is at 0.42% and E-MHCV is at 0.10%, i.e. at a very nascent stage, and is expected to account for 16% of the overall LCV & MHCV industry by 2035.

5.3. Overview of the Domestic EV Drivetrain Market

The EV drivetrain is the system that transfers power from electric motors to the vehicle's wheels. Compared to internal combustion engine (ICE) drivetrains, EV drivetrains have fewer moving components, which makes them more efficient and requires less maintenance. EV drivetrains are projected to undergo significant advances in component design and operational efficiency. Advances in materials research have accelerated the creation of lighter and more resilient drivetrain components, thereby reduced energy loss and improving vehicle efficiency.

5.3.1. EV Drivetrain Components

EV Drivetrain, a key component of electric vehicles, is crucial for determining the vehicle's performance indicators, impacting its power, efficiency, and overall driving experience, making it a vital component of the vehicle.

The main components of an electric drivetrain system work together to convert electrical energy into mechanical power for vehicle propulsion.

Battery Pack System - The battery pack is the primary energy storage unit in an electric drivetrain system. It typically consists of lithium-ion cells arranged in modules and provides the electrical power needed to run the vehicle. The capacity and efficiency of the battery pack directly influence the vehicle's range and performance.

Electric (Drive) Motor - Although EV batteries supply DC (Direct Current) power, most electric motors used in electric vehicles are AC (Alternating Current) motors. To make this work, the motor controller—or inverter—plays a critical role by converting the battery's DC power into AC power suitable for the motor. This allows for precise control of motor speed and torque, improving efficiency and performance. For low-performance go-kart vehicles and two-wheelers, BLDC Hub motors are recommended. For three-wheelers and two-wheelers, BLDC motors with or without an external gear system are suitable. For high-power applications like two-wheelers, cars, buses, and trucks, Permanent Magnet Synchronous Motors (PMSM) or Induction motors are ideal. Once synchronous reluctance and switched reluctance motors become cost-effective, more options for electric vehicle applications can be achieved.

Motor Controller - It is an electronic module that interfaces between the batteries (DC power sources) and the motor (AC or BLDC). The choice of motor controller largely depends on the specific electric vehicle application and motor characteristics. Such considerations make it essential to select the most suitable controller to achieve the desired performance and energy efficiency.

Types of motor controllers – AC Induction Motor Controllers, BLDC Motor Controllers, PMSM Controllers

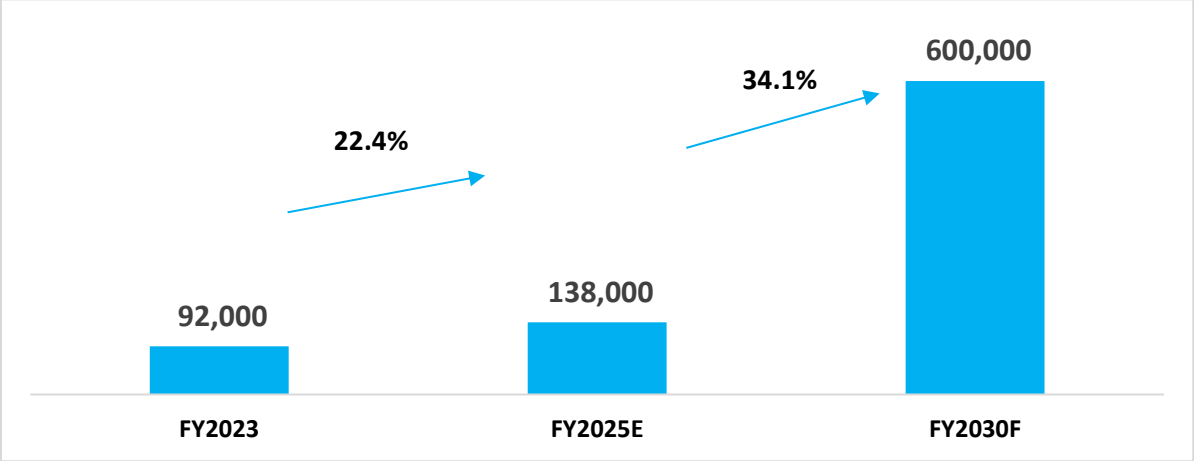
Transmission (Gearboxes) and Differentials - Gearboxes are key components of EV drivetrains for optimizing vehicle performance. Single-speed gearboxes, known for their simplicity and efficiency, are becoming increasingly common in electric vehicles due to their ability to offer a continuous and steady power supply. Multi-speed gearboxes, on the other hand, are still useful in hybrid vehicles and high-performance applications because they can optimize power across a wider range of speeds. An EV drivetrain differential serves a similar purpose as in traditional vehicles: it helps distribute power to the wheels, especially in multi-axle or all-wheel-drive configurations. However, EV differentials can differ significantly due to the unique nature of electric propulsion.

Vehicle control unit and Power Electronics - Power electronics, including the Vehicle control unit, are crucial for controlling and managing the flow of electrical energy from the batteries to the drivetrain and other electrical sub-systems. The main components include a Vehicle control unit, a DC-DC converter, and an On-board charger.

Thermal Management System - This system regulates the temperature of the battery, motor, and power electronics to maintain optimal operating conditions and extend the lifespan of components.

5.3.2. Domestic EV Drivetrain Market – Market Size and Growth Outlook (Excluding Battery)

Exhibit 5.8: Domestic EV Drivetrain Market, FY2023 - FY2025E- FY2030F, INR Million

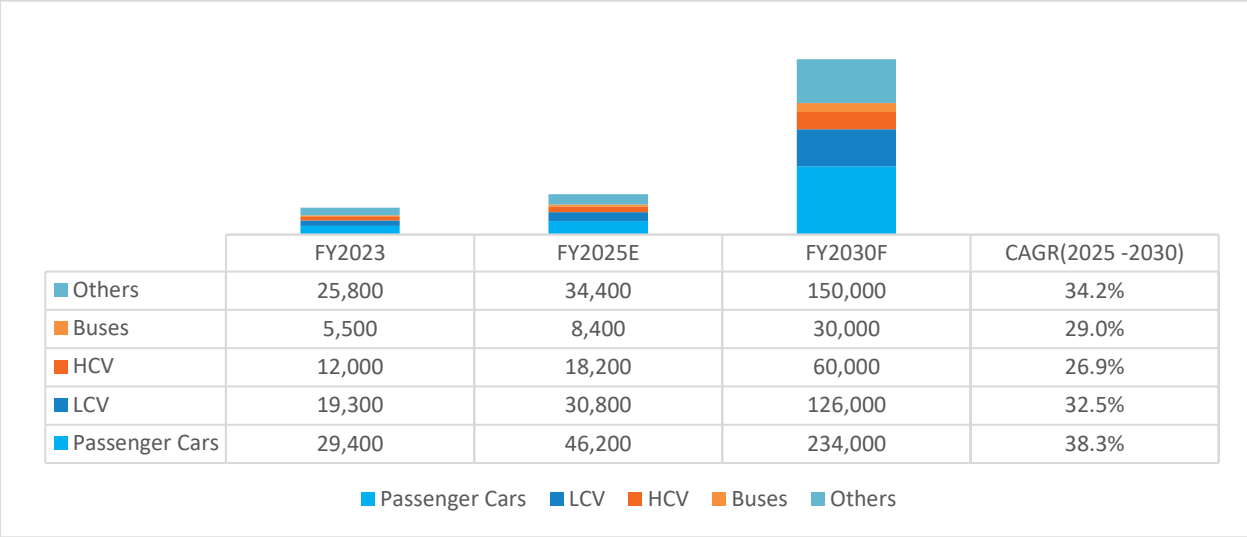


Source: Frost & Sullivan Analysis

The efficient operation of the drivetrain is made up of several components, including an electronic motor (synchronous and asynchronous), power electronic components, and various transmission units depending on the system utilized in the vehicle. These elements are more expensive, increasing the total cost of the electric drive system. The high cost of the drivetrain system is one of the reasons behind the increase in car pricing.

5.3.3. Domestic EV Drivetrain Market – Market Size by Vehicle Type (in value)

Exhibit 5.9. Domestic EV Drivetrain Market, Market Size by Vehicle Type, FY2023 - FY2025E- FY2030F, INR Million



	FY2023	FY2025E	FY2030F	CAGR(2025 -2030)
Others	25,800	34,400	150,000	34.2%
Buses	5,500	8,400	30,000	29.0%
HCV	12,000	18,200	60,000	26.9%
LCV	19,300	30,800	126,000	32.5%
Passenger Cars	29,400	46,200	234,000	38.3%

Others – e2w and e3w *Source: Frost & Sullivan Analysis*

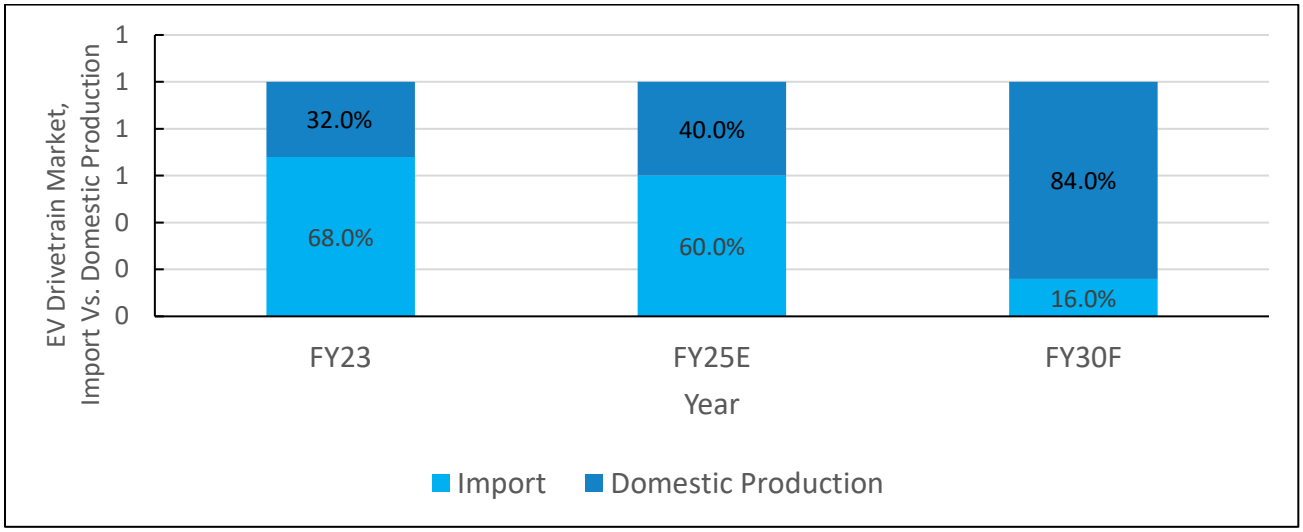
India's push toward vehicle electrification is set to boost demand for EV drivetrains significantly:

- Three-Wheelers (70–80% electrification): Rapid growth in cargo and urban passenger use is driving demand for compact, efficient drivetrains.
- Electric LCVs (20–30% penetration): Last-mile delivery growth is fueling the need for durable, high-torque drivetrains.
- Electric PVs (15–20% penetration): Urban adoption is rising, requiring scalable drivetrain platforms.
- Electric Buses (30% market share): Government-led fleet electrification is accelerating demand for high-performance drivetrains.

Favorable policies, falling battery costs, and urban logistics growth are key enablers of drivetrain market expansion across segments.

5.3.4. EV Drivetrain – Market Split by Import Vs. Domestic Production

Exhibit 5.10: EV Drivetrain, Market Split by Import Vs. Domestic Production , FY2023 - FY2025E-FY2030F



Source: Frost & Sullivan Analysis

India's electric vehicle (EV) industry faces significant challenges due to its heavy reliance on imported drivetrain components, which hampers local innovation and increases production costs. Around 60-70% of critical EV components, including motors, controllers, and gearboxes, are sourced from international suppliers, primarily from China. This reliance poses risks such as increased costs and vulnerability to supply chain disruptions during geopolitical tensions or global crises.

5.4. Indian Government Policy Announcements for the promotion of the EV market

- The Indian government has implemented several schemes to promote the adoption and manufacturing of hybrid and electric vehicles. The FAME India Scheme Phase-II, implemented from April 1, 2019, with a total budgetary support of ₹11,500 crore, incentivizes the production of e-2Ws, e-3Ws, e-4Ws, e-buses, and EV public charging stations. This scheme is no longer active, having officially ended in March 2024. A temporary extension was granted until July 31, 2024, to prevent disruption to the EV sector. However, the scheme was widely regarded as a landmark initiative to accelerate the adoption of electric vehicles in India.

- **The Production Linked Incentive (PLI) Scheme for Automobile and Auto Component Industry** in India (PLI-Auto) aims to enhance India's manufacturing capabilities for Advanced Automotive Technology (AAT) products with a budgetary outlay of ₹25,938 Crore. The Government notified this scheme on 23rd September 2021. The PLI Scheme for the Automobile and Auto Components Industry supports the domestic manufacturing of key EV drivetrain components to boost India's EV ecosystem. It covers traction battery packs, Battery Management Systems (BMS), electric motors (PMSM, induction motors), power electronics controllers (inverters, motor controllers, DC-DC converters), onboard chargers, electric axles, transmissions, and Vehicle Control Units (VCU). The scheme aims to enhance India's EV manufacturing capabilities by incentivizing the use of these advanced components and reducing import dependence.

- **The PLI Scheme for Advanced Chemistry Cell (ACC)** was approved on May 12, 2021, with a budgetary outlay of ₹18,100 crore. The scheme aims to establish a competitive domestic manufacturing ecosystem for 50 GWh of ACC batteries.

- **PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme** comes with a budget of ₹10,900 crore, notified on 29th Sep 2024. The two-year scheme supports electric vehicles, including e-2W, e-3W, e-Trucks, e-buses, e-Ambulances, EV public charging stations, and upgradation of vehicle testing agencies.

- **PM e-Bus Sewa-Payment Security Mechanism (PSM) Scheme:** This Scheme, notified on 28th October 2024, has an outlay of ₹3,435.33 crore and aims to support the deployment of more than 38,000 electric buses. The scheme provides payment security to e-bus operators in the event of default by Public Transport Authorities.

- **Scheme for Promotion of Manufacturing of Electric Passenger Cars in India (SPMEPCI)** was notified on 15th March 2024 to promote the manufacturing of electric cars in India, requiring applicants to invest a minimum of ₹4,150 crore and achieve a minimum Domestic Value Addition (DVA) of 25% at the end of the third and 50% at the end of the fifth year.

5.5. Dominance of Chinese Manufacturers in the Global and Indian EV Market

Role in the Global Market:

The Chinese government significantly bolstered the EV sector by enhancing infrastructure, supporting research, and providing subsidies to local manufacturers, establishing China's global dominance.
In Asia, Chinese EVs face low consumer preference due to limited brand recognition, trust, and infrastructure availability. To address these challenges, Chinese OEMs will initially support the region's efforts to accelerate electric mobility adoption, focusing on battery technology.
Chinese companies are expanding into both established and emerging markets for electric vehicles (EVs) due to their access to critical minerals, production capacity, and innovation. China currently produces 54% of the world's EVs and supplies key components to global car manufacturers like Tesla and Toyota. China's control of key mineral supplies and refining capacity has secured its position in the global EV market.
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5.6. Competitive Landscape of Domestic EV Drivetrain Solution Providers

	Company	Description	Components Offering	Segments Focus
1	Electra EV (Electro drive Powertrain Solutions Pvt Ltd, Coimbatore)	Involved in the design, development, manufacturing, supply, and servicing of EV powertrains.	Entire Powertrain kits, Battery packs, Chargers	4Ws (Passenger cars and Commercial Vehicles)

2	Tata AutoComp, Pune	One of the largest EV component suppliers in India, catering to multiple vehicle segments.	Battery Pack, BMS, Battery Thermal Management System, Motors, Controllers, Integrated Drivetrain, E-Compressor, Cooling Modules, AC & DC Chargers (3 kW to 300 kW)	2W, 3W, 4W
3	Entuple E-Mobility, Bangalore	EV R&D house specializing in Drivetrains (Motors + Controllers) and Charging Stations.	BLDC, PMSM, SynRM electric motors (1kW-150kW), Controllers, Charging Station Development	2Ws, 3Ws, 4Ws, Heavy Commercial Vehicles
4	Dana TM4, Pune	Manufacturing high-voltage motors and inverters for e-buses and various EVs.	Motors, Inverters, Vehicle Control Units	2W, 3W, 4W, Heavy Vehicles
5	Rotomag Enertec Limited, Gujarat	Rotomag Enertec Limited offers a range of industrial drive solutions under multiple brands, including “Rotomag,” “Rotomotive,” “Rotodrive,” and “Cyclo,” and manufactures PMDC, BLDC, and AC motors, as well as gearboxes	Motors, Controllers, Differentials	2W, 3W, Golf Carts
6	Virya Mobility, Bangalore	A Maini Group company offering e-mobility solutions, chargers, and powertrains.	1kW-30kW powertrain components, Chargers, DC-DC Converters	3Ws (e-Rickshaws, e-Auto), 4W Micro Trucks
7	Sona Comstar, Gurgaon	Developing integrated powertrain solutions for EVs in Indian & international markets.	Final Drive Differential Assembly, Hub-Wheel Motor (2W), Drive Motor (2W & 3W), Motor Controller	2W, 3W, 4W
8	SEG Automotive, Bangalore	Former Bosch division, now producing e-motors for Indian & overseas markets.	Electric Motors (5kW & 8kW), Controllers	2W, 3W
9	Jayem Automotives, Coimbatore	Over four decades in automotive product development, focusing on e-mobility.	Induction Motors, Controller, Charger	N/A
10	Napino Auto & Electronics, Gurgaon	Leading automotive electronics supplier, working with Ather Energy and other OEMs.	Electric Motors (BLDC), Controllers, BMS, Wire Harness	2W, 3W

11	Rizel Automotive, Hyderabad	Developing high-performance, lightweight, low-cost EV motors for pilot runs.	PMSM Motors (20kW-150kW for 3W, 4W, Heavy Vehicles), Developing 2kW-20kW Motors for 2W, 3W	3W, 4W, Commercial Vehicles
12	Mahle Electric Drives India, Coimbatore	Manufacturing electric motors for EV applications.	Electric Motors	2W, 3W
13	Elecnovo Pvt Ltd, Bangalore	Specializing in indigenous electric motors and controllers for EVs.	Electric Motors, Electronic Controllers	Electric Bicycles, e-Rickshaws, e-Scooters, Motorcycles, Passenger & Goods Vehicles
14	C-Electric Automotive Drives, Cochin	Provides scalable electric powertrains up to 20kW; supplies controllers to SEG Automotive.	Controllers, Instrument Clusters	2W, 3W
15	Konmos Technologies, Rajkot	Produces drivetrains; offers custom solutions for OEMs.	PMSM Motors (1kW-50kW), Controllers	2W, 3W
16	Physics Motor Technology, Bangalore	Focuses on BLDC & PMSM traction motors for EV powertrains.	Hub Motors (800W-2kW for 2W), Mid-Mount Motors (3kW-20kW for 2W & 4W)	2W, 3W, 4W
17	Sterling Gtake E-Mobility, Faridabad	JV between Sterling Tools Ltd. & Jiangsu Gtake Electric Co. Ltd for EV motor control units.	Motor Controllers, Induction & PMSM Motors	N/A
18	Temsrax, Hyderabad	Claims to be India's first indigenous EV powertrain manufacturer.	Electric Motors (BLDC, PMSM), Controllers, Chargers, DC-DC Converters	2W, 3W
19	TSUYO Manufacturing, Noida	Specializes in BLDC and PMSM powertrains and conversion kits.	Motors (BLDC, PMSM, AC Induction), Controllers	2W, 3W, 4W, e-Cycle, e-Tractor, e-Truck, Golf Cart
20	Varroc, Pune	Supplies inverters and motors for EVs; works with Bajaj.	Inverters, Motors	N/A
21	Axiom EV Products, Hyderabad	Develops chargers, converters, and motor controllers for EVs.	Chargers, Converters, Motor Controllers	3W, 4W

Overview of Select Products with Applications in Railways

6.1. Overview of Select Products with Applications in Railways

A. BLDC (Brushless Direct Current) Carriage Fans

BLDC (Brushless DC) carriage fans are widely used in railway applications due to their energy efficiency, durability, and low maintenance requirements. BLDC fans can operate on both AC and DC power supplies, making them suitable for various railway power systems

Key Features and Benefits

Energy Efficiency: BLDC carriage fans consume up to 50% less power compared to conventional fans, significantly reducing energy costs for railways

Durability: The brushless design extends the motor's lifespan, reducing maintenance requirements and improving overall reliability

Less Noise: BLDC fans operate at noise levels below 55 dBA, which ensures quieter performance compared to traditional fans

BLDC fans are used in various types of railway carriages, including:

- EMU (Electric Multiple Unit)
- DMU (Diesel Multiple Unit)
- MEMU (Mainline Electric Multiple Unit)

These fans are designed to operate efficiently in the challenging conditions of railway coaches, providing improved performance and energy savings.

Key application areas

- Passenger coach ventilation and Cooling
- Locomotive cab cooling
- Electronics cooling
- Toilet ventilation systems

B. Auxiliary Motors

Auxiliary motors play a crucial role in railway systems, providing power for various essential functions beyond the main traction motors. These motors are typically AC, 3-phase, squirrel cage induction type, known for their robustness and low maintenance requirements.

Types of Auxiliary Motors in Railways - Applications

- Blower Motors – Provide cooling for traction motors and electrical components.
- Compressor Motors – Power air compressors for braking and pneumatic operations.
- Pump Motors – Drive oil and water pumps for cooling and lubrication systems.
- HVAC Motors – Operate heating, ventilation, and air conditioning (HVAC) systems.
- Battery Charging Motors – Maintain battery power for emergency and auxiliary systems.
- Door Operation Motors – Enable automatic opening and closing of train doors.

Importance of Auxiliary Motors in Railways

- Enhance passenger comfort (air conditioning, lighting, etc.).
- Support braking and safety systems (compressor motors for air brakes).
- Improve efficiency by ensuring optimal operating conditions for traction motors.
- Maintain uninterrupted power supply for essential onboard systems.

By providing reliable electrical power to these crucial systems, auxiliary motors contribute significantly to the overall performance, safety, and comfort of railway operations.

C. Traction Motors

Traction motors are essential components in railway systems, responsible for converting electrical energy into mechanical power to propel trains. These motors are designed to operate under demanding conditions, providing high torque at low speeds and efficient performance across various speed ranges.

Types of Traction Motors

1. DC Traction Motors
    - Used in older locomotives and metro systems.
    - Require frequent maintenance due to brushes and commutators.
    - Examples: Series-wound DC motors.
2. AC Traction Motors
    - More efficient, reliable, and requires less maintenance.
    - Used in modern locomotives and high-speed trains.
    - Examples: Three-phase induction motors and permanent Magnet Synchronous Motors (PMSM).

Applications

- Electric locomotives
- Diesel-electric locomotives
- Electric Multiple Units (EMUs)
- Light Rail Vehicles (LRVs)
- Metro systems
- High-speed trains

D. Point Machines

Point machines, also known as switch machines or turnout machines, are essential devices used in railway systems to control the movement of railway switches or turnouts, guiding trains from one track to another. These machines play a crucial role in ensuring safe and efficient rail operations.

Importance in Railway Infrastructure

Point machines are vital components of railway signaling and control systems. They ensure that trains are directed along the correct routes and prevent accidents due to improper switch alignment. As railway

technology has advanced, point machines have become increasingly sophisticated, incorporating features like:

- Remote operation capabilities
- Automated control systems
- Sensors for position monitoring
- Maintenance and lubrication points for improved longevity

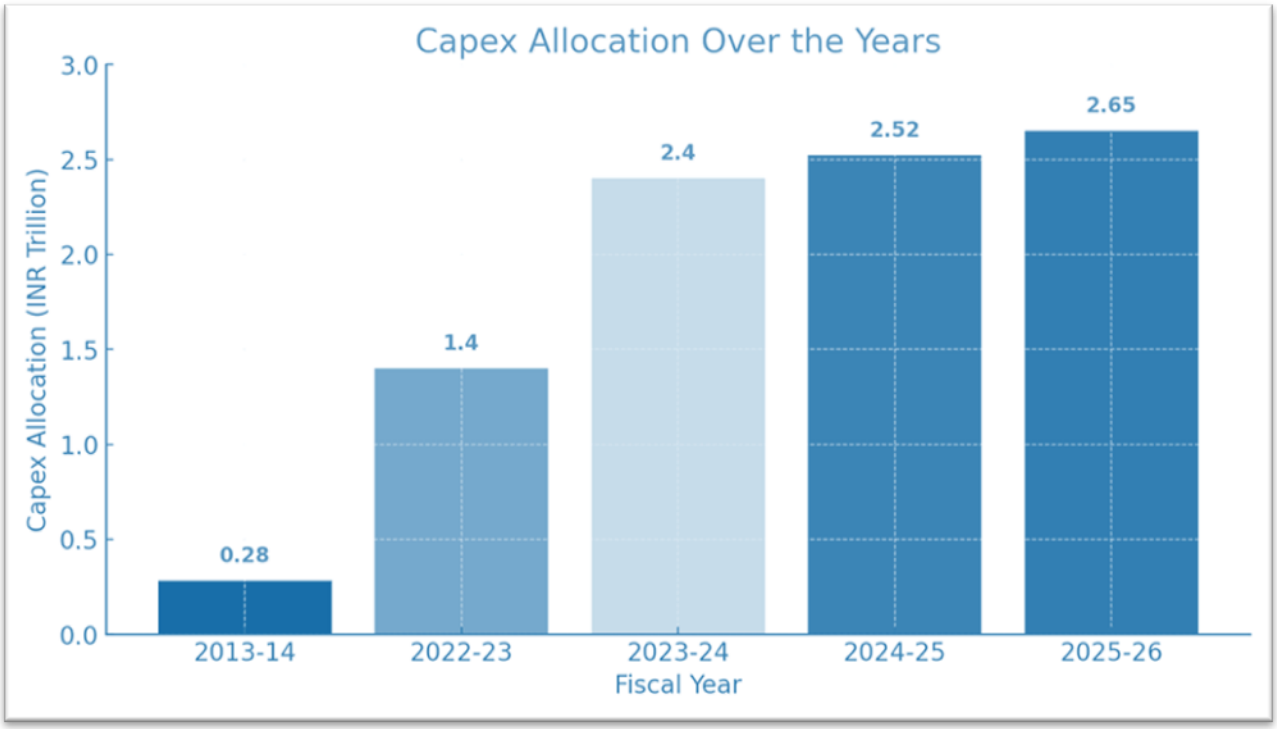
Key Installation Locations

- Mainline Railways
- Metro and Light Rail
- Industrial Railways
- High-Speed Rail Networks

6.2. Size of Capex for Indian Railways

Indian Railways has seen a significant increase in its capital expenditure (capex) over the past decade, with substantial allocations aimed at modernizing infrastructure, enhancing safety, and expanding capacity. Below is a summary of the historical capex data and projections.

Exhibit 6.1: CAPEX Allocation of Indian Railways, FY2013-14, FY2025-2026 INR Trillion



Source: Frost & Sullivan Analysis

In the fiscal year 2024-25, Indian Railways received a capex allocation of ₹2.52 trillion, marking a 5% increase from the previous year. This budget emphasizes safety, with ₹1.08 trillion dedicated to critical safety works, including the implementation of the Kavach system and the overhaul of old lines. The 2023-24 budget allocated ₹2.4 trillion for capex, focusing on railway tracks, wagons, trains, electrification, signaling, and station development. This expenditure is part of a broader government push to open new lines and expand electrification, targeting net-zero carbon emissions by 2030. The government has set ambitious goals, including achieving net-zero carbon emissions and completing Dedicated Freight Corridors, which require substantial investments in infrastructure, technology, and safety measures. The consistent increase in capex allocations reflects the government's commitment to transforming Indian Railways into a modern, efficient, and safe transportation network.
The Indian Railways plans to procure 7,000-8,000 new train sets over the next decade, aim to reach 3,000 MT freight loading by 2030 and construct 100,000 km of new railway tracks over the next 20 years. This ambitious growth trend and historical growth suggest that the capex for Indian Railways could increase significantly by 2030, potentially reaching or exceeding Rs 3 trillion annually.

Indian Railways' capital expenditure (capex) highlights from the Union Budget 2025-26, focusing on railway tracks, wagons, trains, electrification, signaling, and station development:

- Total Capex: ₹26,500 billion (unchanged from FY25), with ₹25,200 billion from budgetary support.
- Railway Tracks: ₹228 billion for track renewal; part of ₹46,000 billion for new projects for new lines and doubling.
- Wagons & Trains: ~₹509.03 billion (based on FY25) for 200 Vande Bharat, 100 Amrit Bharat, 50 Namo Bharat trains, and 17,500 non-AC coaches.
- Electrification: Funding embedded in ₹26,500 billion to complete 100% broad-gauge electrification by March 31, 2026.
- Signaling: ₹68 billion for upgrades, including the Kavach system on 15,000 km of tracks.
- Station Development: Included in ₹46,000 billion in new projects, targeting 1,309 station upgrades over time.

6.3. Key Growth Drivers for Indian Railways

The Indian government is implementing several initiatives to boost growth and modernize railway infrastructure, focusing on infrastructure expansion, technological advancements, and operational efficiency improvements.

Infrastructure Development

National Rail Plan 2030 - The government has developed a National Rail Plan (NRP) 2030 to build infrastructure by 2030 that can cater to traffic requirements up to 2050. This comprehensive plan aims to expand and upgrade the existing railway network significantly.

High-Speed Rail Projects - India is developing its first high-speed rail corridor between Mumbai and Ahmedabad, spanning 508 kilometers. The project, overseen by the National High-Speed Rail Corporation

Limited (NHSRCL), is expected to revolutionize inter-city travel and showcase India's technological capabilities.

Dedicated Freight Corridors - The Dedicated Freight Corridor project aims to enhance freight capacity and reduce logistics costs. This project is transforming India's logistics sector by allowing increased freight transportation without interference from passenger trains.

Technological Advancements

Vande Bharat Trains - Indian Railways aims to produce 400 new Vande Bharat trains over the next three years. These semi-high-speed trains represent a significant upgrade in passenger comfort and travel time.

Hydrogen Trains - The railway sector is introducing hydrogen trains as part of the Hydrogen for Heritage initiative. This aligns with achieving net-zero carbon emissions by 2030 and demonstrates a commitment to sustainable transportation.

Kavach Safety System - The indigenous train collision avoidance system, Kavach, has been deployed across major railway zones, covering over 1,548 Route Kilometers (RKm). This technology significantly enhances railway safety.

Modernization Initiatives

Station Redevelopment - The Amrit Bharat Station Scheme aims to redevelop 1,337 stations, with work already underway at 1,197. This initiative focuses on improving passenger amenities and modernizing station infrastructure.

Electrification and Renewable Energy - Indian Railways is pursuing 100% electrification of its network. Additionally, it aims to achieve 30 GW of renewable energy capacity by 2029-30, with 375 MW of solar energy and 103 MW of wind energy already commissioned as of October 2024.

6.4. Threats and Challenges for Products/ Components Supplied for Railways in India

Market and Competition Issues

- Intense Competition: The entry of inexperienced companies from unrelated sectors has led to smaller tender sizes and aggressive pricing strategies, intensifying competition.
- Relaxed Pre-qualification Criteria: This allows companies from unrelated sectors to bid on railway tenders, potentially compromising quality and safety standards.

Regulatory and Compliance Challenges

- Stringent quality standards by Indian Railways and RDSO.
- Slow procurement processes require extensive documentation and compliance.
- Policy uncertainty due to frequent changes in procurement policies and evolving technical specifications
- Limited design flexibility due to predetermined elements in EPC projects.

Supply Chain and Manufacturing challenges

- Procurement & Logistics: Large-scale orders require strong production capabilities, and disruptions in raw material supply can impact deliveries.
- Localization Pressure: Railways demand locally sourced components, limiting global supplier reliance.
- Quality Control: Investing in precision manufacturing and advanced machinery is crucial for safety and performance.

Financial and Operational Challenges

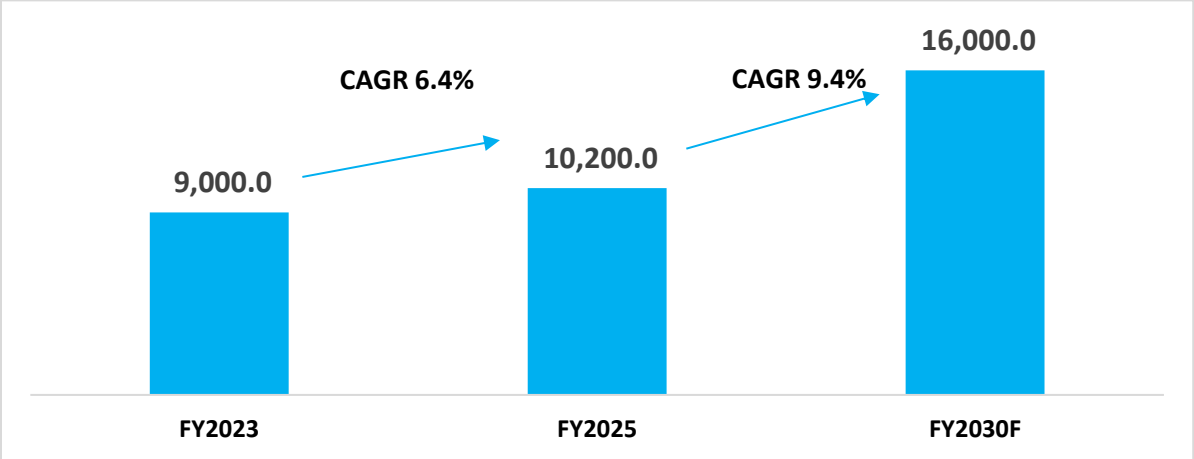
- Payment Delays: Employer's payment schedules cause financial strain for suppliers.
- Working Capital Issues: EPC contracts often limit payments towards later stages, causing financial pressure.
- High Initial Investment: Meeting railway specifications requires R&D, testing, and certification, increasing entry barriers.

RDSO vendor approval process poses several challenges and threats

- Stringent Standards: High technical and quality requirements can strain smaller vendors, risking rejection if unmet.
- Lengthy Process: Multi-stage approvals (20-25+ days) delay market entry and increase costs.
- Financial Burden: Significant investments in testing, infrastructure, and fees deter new or small firms.
- Competition: Established vendors dominate, limiting access for newcomers.

6.5. Domestic Traction Motors Market - Market Size and Growth Outlook

Exhibit 6.2: Domestic Traction Motors Market, FY2023 - FY2025- FY2030F, INR Million



Source: Frost & Sullivan Analysis

The Indian Domestic Traction motor market will be worth INR 10,200 million in FY2025. The market is predicted to grow at a CAGR of 9.4% over the next five years (FY2025-2030), owing to driven by the

modernization of rail networks and increasing demand for efficient transportation. The growth of metro rail networks, high-speed rail projects, technological advancements like regenerative braking systems and energy-efficient motors, and the integration of IoT and AI will further fuel the market. India's manufacturing hub status and sustainability focus will also contribute to market growth.
Indian Railways aims to achieve 100% electrification of its ~66,000 route kilometers (RKM) broad-gauge network by March 31, 2026. As of FY25, approximately 95% of the network is electrified, with the remaining ~3,300 RKM targeted for completion by FY26. The Union Budget 2025-26 has allocated ₹26,500 billion for electrification and rolling stock upgrades, driving significant demand for traction motors. By FY26, an estimated 5,000-6,000 additional traction motors will be required for new locomotives and Electric Multiple Units (EMUs). Key growth drivers include the transition from diesel to electric locomotives, the expansion of Vande Bharat trains, and the retrofitting of existing rolling stock.

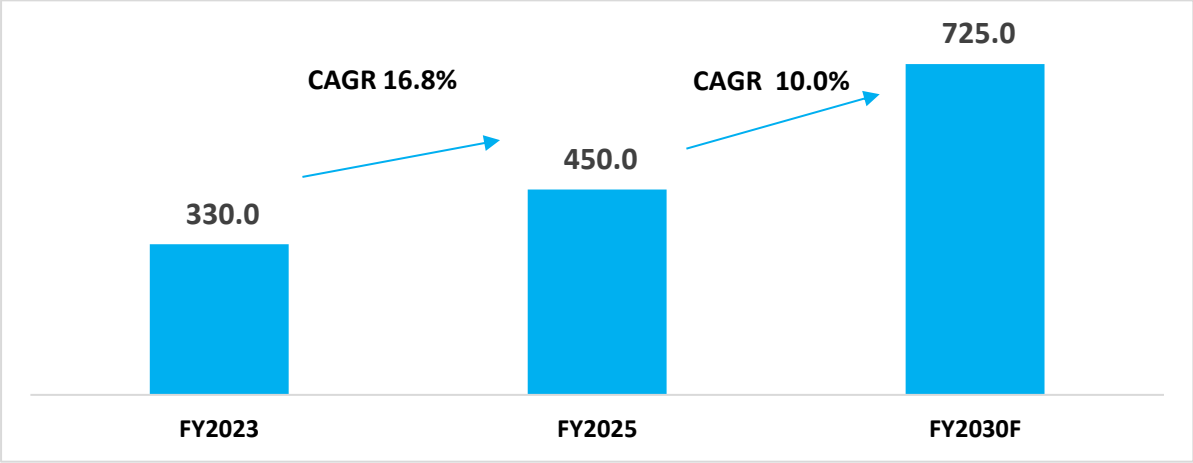
6.5.1. Key Growth Drivers for the Domestic Traction Motors Market

- **Rail Infrastructure Investments:** Indian Railways' modernization (e.g., Dedicated Freight Corridors) boosts traction motor demand, supported by Make in India policies.
- **Rail Electrification Goals:** Aiming for 100% electrification by 2030 increases demand for energy-efficient traction motors, with a focus on net-zero emissions.
- **Urban Rail Expansion:** Urbanization and metro rail growth in cities drive traction motor demand, alongside semi-high-speed projects like Vande Bharat Express.
- **Technological Advancements**: The adoption of efficient motors (PMSM, AC) and smart sensors enhances performance and maintenance.
- **Public-Private Partnerships & FDI:** Increased private sector involvement and foreign investments in rail infrastructure and traction motor manufacturing.
- **High-Power Locomotive Demand:** Expansion of freight corridors and higher-speed passenger trains necessitate advanced, efficient traction motors.

These factors support the growth of India's railway traction motor market as the country focuses on modernization and sustainability.

6.6. Domestic BLDC Carriage Fans Market - Market Size and Growth Outlook

Exhibit 6.3: Domestic BLDC Carriage Fans Market, FY2023 - FY2025- FY2030F, INR Million



Source: Frost & Sullivan Analysis

The Indian BLDC Carriage fans market will be worth INR 450.0 million in FY2025. The market is predicted to grow at a CAGR of 10.0% over the next five years (FY2025-2030) due to modernization initiatives, increasing passenger comfort expectations, and government policies promoting energy efficiency.

The market for BLDC carriage fans is anticipated to expand due to government policies promoting energy efficiency, increasing electric vehicle adoption, and increasing awareness of BLDC technology's long-term cost savings. BLDC fans are becoming increasingly popular in new trains and retrofitting existing coaches. Indian companies are manufacturing them locally, reducing costs and making them more accessible. Smart features like speed control and IoT monitoring are also gaining traction.

6.6.1. Key Growth Drivers for the Domestic BLDC Carriage Fans

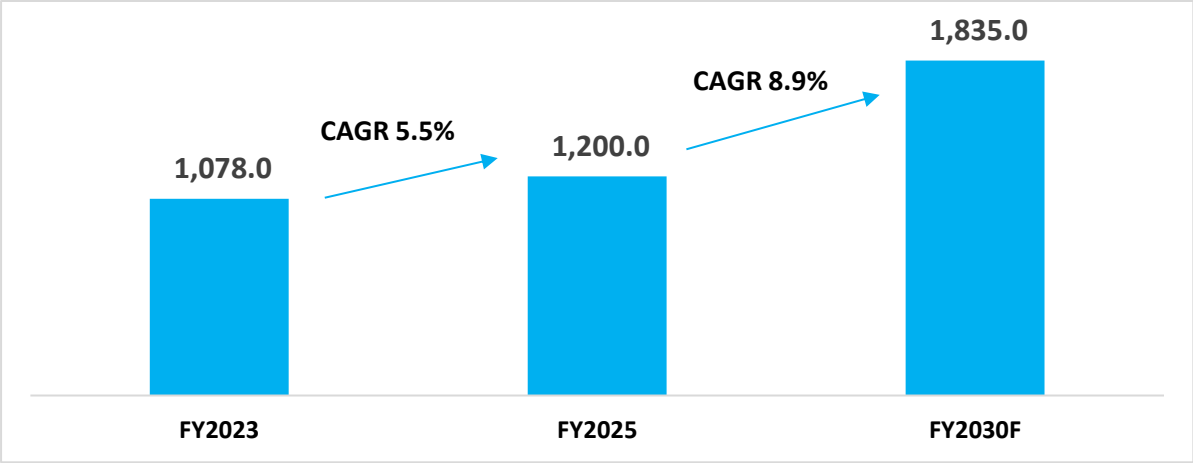
- **Energy Efficiency and Cost Savings -** BLDC fans are more energy-efficient than conventional fans, aiding Indian Railways' 2030 Net Zero emissions goal. BLDC fans use 30-50% less energy than conventional fans, reducing electricity costs and aligning with Indian Railways' goal to cut energy expenses.
- **Government Policies and Electrification Initiatives -** Indian Railways is replacing old fans with BLDC fans. The Bureau of Energy Efficiency (BEE) mandated star labeling for ceiling fans starting January 1, 2023, rendering older models obsolete. Increased electrification boosts demand for efficient components.

- **Incentives & Push for Sustainable Solutions -** Energy Efficiency Services Limited (EESL) initiatives: Government-backed organizations promote the adoption of energy-efficient appliances. Tenders favor energy-saving technologies: Railways increasingly specify BLDC fans in procurement contracts.

- **Technological Advancements -** BLDC fans feature low power consumption, lightweight design, low noise, and durability. They are suitable for fireproof coaches and can operate in extreme conditions. With fewer moving parts and no carbon brushes, BLDC fans require less maintenance and last longer.

6.7. Domestic Auxiliary Motors Market - Market Size and Growth Outlook

Exhibit 6.4: Domestic Auxiliary Motors Market, FY2023 - FY2025- FY2030F, INR Million



Source: Frost & Sullivan Analysis

The Indian Auxiliary Motors market will be worth INR 1200 million in FY2025. The market is expected to expand at a compound annual growth rate (CAGR) of 8.9% over the next five years (FY2025 -2030), driven by the modernization of Indian Railways, rapid urbanization, and the growth of metro rail projects. The railway sector accounts for a significant share of the market, with auxiliary motors being widely used in locomotives, coaches, and metro trains.

The Indian auxiliary motors market is expected to experience robust growth due to the railway sector's expansion, urbanization, and government initiatives. The adoption of smart and energy-efficient motors, with a focus on sustainability and digitalization, is expected to drive demand. The market will be strengthened by collaborations between domestic and international players for technology transfer and local manufacturing.

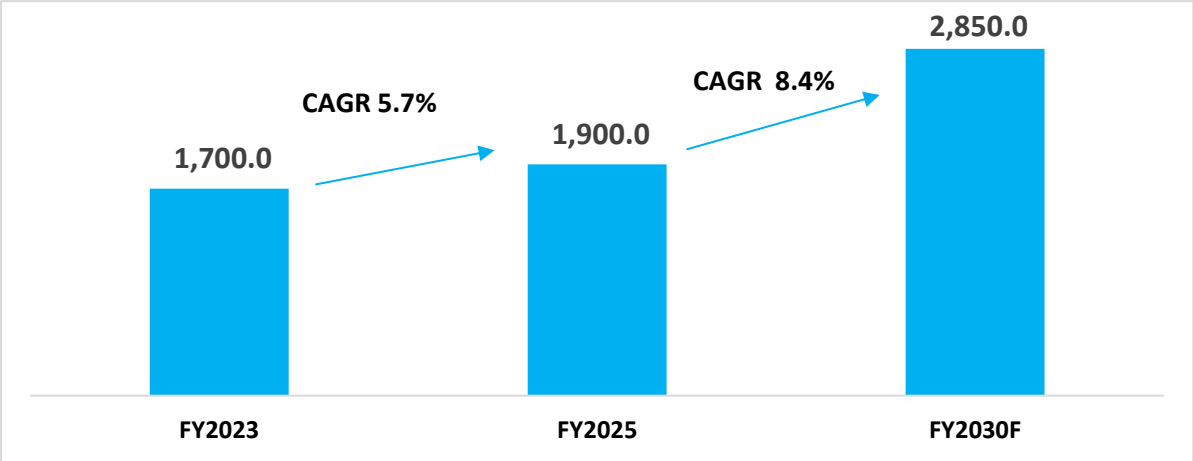
6.7.1. Key Growth Drivers for the Domestic Auxiliary Motors Market

- **Expansion of Railway Infrastructure:** India initially planned to electrify over 28,000 km of railway tracks by 2024 as part of its railway modernization efforts, but as of March 27, 2025, the scope and timeline have expanded. This electrification drive continues to boost demand for related infrastructure, including auxiliary power systems.
- **Increasing Production of Rolling Stock:** Wagon production rose from 22,042 in FY24 to 26,146 in FY25; locomotive production increased from 968 to 1,042, boosting demand for auxiliary motors.
- **Technological Advancements:** Modern technologies like static inverters and high-power density motors are enhancing auxiliary power systems.

- **Government Initiatives and Investments:** The government plans to introduce 100 Amrit Bharat trains, build 100,000 km of new tracks, and implement the Kavach safety system across 44,000 km. Government policies like 'Atmanirbhar Bharat' encourage local production of railway components, including auxiliary motors.
- **Shift Towards Electrification and Sustainability:** Focus on electrification and carbon reduction is increasing demand for efficient auxiliary power systems. The government's aggressive electrification drive and rapid urbanization increase demand for auxiliary motors in locomotives and coaches.

6.8. Domestic Point Machines Market - Market Size and Growth Outlook

Exhibit 6.5: Domestic Point Machines Market, FY2023 - FY2025- FY2030F, INR Million



Source: Frost & Sullivan Analysis

The Indian point machine market is expected to be worth INR 1900 million in FY2025. The market is predicted to grow at a CAGR of 8.4% over the next five years (FY2025- 2030), owing to increased investments in railway infrastructure and urban transport systems. The market size is influenced by government investments in railway modernization, expansion of metro rail networks, and the adoption of advanced signalling technologies. The Indian point machine market is expected to experience steady growth due to the Indian Railways' plan for 100% electrification and Kavach, efficient public transportation, and increased focus on safety and automation in railway operations.

6.8.1. Key Growth Drivers for the Domestic Point Machines Market

- **Railway Infrastructure Expansion:** Government focus on modernization and metro expansion boosts demand for advanced signaling systems.
- **Electrification and Automation:** 100% electrification and automatic signaling increased the need for electrically operated point machines and Communication-Based Train Control (CBTC) systems.
- **Safety and Reliability:** Investments in fail-safe signaling systems and European Train Control System (ETCS) Level 2 implementation enhance point machine adoption.
- **Make in India:** Local manufacturing initiatives reduce imports, with companies investing in domestic production of point machines.

- **Rising Traffic:** Increased passenger and freight traffic drives demand for efficient rail operations and reliable point machines.

6.8.2. Investments in the Domestic Point Machines Market

Modernization Efforts

Indian Railways is focusing on upgrading its technology and systems, which could potentially include investments in Point machines. There is a strong emphasis on improving safety systems, which may involve upgrading Point machines as part of the signaling infrastructure.

Texmaco Rail & Engineering's Strategic Partnerships: Texmaco Rail & Engineering has formed strategic alliances to enhance its technological capabilities. The company has collaborated with international players such as Wabtec Corporation (formerly GE Transportation) and Nymburk. These partnerships aim to leverage global expertise for the development of advanced railway components, including point machines.

6.9. Competitive Landscape of Domestic Companies

A. Traction Motors

Traction motors are critical components in electric vehicles (EVs), locomotives, and other rail systems. The growth in the railway sector and urban transportation systems drive the demand for traction motors. Companies are focusing on developing high-efficiency motors to meet the increasing demand for energy-efficient solutions.

There are around 8 - 10 players offering traction motors in the Indian market. Key players are listed below.

	Company	Product Offerings
1	**CG Power and Industrial Solution Limited**	Offers a wide range of AC and DC traction motors known for high operational efficiency, power-to-weight ratio, and reliability
2	**Medha Traction Equipment Pvt. Ltd**	A joint venture between Medha Servo Drives Pvt. Ltd. and Traktions systeme Austria, specializing in AC traction motors, traction alternators, and gearboxes for various railway applications
3	**Kirloskar Electric**	Kirloskar Electric manufactures traction motors, including the DC Traction Motor KTM-15250 and the DC 90 Traction Motor.
4	**Saini Electricals**	Saini Electricals manufactures AC/DC traction motors, alternators, reactors, auxiliary equipment, and sub-assemblies for various rail vehicles
5	**Rotomag Enertec Limited**	Offers Traction Motors for Material Handling systems

B. BLDC Carriage Fans

The need for energy-efficient and reliable solutions in railway applications drives the market for BLDC carriage fans. Companies are innovating to meet stringent specifications and improve fan performance.

BLDC fans are increasingly being adopted in Indian railways due to their energy efficiency, durability, and low maintenance requirements.

Key Players' details are listed below.

	Company	Product Offerings
1	**Light Engineering Corporation**	Leading manufacturer and supplier of BLDC railway carriage fans. They offer fans in various sizes and voltages, including 110V AC and DC.
2	**CG Power and Industrial Solutions Ltd.**	Developed BLDC fans for Indian Railways coaches, focusing on low power consumption, lightweight design, and low noise levels. These fans are suitable for fireproof coaches.
3	**Vidisha Electricals**	They are an approved vendor to Indian Railways for manufacturing and supplying rail carriage fans, including BLDC models. They offer various types such as bracket, fixed, and swiveling fans in sizes from 225 mm to 450 mm.
4	**R. Kanwar Electricals**	Located in Noida, Uttar Pradesh, they are an Indian Railways-approved OEM for BLDC railway carriage fans. Their fans come in sizes from 225 mm to 450 mm and are designed according to RDSO specifications.
5	**Saria Industries Corporation**	Approved by Indian Railways for manufacturing BLDC Fans, Crew Fans, Universal AC/DC Brushless Fans, and Wheel Set Earthing Equipment. They are ISO 9001:2015 and ISO 14001:2015 accredited.
6	**Rotomag Enertec Limited**	Indian manufacturer specializing in Brushless DC (BLDC) motors and gear motors, catering to various industrial applications. It offers a wide range of BLDC motors suitable for sectors like solar tracking, automation, and electric mobility.

C. Auxiliary Motors

The market is characterized by both domestic and international players striving to enhance their market positions. Companies are adopting strategies such as acquisitions, partnerships, and product launches to meet the evolving demands of the railway sector. The presence of established firms like BBL and Kirloskar Electric, alongside specialized manufacturers such as LHP Motors, contributes to a dynamic and competitive market environment.

Key Player's details are listed below.

	Company	Product Offerings
1	**LHP Motors**	LHP Motors has been supplying auxiliary motors to Indian Railways. Their motors are AC, three-phase, squirrel cage induction types, known for their robustness and minimal maintenance requirement.
2	**CG Power and Industrial Solutions Ltd**	CG manufactures and supplies auxiliary motors for locomotives as part of its comprehensive product portfolio for Indian Railways. Their auxiliary motors are designed to meet the demanding conditions of railway operations, contributing to the efficiency and reliability of locomotives.
3	**Saini Electricals**	SAINI offers a comprehensive range of auxiliary motors and alternators for various types of rail vehicles. They are an RDSO-approved vendor for supplying items to Indian Railways and focus on providing high-quality, reliable products.
4	**Medha Servo Drives Pvt. Ltd.**	A leading Indian company specializing in traction systems and auxiliary power solutions for railways.

D. Point Machines

Indian Railways, one of the largest railway networks in the world, relies on various suppliers for point machines, which are critical for the safe and efficient operation of railway tracks. Point machines are used to switch tracks and ensure the correct alignment of rails. There are 7 -8 key suppliers and manufacturers of point machines for Indian Railways. Key Player's details are listed below.

	Company	Product Offerings
1	**Kernex Microsystems (India) Ltd.**	Kernex is an Indian company specializing in railway signaling and safety systems, including point machines. They provide advanced point machines that comply with Indian Railways' standards.
2	HBL Power Systems Ltd.	HBL Power Systems is an Indian company that manufactures railway signaling equipment, including point machines. They are a trusted supplier for Indian Railways.
3	**Patil Group**	Manufactures 143 mm and 220 mm throw IRS-type electric point machines, both trailable and non-trailable, with AC & DC operation
4	**CG Power and Industrial Solutions Ltd.**	CG offers electric point machines in 143 mm, 220 mm, and 175 mm (both trailable and non-trailable types). Their machines feature internal locking and detection mechanisms and are designed for both left and right-hand operations.

5	**Rotomag Enertec Limited**	Rotomag Enertec Limited has supplied point machine motors for electric point machines to Indian Railways. Rotomag Enertec Limited is a supplier of point machine motors conforming to IRS specifications (IRS: S-37/82 Amd . 3) with 160V AC immunity, though without IP67 protection.

Overview of Domestic Agriculture Pumps Market

7.1. Overview of Domestic Agriculture Pumps Market

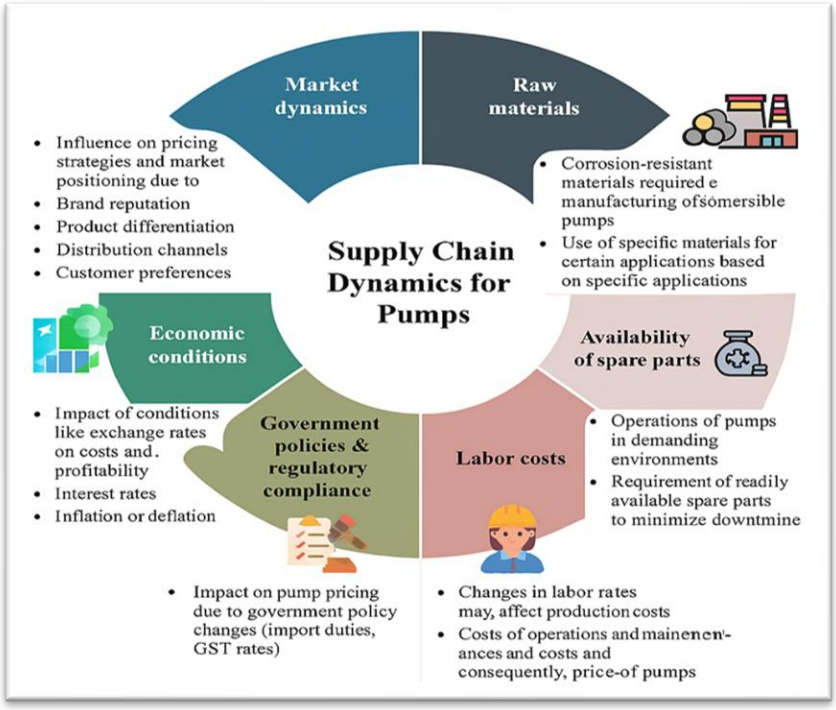
India's agricultural pump market plays a vital role in supporting the country's farming sector. These pumps extract water from diverse sources such as rivers, wells, and borewells, ensuring a steady water supply for crops and enhancing agricultural productivity. The market has grown significantly due to government initiatives, subsidies, and the need for efficient water management in agriculture. The demand for agricultural pumps is influenced by monsoon patterns, groundwater availability, and electricity supply in rural areas.

7.1.1. Different Types of Agriculture Pumps and Their Applications - Classification based on source of power

Exhibit 7.1: Agriculture Pump Types and Key Application Areas

Type of Pump	Description	Suitable For	Applications	Variants
Diesel-Operated Pumps	Engine-driven pump sets independent of grid; quick to deploy, high fuel and maintenance costs; emits exhaust.	Areas without reliable electricity, emergency use, mobile/temporary setups, small–medium farms.	Irrigation (flood/sprinkler), water transfer from canals/ponds/rivers, dewatering/flood drainage.	Trolley-mounted or stationary; centrifugal (most common) or trash pumps; recoil/electric start; 3–25 HP+ ranges.
Grid-Connected Electric Pumps	Motor-driven using utility power; low operating cost where power is reliable; supports automation and VFDs.	Regions with stable grid supply, medium–large farms, community tube-wells, high duty cycles.	Irrigation (sprinkler/drip), lift irrigation, water distribution networks.	Submersible borewell or surface/end-suction; single-phase/three-phase; multi-stage; with/without VFD/soft starter.
Solar Pumps	PV-powered, zero fuel cost; low O&M; primarily daytime operation; optional hybrid controllers.	Off-grid or poor-grid areas, remote farms, daytime irrigation, livestock watering.	Drip/sprinkler irrigation, rural water supply, pond/field lifting.	Submersible or surface; DC (BLDC) or AC (with inverter); optional hybrid solar-grid/diesel; with MPPT controller.

7.1.2. Key Supply Chain Dynamics of Pumps



- **Customization vs. Standardization:** Meeting unique performance requirements often necessitates product customization, which introduces additional complexity into the supply chain. Striking a balance between efficient mass production and tailored solutions remains a key challenge for manufacturers.
- **Geographical Dispersion:** The global nature of centrifugal pump manufacturing adds another layer of complexity. Different regions often specialize in specific types or sizes of pumps—for instance, Japan is known for heat pumps, while Germany and Italy are recognized for delivering customized pumping solutions tailored to chemical industry needs. This regional specialization impacts sourcing, logistics, and coordination within the supply chain.

7.2. Key Growth Drivers of the Domestic Agricultural Pumps Market

1. **Government Initiatives & Subsidies -** The Indian government has launched initiatives like PM-KUSUM to encourage farmers to adopt solar pumps. State-level subsidies for energy-efficient and solar-powered pumps, along with rural electrification programs, are also enhancing access to electric pumps for agricultural use.
2. **Rising Farm Mechanization** -The trend toward farm mechanization is boosting the demand for agricultural equipment, including pumps. Farmers increasingly invest in mechanized solutions to reduce labor costs and improve productivity.

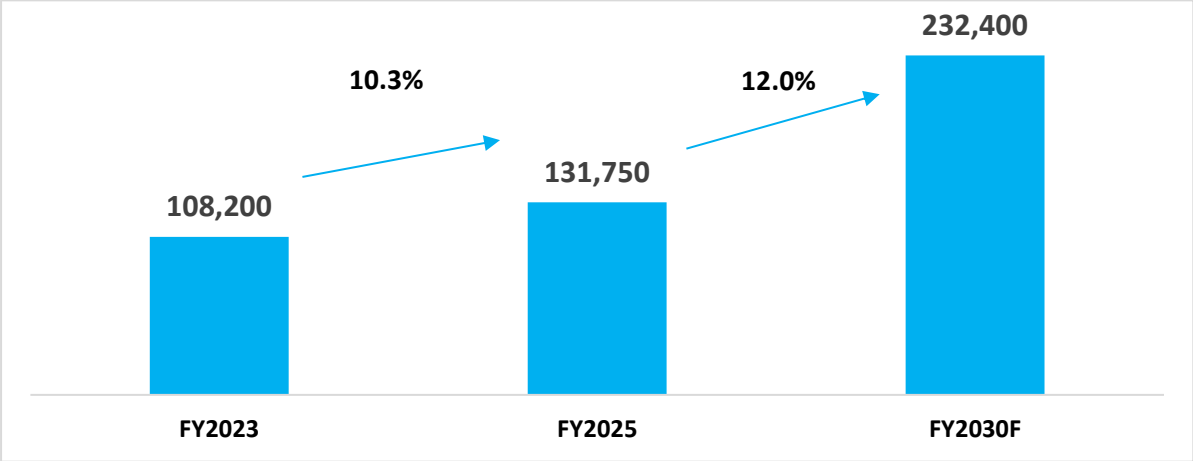
3. **Rising Demand for Water-efficient Solutions -**With the depletion of groundwater levels and erratic rainfall patterns, there is an increasing demand for energy-efficient and high-capacity pumps. Both government and private sector efforts are focused on promoting drip and sprinkler irrigation systems to meet this demand.
4. **Adoption of Solar-powered Pumps** - Adopting off-grid solar pumps is increasing, largely due to unreliable electricity in rural areas. The declining prices of solar panels are also making these pumps more accessible and affordable for farmers.
5. **Growth in Agri-tech & Smart Irrigation** -The agricultural sector is integrating IoT-enabled smart pumps that facilitate remote monitoring and enhance efficiency. These smart pumps are being paired with precision farming technologies to boost agricultural productivity.
6. **Increasing Rural Electrification & Grid Connectivity -**The development of rural electricity infrastructure is essential for the shift from diesel to electric pumps. Programs like the Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) are improving power supply in rural areas.
7. **Financing and Micro-credit Availability -** Increasing access to microfinance, NBFC loans, and equipment leasing is helping small and marginal farmers invest in pump technologies

7.3. Threats and Challenges for the Domestic Agricultural Pumps Market

1. **High upfront costs and financial constraints:** Agricultural pumps require significant initial investment, making it difficult for small and marginal farmers to afford them.
2. **Limited credit:** Farmers often lack access to affordable finance, making it difficult to purchase sophisticated pumping systems.
3. **Subsidy delays:** Government subsidies for agricultural pumps are often delayed or inadequate, deterring farmers from upgrading their equipment.
4. **Unreliable power supply and reliance on diesel pumps:** Frequent power outages and uneven electricity supplies in rural areas necessitate the use of diesel pumps, which are expensive and environmentally damaging.
5. **Environmental concerns:** Overuse of agricultural pumps leads to groundwater overexploitation, carbon emissions, and soil degradation.
6. **Infrastructure and supply chain issues:** Poor distribution networks and lack of after-sales support hinder farmers from investing in modern pumps.
7. **Competition from low-quality products:** The market is saturated with low-quality, low-cost pumps, reducing demand for high-quality, energy-efficient versions.
8. **Technological barriers:** Slow uptake of solar pumps due to high costs, lack of awareness, and technical hurdles.
9. **Market fragmentation:** Inconsistency in product quality and pricing due to multiple small and unorganized businesses.

7.4. Domestic Agriculture Pumps Market - Market Size and Growth Outlook

Exhibit 7.2: Domestic Agriculture Pumps Market, FY2023 - FY2025- FY2030F, INR Million



Source: Frost & Sullivan Analysis

The Indian Agriculture pumps market will be worth INR 131,750 million in FY2025. The market is predicted to grow at a CAGR of 12.0% over the next five years (FY2025- 2030). The Indian agricultural pump market is expected to grow rapidly due to government initiatives, increasing irrigation demand, and the expansion of rural electrification projects.

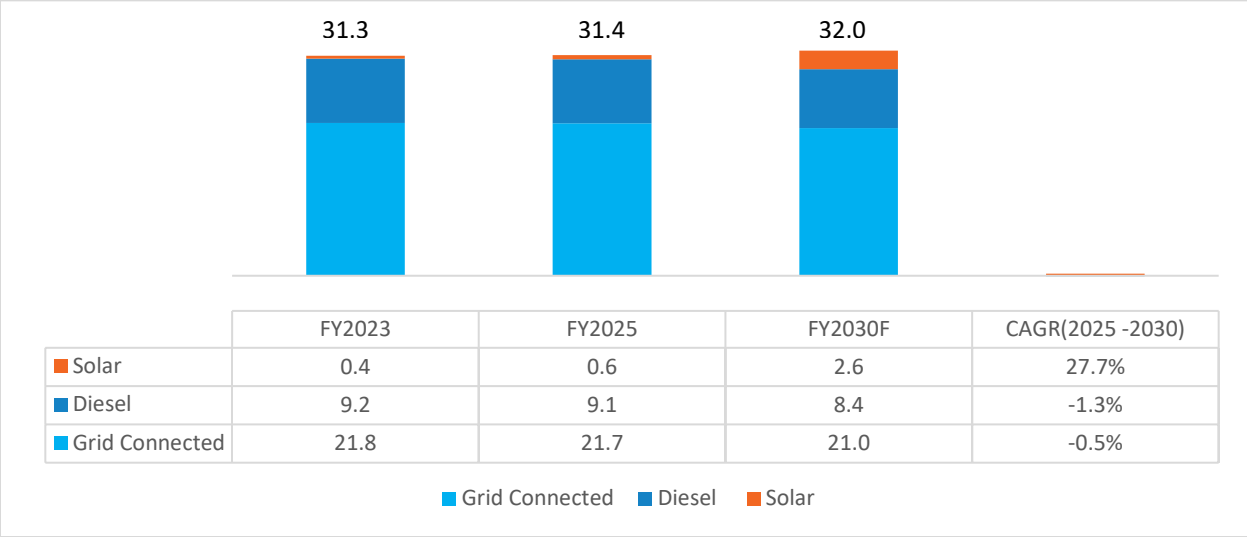
Agriculture remains a key driver of pump demand in India, owing to the country's vast agricultural landscape and the critical role of irrigation in farm productivity. Pumps are essential for effective water management, enabling reliable and efficient distribution of water across farmlands. Increasingly, farmers are adopting solar-powered pumps, attracted by lower operating costs and environmental sustainability compared to conventional diesel or electric pumps. This shift toward renewable energy solutions is further accelerating the transition to efficient and eco-friendly irrigation systems. Key players in the Indian agricultural pump market (grid connected) include CRI, Texmo, KBL, Lubi, Crompton, Jindal, Mahendra etc. Key players for the agriculture pumps (solar powered) include Oswal Pumps, Rotomag Enertec Limited and Shakti Pumps all of whom are actively catering to this growing demand.

High fuel costs, unreliable electricity, and the shift toward modern irrigation methods drive the rising demand for solar and energy-efficient pumps in Indian agriculture. Water scarcity and declining groundwater levels further accelerate the need for efficient submersible and borewell pumps. Increased farmer incomes, easier financing, and the growth of high-value crops through agri-exports and horticulture are making advanced irrigation technologies more accessible and essential. Further, Solar pump, being an independent stand-alone unit, is easily movable and therefore, is an enabler for crop diversification and irrigation scheduling.

7.5. Domestic Agriculture Pumps - Market Split by grid-connected, diesel, and solar (in volume)

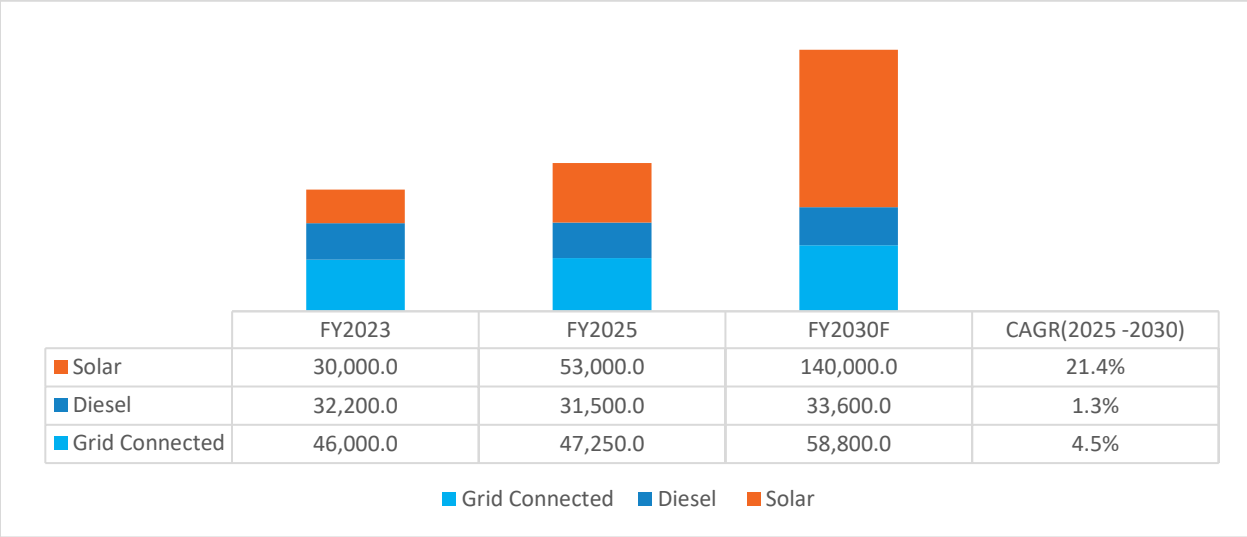
Grid-connected Pumps: Grid-connected pumps are widely used in India, particularly in regions with a reliable electricity supply. They are cost-effective for farmers with subsidized or low-cost electricity. They dominate the market due to their widespread availability and lower operational costs. However, their dependence on grid electricity makes them vulnerable to power outages and inconsistent supply, especially in rural areas.

Exhibit 7.3: Domestic Agriculture Pumps - Market Split by Source (in volume terms), FY2023 - FY2025-FY2030F, Mn unit



	FY2023	FY2025	FY2030F	CAGR(2025 -2030)
Solar	0.4	0.6	2.6	27.7%
Diesel	9.2	9.1	8.4	-1.3%
Grid Connected	21.8	21.7	21.0	-0.5%

Exhibit 7.3: Domestic Agriculture Pumps - Market Split by Source (in value terms), FY2023 - FY2025 FY2030F, INR million (



	FY2023	FY2025	FY2030F	CAGR(2025 -2030)
Solar	30,000.0	53,000.0	140,000.0	21.4%
Diesel	32,200.0	31,500.0	33,600.0	1.3%
Grid Connected	46,000.0	47,250.0	58,800.0	4.5%

Source: Frost & Sullivan Analysis

Diesel Pumps: Diesel pumps are used in remote and off-grid areas with limited access to grid electricity. However, their market share is declining due to rising diesel costs and environmental concerns. Challenges include high operational costs and environmental pollution, while government policies promoting cleaner energy alternatives are also reducing demand.

Solar Pumps: The Indian agriculture pumps market is expected to witness significant growth in the solar pumps segment, driven by government support and declining solar panel costs. Solar pumps in India are gaining popularity due to government initiatives promoting renewable energy and sustainable agriculture. These pumps, powered by solar panels, are ideal for regions with abundant sunlight. The market share is

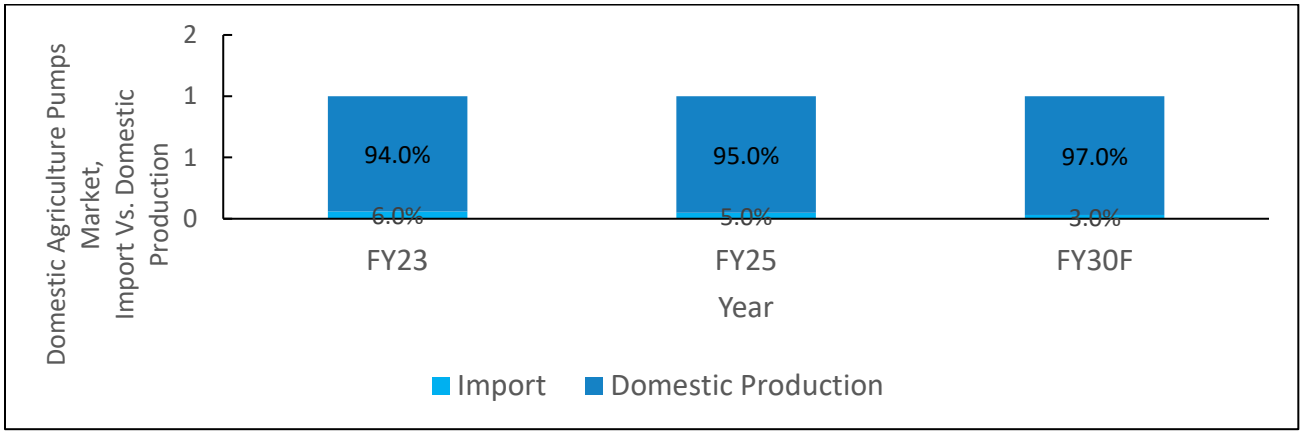
rapidly growing due to subsidies, falling costs, and the need for energy-efficient solutions. Challenges include high installation costs and dependence on sunlight availability.

The Indian agriculture pump market is shifting towards sustainable, energy-efficient solutions, with solar pumps emerging as a key player. Government policies and environmental concerns support this shift. Grid-connected pumps will continue to dominate in regions with reliable electricity supply, while diesel pumps are expected to lose market share due to environmental, reliability and cost concerns.

7.6. Domestic Agriculture Pumps Market - Market Split by Import vs Domestic Production

The import of agricultural pumps in India is quite insignificant since domestic manufacturers meet most of the demand. Price competition and low profit margins are the major hurdles foreign manufacturers face when attempting to break into the market. The pumps manufactured in China constitute the major share of imports, owing to their low costs. The imports constitute only about 5% of the total agricultural pump market in India. The government has been promoting "Make in India" initiatives, which could boost local manufacturing. India's recent focus on self-reliance and domestic manufacturing may result in a reduction in agricultural pump imports. The adoption of more efficient and technologically advanced pumps could influence import trends.

Exhibit 7.4: Domestic Agriculture Pumps, Market Split by Import Vs. Domestic Production , FY2023 - FY2025- FY2030F



Source: Frost & Sullivan Analysis

The Indian government is boosting the local manufacturing of agricultural pumps through various initiatives. Financial incentives and subsidies like PM-KUSUM (offering up to 90% subsidy) and state-level schemes support farmers in adopting efficient irrigation solutions. Under Make in India and Atmanirbhar Bharat, import restrictions, incentives for MSMEs, and startup support promote domestic production. Energy efficiency programs such as BEE star-rated pumps and AgDSM encourage the use of energy-efficient models. While pumps are not directly covered, the PLI scheme indirectly benefits manufacturers by supporting electric motors and solar panel components. The government also fosters R&D and technology upgrades through NICRA, ICAR, and IIT collaborations to develop cost-effective solutions. Additionally, digital initiatives like the Government e-Marketplace (GeM) enable direct procurement, while online subsidy portals streamline farmer access to benefits. If domestic manufacturers can meet the demand for advanced pumps, imports might decrease.

Overview of Global and Domestic Solar Pumps Market for household, agriculture, and public utilities applications

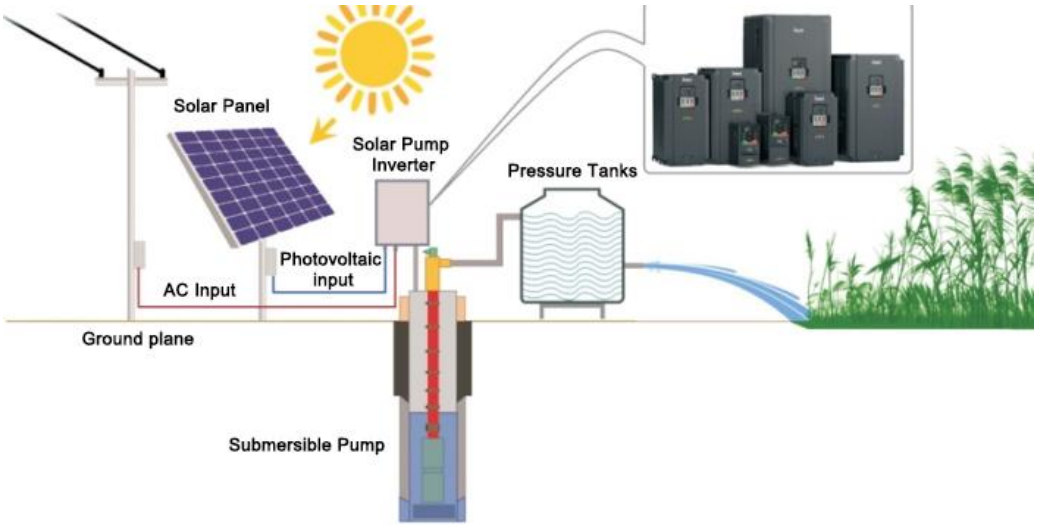
8.1. Solar Pumps Overview

A solar pump is an electric pump powered by electricity generated from solar panels. It harnesses solar energy to drive the motor, enabling the extraction of water from deep underground sources. As a clean and sustainable solution, it offers a reliable alternative to grid-dependent and diesel-powered pumps, which are often inconsistent or environmentally harmful. Solar pumps are widely used for agricultural irrigation, particularly in areas with limited or no access to electricity, as well as for domestic and community water supply.

There are two main types: Surface Solar Pumps, used for shallow sources like ponds, canals, reservoirs or rivers, and Submersible Solar Pumps, designed for deep sources like boreholes or wells. Both types are essential for water supply and transportation.

8.1.1. Primary Components of Solar Pumping System

Exhibit 8.1: Solar Pumping System – Pump and Key Components



Source: Cedar Solar

	Components	Functions/ Applications
1	Solar Photovoltaic (PV) Panels	Convert sunlight into electricity; power output depends on efficiency, size, and mounting orientation.
2	Pump Controller (Inverter/MPPT Controller)	Regulates voltage and current; MPPT optimizes power based on sunlight; protects pump from fluctuations and dry run.
3	Water Pump (AC or DC Pump)	Lifts and moves water from the source; available as surface or submersible, based on application.
4	Storage Tank (Optional)	Stores water for use during low sunlight; ensures a continuous supply during night or cloudy conditions

5	Piping and Distribution System	Transports water to tanks or fields; proper sizing reduces energy loss and boosts efficiency.
6	Batteries (Optional for Hybrid Systems)	Stores excess solar energy for night or cloudy use; often replaced by water tanks due to cost and maintenance.
7	Electric Motors	Drives the pump using solar power; typically, DC motors or AC motors with inverters.
8	Inverter (for AC Motor)	Converts DC to AC to power AC motors; not needed for DC pump systems.

8.2. Key Growth Drivers for Solar Pumps - Global Market

The growth of the solar pump market is driven by multiple factors, including strong government support through subsidies, the energy efficiency and cost savings offered by solar technology, and growing concerns around water scarcity, climate change, and erratic rainfall. The need to reduce dependence on diesel pumps, coupled with lower operating costs and suitability for remote areas with limited grid access, is accelerating adoption. Government initiatives such as India's PM-KUSUM scheme, the USA's Rural Energy for America Program, and the UAE's Solar Rebate Program are playing a key role. In addition to subsidies, many countries are offering grants, low-interest loans, and tax incentives to promote the use of solar pumps and other renewable energy solutions.

1. Increasing Interest in Sustainable Farming

Farmers are turning to solar pumps to lessen their dependence on costly or unreliable fossil fuels and grid electricity, especially in rural areas. These pumps offer an eco-friendly and economical irrigation solution, particularly in sunny regions.

2. Government Support and Financial Aid

Numerous governments around the globe are encouraging the use of solar energy through financial incentives, tax breaks, and subsidies for solar pump installations. Policies focused on lowering carbon emissions and meeting renewable energy goals are driving market expansion.

3. Falling Prices of Solar Technology

The prices of solar panels and associated components have significantly dropped over the years, making solar pumps more accessible for farmers and businesses. Enhanced efficiency and production scale have contributed to this cost reduction.

4. Energy Autonomy and Dependability

Solar pumps provide energy autonomy, especially in remote or off-grid locations with limited electricity access. They serve as a dependable power source for irrigation, lessening reliance on unstable grid electricity or diesel generators.

5. Water Scarcity and Effective Water Management

The increasing scarcity of water in various regions has heightened the demand for efficient water management systems, including solar-powered irrigation. Solar is more suitable for drip irrigation and

sprinkler irrigation and thus facilitates accurate water delivery, minimizing waste and enhancing crop productivity.

6. Technological Innovations

Advancements in solar pump technology, such as greater efficiency, smart monitoring systems, and IoT integration, are making them more attractive. Modern solar pumps can function in low-light conditions and store surplus energy for future use.

7. Environmental Awareness and Climate Change

Growing consciousness about environmental challenges and the necessity to cut greenhouse gas emissions is propelling the adoption of clean energy solutions like solar pumps. These pumps help lower carbon footprints by replacing diesel-powered alternatives.

8. Worldwide Trends in Renewable Energy

The global transition to renewable energy is benefiting the solar pump market. Solar pumps support international sustainability objectives, including the United Nations' Sustainable Development Goals (SDGs).

8.3. Threats and Challenges for the Global Solar Pumps Market

A. High Initial Costs

Capital Expenses: The initial costs associated with solar pumps, including solar panels, pumps, and installation, can be prohibitively high, creating a financial hurdle for small farmers and rural communities, especially in developing countries.

Limited Access to Financing: Many potential users find it difficult to obtain affordable financing options, hindering their ability to invest in solar pump systems.

B. Technological Limitations

Efficiency and Dependability: Solar pumps rely on sunlight, which can be variable due to weather changes, seasonal shifts, and geographical differences, affecting their reliability and efficiency.

Battery Storage Issues: Although batteries can help address energy intermittency, they are expensive, have limited lifespans, and require regular maintenance, increasing overall operational costs.

C. Awareness and Knowledge Gaps

Low Awareness: Many rural communities lack knowledge about the benefits and functioning of solar pumps.

Skill Shortages: The installation, operation, and maintenance of solar pumps require technical skills that

may be absent in some areas, leading to inefficient use or system failures.

D. Infrastructure and Integration Challenges

Grid Connectivity Issues: In remote or off-grid locations, connecting solar pumps to existing infrastructure can be complicated and costly.

Lack of Support Services: Some regions do not have essential support services, such as distribution networks, repair facilities, and spare parts, which can impede adoption and long-term maintenance.

E. Policy and Regulatory Challenges

Inconsistent Regulations: Unclear or varying government policies regarding renewable energy can create uncertainty for users and investors.

Fossil Fuel Subsidies: In many areas, traditional energy sources like diesel and electricity receive significant subsidies, making them more financially appealing than solar alternatives.

F. Market Competition

Prevalence of Conventional Pumps: Diesel and electric pumps remain popular due to their lower initial costs and established supply chains.

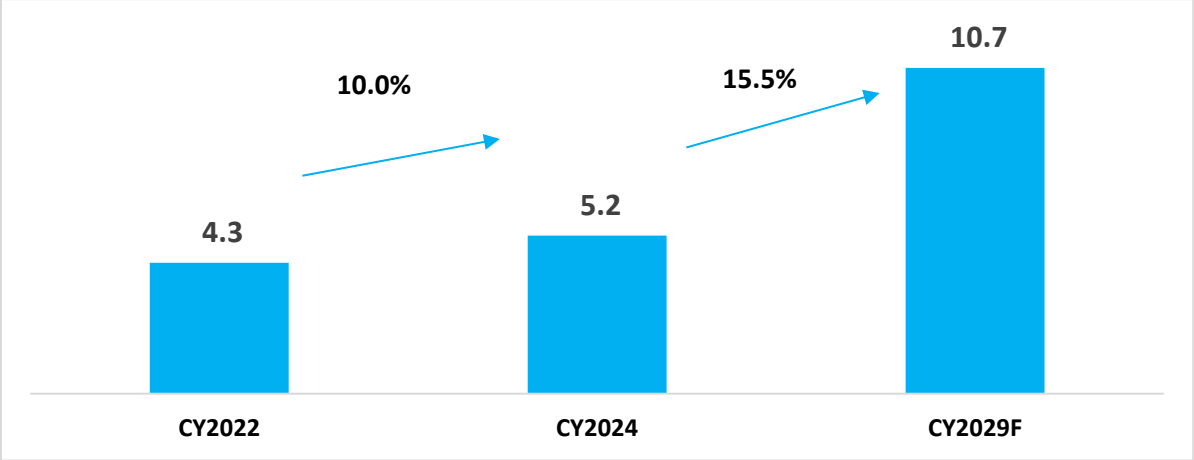
Reliance on Raw Materials: Solar panels and pumps are manufactured using materials such as silicon and rare earth metals, which may experience supply shortages and fluctuating prices.

8.4. Global Solar Pumps Market - Market Size and Growth Outlook

The global solar pump market has been experiencing significant growth, driven by increasing demand for sustainable and energy-efficient water pumping solutions, particularly in the agriculture and water management sectors.

The Global market for Solar Pumps was valued at USD 5.2 Billion in CY2024. It is projected to experience a CAGR of approximately 15.5% over the forecast period, reaching INR 10.7 billion by CY2029.

Exhibit 8.2: Global Solar Pumps Market, CY2022 - CY2024- CY2029F, USD Billion

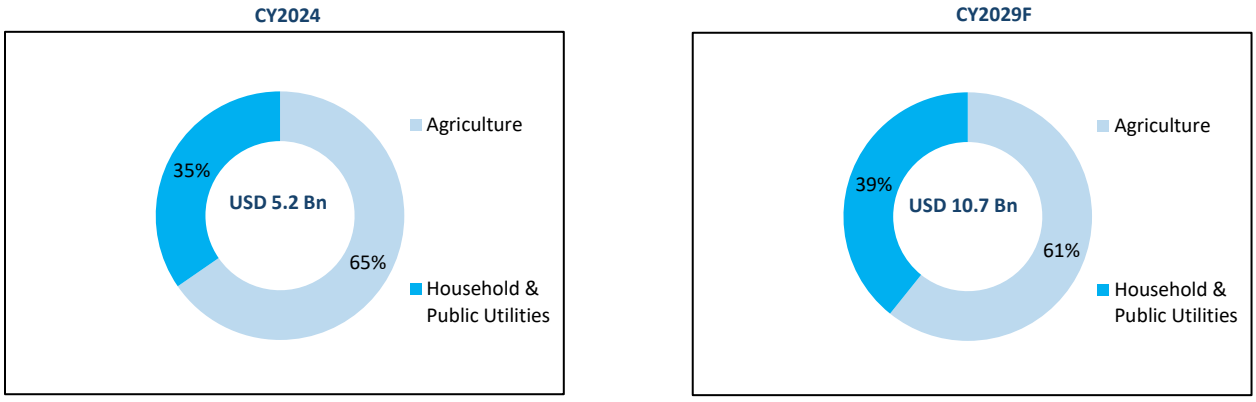


Source: Frost & Sullivan Analysis

The global solar pump market is on a steady growth trajectory, propelled by technological advancements, supportive governmental initiatives, and an increasing shift toward renewable energy sources. Governments worldwide are promoting solar energy adoption by offering incentives, subsidies, and favourable policies, such as equipment purchase subsidies, financing options, and tax credits. These measures reduce the upfront costs of investing in solar pumping systems and serve as a strong incentive for individuals and businesses to adopt this sustainable energy solution. The trend is expected to continue in regions with abundant sunlight and agriculture-dependent economies.

8.4.1. Global Solar Pumps - Market Split by Application

Exhibit 8.3: Global Solar Pumps Market, Split by Application, CY2024, CY2029F USD Billion



Source: Frost & Sullivan Analysis

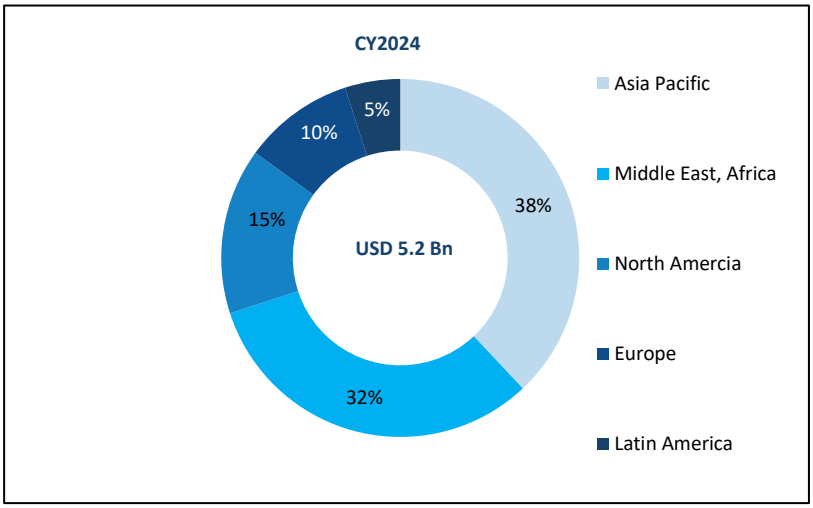
Agriculture is the largest segment in the solar pump market, driven by the high demand for irrigation in developing countries.

The agriculture sector accounts for around 65.0% of solar pump installations in 2024, driven by the growing demand for sustainable irrigation solutions. Other applications include industrial and commercial

uses, with solar-powered pumps increasing in fish farming and wastewater treatment, supporting eco-friendly industrial water management.

8.4.2. Global Solar Pumps - Market Split by Region

Exhibit 8.4: Global Solar Pumps Market, Split by Segmentation, CY2024, USD Billion



Asia-Pacific

- leads the global solar pump market.
- Strong governmental initiatives promoting renewable energy.
- Key contributors: India (PM-KUSUM scheme for farmers) and China (clean energy solutions for agricultural & residential use).

Africa

- Significant market share is driven by solar pump adoption.
- Addresses water scarcity, improves agricultural productivity, and reduces energy poverty.

North America

- Stringent environmental regulations and renewable energy adoption drive growth.
- Increasing demand for sustainable water management solutions.

Europe

- Driven by regulatory mandates and government support for renewable energy.

Middle East

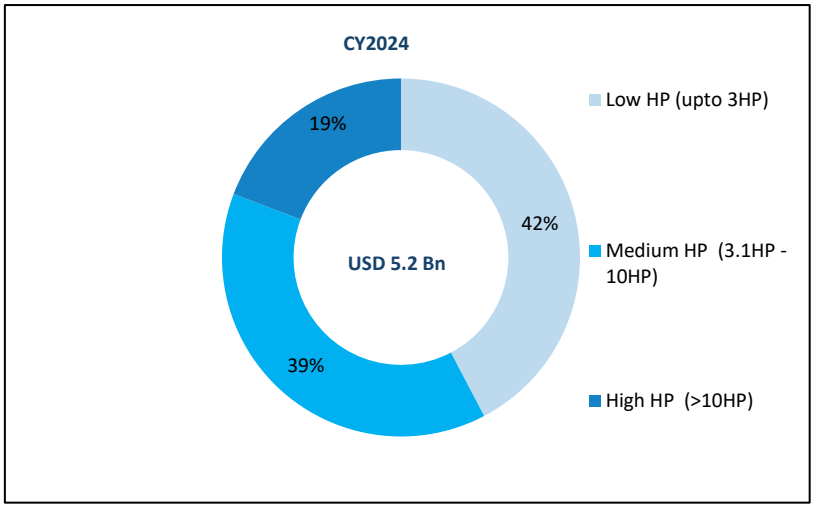
- Experiencing notable growth due to arid climate and water scarcity issues.

8.4.3. Global Solar Pumps – Market Split by HP Rating

The HP (horsepower) rating measures the power output of a device like a solar pump's motor, determining its capacity to move water. For solar pumps, it's critical because it dictates the energy needed from solar panels—higher HP ratings require more panels or storage.

The Solar Pumps with low HP rating is primarily used for small-scale irrigation, drinking water supply for rural households, and small farms, driven by affordability, ease of installation, and government subsidies for rural electrification and water access. The Solar Pumps with medium HP rating is growing, balancing power and cost for mid-sized farms and projects, driven by increasing adoption in semi-urban and rural areas and awareness of solar energy benefits. High-horsepower solar pumps are increasingly adopted for large-scale irrigation, industrial water supply, and municipal water systems. Their demand is driven by the growing scale of agricultural and industrial projects, the need for high operational efficiency, cost savings, and supportive environmental regulations that encourage the use of renewable energy.

Exhibit 8.5: Global Solar Pumps Market, Split by HP Rating, CY2024, USD Billion



The Asia-Pacific market dominates the medium HP pump market due to high agricultural activity and government initiatives. Africa sees significant demand for these pumps for rural water supply and small-scale farming. North America and Europe see higher adoption of High HP and above 15 HP pumps for commercial and industrial applications. Latin America sees a growing market for medium HP pumps.

8.4.4. Global Solar Pumps – Replacement Market Potential

The replacement market potential for global solar pumps is poised for significant growth, driven by factors such as aging installations, technological advancements, and increasing demand for sustainable irrigation solutions. Here's a breakdown of key aspects:

Market Drivers for Replacement Demand

- Aging Solar Pump Systems: Many early solar pumps (installed 10–15 years ago) are nearing the end of their lifespan (~15–20 years for panels, ~5–10 years for pumps/batteries).
- Technological Upgrades: Newer solar pumps offer higher efficiency, IoT integration, and better durability, encouraging replacements.

- Declining Solar Panel Efficiency: Solar panels degrade at ~0.5–1% per year, making replacements economically viable after 15+ years.
- Policy Incentives: Governments in India, Africa, and the Middle East are promoting solar irrigation, including subsidies for upgrades.

Year	Total Solar Pumps Market (USD Billion)	Replacement Market Share (%)	Replacement Market Value (USD Billion)
2024	5.2	7.0%	0.36
2029	10.7	15.0%	1.60

As the market matures, the replacement share could rise (e.g., upto 25%) due to a larger installed base aging.

8.5. India Solar Pumps Market Analysis

8.5.1. Key Growth drivers for the domestic solar pumps market

A. Abundant Sun Days and Solar Energy Potential:

India has bright sunny weather for 250 to 300 days per year, providing significant solar energy potential. This sufficient sunlight is required for solar pumps to function properly, making them a viable irrigation option.

B. Falling Solar Module Prices:

Solar module prices declined by 3.3% in Q3 2024, making solar-powered irrigation systems increasingly cost-competitive

C. Rising incomes and increased awareness of efficient irrigation systems.

As incomes rise and people become more aware of effective irrigation methods, the demand for drip and sprinkler irrigation systems increases. Solar pumps are frequently combined into these systems, increasing their appeal.

D. Need for sustainable and eco-friendly solutions:

The demand for sustainable practices is encouraging the use of solar pumps, which provide clean and renewable energy. This is consistent with India's overall goals of lowering carbon emissions and increasing environmental sustainability.

E. Inadequate grid coverage:

Many places in India lack stable grid connectivity, making solar pumps an important option for powering

irrigation systems. Solar pumps can work independently of the grid, ensuring reliable energy access.

F. Cost-effectiveness as compared to diesel and grid-connected fuels:

Solar pumps have lower operational and maintenance costs compared to diesel pumps, which require frequent fuel purchases and maintenance. .

G. Lack of Irrigation Solutions:

The current gap in irrigation solutions represents a substantial opportunity for growth in the solar pump market. Solar pumps can alleviate water constraints and increase agricultural output, particularly in rural regions.

H. Crop Diversification

Solar Pump gives the liberty to the famer to schedule the irrigation as per the requirement of the crop and thus enables the farmers to go for crop diversification.

8.6. Other Key Growth Drivers – Solar Pumps

Lack of Irrigation Solutions: A Growth Opportunity

The lack of efficient irrigation solutions in India creates a tremendous opportunity for expansion, notably in the use of solar-powered irrigation systems. The following are major data points and comparative assessments that illustrate this opportunity:

1. Rainfall Coverage and Shortages in India

Rainfall Dependency: The monsoon season (June to September) accounts for around 70% of India's yearly rainfall. However, the distribution is extremely unequal, resulting in droughts in some areas and flooding in others.

Rainfall Shortfall: According to the India Meteorological Department (IMD), over 42% of India's geographical area is experiencing drought-like conditions due to irregular rainfall patterns.

Impact on Agriculture: Unpredictable rainfall and water scarcity reduce crop production, making irrigation systems essential for agricultural sustainability.

2. Agricultural Land: Rain-fed or Irrigated

Rain-fed Agriculture: Approximately 52% of India's agricultural land is rainfed, meaning it relies entirely on rainfall for water. This represents roughly 40% of the country's overall food production. Only 48% of agricultural land is irrigated, which includes canals, tube wells, and other sources.
Government Initiatives to Boost the Adoption of Solar Pumps in India

Over half of India's farmland remains rain-dependent, leaving millions of farmers vulnerable to erratic monsoons. Bridging this irrigation gap - especially through clean, grid-independent solar pump solutions - can transform agricultural productivity and climate resilience.

8.6.1. Key Threats and Challenges - Domestic Solar Pumps Market in Agriculture

Category	Key Threats/ Challenges	Impact
High Initial Costs	High upfront capital costs despite subsidies.	Limits adoption among small and marginal farmers.
Dependence on Subsidies	Heavy reliance on government subsidies and schemes like PM-KUSUM	Delays in subsidy disbursement and policy changes hinder adoption.
Technical Challenges	Lack of technical knowledge among farmers for installation and maintenance.	Poor maintenance leads to inefficiencies and system failures.
Intermittent Energy	Solar energy availability depends on sunlight, which is weather-dependent.	Reduced pump efficiency during cloudy days or monsoon seasons.
Land and Water Issues	Requires adequate land and access to groundwater or surface water.	Limited feasibility in water-scarce or fragmented land regions.
Quality Issues	Prevalence of low-quality solar pumps and components.	Frequent breakdowns, higher maintenance costs, and reduced trust among farmers.
Low Awareness	Limited awareness among farmers, especially in remote areas.	Slower adoption rates and continued reliance on traditional pumps.
Grid Integration	Poor grid connectivity and infrastructure for grid-connected solar pumps.	Limits the potential for grid-connected solar pump systems.
Climate Risks	Extreme weather events (cyclones, floods, etc.) can damage solar pump installations.	Financial losses and reduced confidence in solar pump technology
High Working Capital	Time lag between pump installation and subsidy release	It creates a financial burden for manufacturers and suppliers

New entrants in the solar pump market face significant barriers to entry, including the need to establish consistent product quality, build a trusted brand image, and overcome the strong customer loyalty enjoyed by established players. In addition, developing an extensive installation network and ensuring reliable after-sales service are critical factors that further raise the entry hurdles for new competitors. New entrants may struggle to sustain their presence in the market, given challenges such as volatile margins and high receivable days.

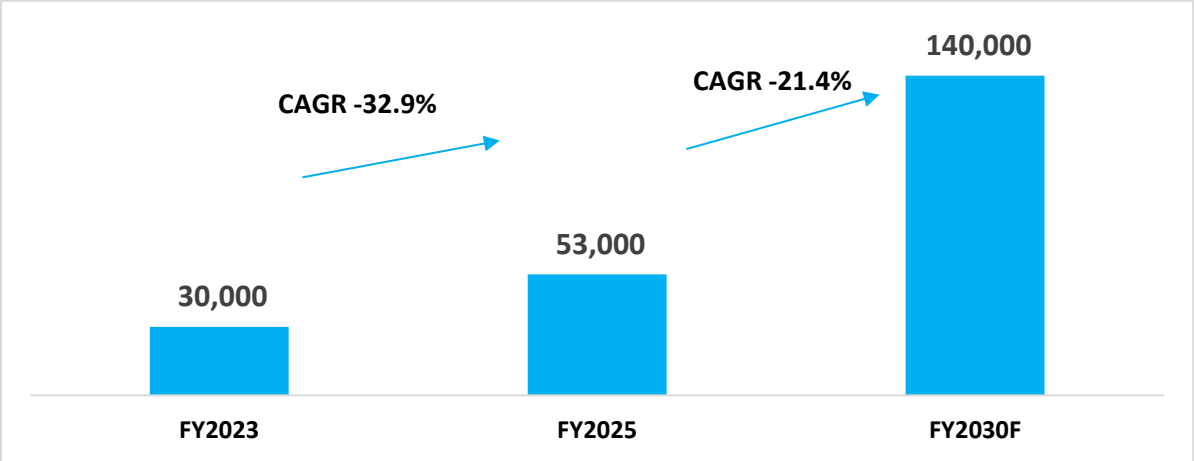
8.7. Domestic Solar Pumps Market - Market Size and Growth Outlook

The Indian solar water pump market is on a robust growth trajectory, propelled by supportive government policies, increasing awareness of sustainable practices, and the active participation of key industry players.

Multiple Indian states announced supportive solar and net-metering policies, while centrally-driven financial incentives and streamlined approvals promoted both utility-scale and distributed solar installation nationwide. These landmark steps established the foundation for India's global leadership in renewable energy growth.

In FY2025, the Indian market for Solar Pumps was valued at INR 53,000 million. It is projected to experience a compound annual growth rate (CAGR) of approximately 21.4% over the forecast period, reaching INR 140,000,million by FY2030.

Exhibit 8.6: Domestic Solar Pumps Market, FY2023 - FY2025- FY2030F, INR Million



Source: Frost & Sullivan Analysis

The Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM) Yojana, launched in 2019, aims to install 20 lakh standalone solar pumps and solarize 15 lakh grid-connected agricultural pumps in India. This initiative, which accounts for over 80.0% of freshwater usage, is particularly beneficial in remote and off-grid areas where electricity access is limited. The program aims to reduce farmers' dependence on diesel and conventional electricity sources.

Entry barriers in the Domestic Solar Pumps market

Entrants in the solar pump market face significant barriers, such as the need to ensure high product quality, which is crucial for gaining the trust of buyers who prioritize reliability in agricultural applications. Establishing a strong brand image is challenging but necessary to overcome customer loyalty towards established players. Additionally, building a widespread installation network and robust after-sales service infrastructure demands substantial investment and operational capability, as these services are critical for customer satisfaction and long-term maintenance in rural areas. These factors combined create a high entry threshold, making it difficult for new companies to compete effectively against incumbents with

proven quality, trusted brands, and well-developed service ecosystems. Additionally, fluctuations in margins as well as high debtor days can deter new entrants in this market.

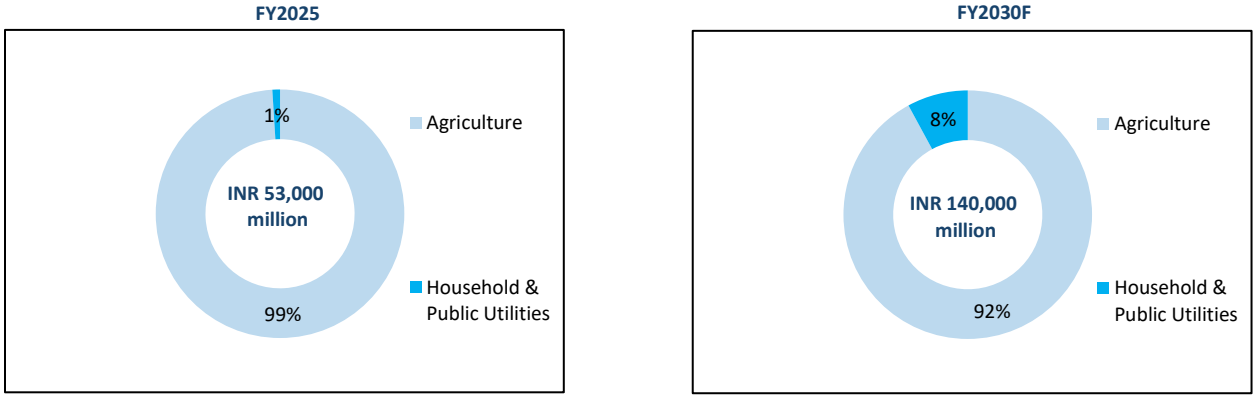
8.7.1. India Solar Pumps - Market Split by Application

The agriculture sector is the largest consumer of solar pumps, with states like Rajasthan, Maharashtra, Uttar Pradesh, and Haryana leading in adoption due to high solar irradiation and government support.

Rajasthan: The 2023 Renewable Energy Policy targets 90 GW by 2030 (65 GW solar), promoting solar pumps via PM-KUSUM subsidies, land access, and a 1 MW net metering cap (2024). The 2019 Investment Scheme offers tax exemptions to support agricultural solar use. Through its FY25-26 budget, the Government of Rajasthan has given a subsidy of INR 900 crores for 25,000 firm ponds, 10,000 diggis, 50,000 solar pumps.
Maharashtra: The 2023 Mukhyamantri Saur Krishi Vahini Yojana 2.0 provides daytime solar power, backed by the 2020 Renewable Energy Policy with land and financial support.
Uttar Pradesh: The updated 2013 Solar Energy Policy has a focus on rural Bundelkhand, plus private investment for agriculture and employment.
Haryana: As per ' IMPLEMENTATION GUIDELINES FOR SOLAR WATER PUMPING SCHEME - YEAR 2025-26' in Haryana, the Department of New & Renewable Energy/HAREDA is providing DC solar pumps of 3 HP to 10 HP capacity in the State with a total 75% subsidy under Component B of the Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyaan (PM-KUSUM).

The household sector is also seeing growth in solar pumps, particularly in rural areas for domestic water supply, especially in off-grid and remote areas. Government initiatives like the Jal Jeevan Mission are driving the adoption of solar pumps for household water supply. The segment is expected to grow at a CAGR of 8-10% in the coming years.

Exhibit 8.7: India Solar Pumps Market, Split by Application, FY2025, FY2030F INR Million



Source: Frost & Sullivan Analysis

The public utilities sector is also seeing significant growth in solar pumps, driven by government initiatives and the need for sustainable urban infrastructure. Smart city projects and the integration of solar pumps with water treatment plants and distribution networks will further propel demand. The segment is projected to grow at a CAGR of 12-15% over the next five years.

India has a significant market potential for solar pumps. With over 144 million farmers, only 30 million currently have access to pumps. Around 8 million farmers use diesel-powered pumps, representing a ₹1,200 billion (USD 14.5B) opportunity for solar replacement.

An additional 114 million farmers lack pump access, 32% of whom are marginal farmers with over one-hectare landholdings. The untapped market for these farmers is valued at ₹2,400 billion (USD 29.1B). Together, the total market potential stands at approximately ₹3,600 billion.

Solar pumps offer advantages over diesel and grid-powered pumps, including cost savings, low maintenance, and environmental benefits.

8.7.2. India Solar Pumps – Market Split by HP Rating

HP Segment	Power Range	Usage	Est. Market Share	Regional and Application Insights
Low HP Rating	Up to 3 HP	Small-scale agriculture, domestic water supply, and small irrigation projects	50 -55% A significant portion of the market is affordable and suitable for small-scale irrigation.	Used in regions with shallow water tables, such as the eastern states in the Gangetic belt.
Medium HP Rating	3.1 – 10 HP	Sprinkler irrigation, medium-scale farming, community water systems	40 - 45% It is projected to experience the highest growth rate during the forecast period, attributed to its balance between cost and performance, making it popular among medium-scale farmers.	Commonly used in regions requiring moderate water lifting capabilities. This range is often supported by government schemes like the PM-KUSUM scheme, which provides financial assistance of up to 7.5 HP.
High HP Rating	Above 10 HP	Large farms, industrial water supply, and	5 -10% Smaller but growing segment (driven by	Regions like Punjab, Haryana, and Rajasthan, where deeper water

		extensive irrigation systems	government schemes and subsidies)	tables require more powerful pumps

The Indian government's KUSUM scheme, which offers subsidies for solar pumps upto 7.5 HP, has significantly increased the adoption of solar pumps across all sectors. Low HP pumps are the most popular solar pumps in India due to their affordability and suitability for small farmers. Medium HP pumps are being adopted as farmers scale up operations, while high HP pumps are gaining traction in regions with large agricultural lands and industrial needs. The market split reflects diverse agricultural and water supply needs across India, with low HP pumps being the most prevalent.

8.7.3. India Solar Pumps – Market Split by Domestic Production Vs. Imports

Category	Key Threats/ Challenges
Year	2023-2024
Domestic Production Share	95%
Import Share	5%
Key Imported Components	Magnets
Major Import Sources	China,

Key government Initiative	Objective	Impact
KUSUM Scheme	20 lakh standalone solar pumps and solarize 15 lakh grid-connected agricultural pumps in India	Reduces diesel/grid electricity dependence, boosts domestic production
Make in India	Promote local solar pump and component manufacturing	Reduces import dependency, strengthens domestic industry
Customs Duty on Imports	40% duty on solar modules, 25% on solar cells	Encourages domestic production, discourages cheap imports

Challenges	Outlook
High Subsidy	For proving grid power for irrigation, the Government incurs huge cost for laying the electric lines and for land acquisition. In addition to that, a significant T&D loss happens for grid power. The subsidy given by the Government for solar pumps is more than offset by the savings done by the Government by avoiding providing grid-connectivity
Dependency on imported solar panels & inverters	Domestic production is expected to increase, reducing imports.

Quality concerns with some domestic components	Investment in R&D and improved manufacturing processes will enhance quality.

8.8. Analysis of supply/demand mismatch for solar pumps for agricultural applications in India

Key Factors	Description	Challenges	Solutions
Market Growth	Growing demand due to government initiatives and technological advancements.	High initial costs, and fragmented supply chains.	Expand subsidy programs, and improve financing options.
Government Initiatives	Schemes like PM-KUSUM provide subsidies for solar pumps.	Limited awareness and accessibility in rural areas.	Increase outreach and simplify application processes.
Technological Advancements	Improved solar panel efficiency and battery storage enhance reliability.	Quality control issues with some manufacturers.	Implement stricter quality standards and regulations.
Demand Side	Increasing demand due to eco-friendly and cost-effective nature.	High upfront costs deter some farmers.	Offer affordable financing options and expand subsidies.
Supply Side	Challenges in meeting demand due to high-quality component shortages.	Dependence on imports and domestic manufacturing gaps.	Enhance domestic solar module production capacity and quality.
Solar Component Availability	Shortages of high-quality solar modules impact supply.	Import tariffs and domestic manufacturing limitations.	Invest in domestic manufacturing and reduce import tariffs.
Regulatory Framework	Need for stricter quality standards to ensure product reliability.	Unregulated vendors selling substandard components.	Enforce quality standards and monitor market compliance.

8.8.1. Government Schemes to Boost Irrigation In India – Various Policy Initiatives

Scheme	Year	Objective	Key Features	Impact on Irrigation
Jawaharlal Nehru National Solar Mission (JNNSM)	2010	Promote solar energy development in India.	- Targeted **100 GW solar capacity by 2022**. - Encouraged **off-grid solar applications**.	- Indirect impact by setting the foundation for **solar-based irrigation**.
National Solar Pumping Program	2014-15	Encourage farmers to use **solar-powered pumps**.	- Subsidies for installing **solar irrigation pumps**.	- Promoted sustainable **off-grid irrigation solutions**.

			- Reduced reliance on **diesel & grid electricity**.	
Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)	2015	Ensure **water availability for every farm** & improve water efficiency.	- **AIBP:** Fast-tracks **major irrigation projects**.	- Increased **irrigation coverage**.
			- **Per Drop More Crop:** Promotes **drip & sprinkler irrigation**.	- Improved **water-use efficiency** through **micro-irrigation**.
			- **Watershed Development:** Enhances **rainwater harvesting**.	
PM Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM KUSUM)	2019	Promote **solar energy in agriculture** to reduce power costs.	**Component A:** 10,000 MW of solar capacity through the installation of small Solar Power Plants of individual plants of capacity up to 2 MW.	- Reduced farmers' electricity & diesel costs.
			- **Component B:** Installation of 10 lakh standalone Solar Powered Agriculture Pumps.	- Promoted **solar-powered irrigation** for sustainability.
			- **Component C:** Solarization of 15 Lakh Grid-connected Agriculture Pumps.	

In 2014, the Indian government rapidly accelerated solar adoption by dramatically raising its national solar target to 100 GW by 2022, rolling out policies such as the Solar Park Scheme (launched December 2014 to develop at least 25 large-scale parks), and introducing the Grid Connected Rooftop Solar Programme with a 40 GW rooftop goal. Multiple Indian states announced supportive solar and net-metering policies, while centrally-driven financial incentives and streamlined approvals promoted both utility-scale and distributed solar installation nationwide. These landmark steps established the foundation for India's global leadership in renewable energy growth

8.8.2. State-wise share of Pump Cost - Central, State Government, and the Farmer

State	Central (%)	State (%)	Farmer (%)
Andhra Pradesh	30	30	40
Arunachal Pradesh	30	30	40
Assam	30	30	40
Bihar	30	30	40
Chhattisgarh	30	30	40
Delhi	30	30	40

Goa	30	30	40
Gujarat	30	30	40
Haryana	30	45	25
Himachal Pradesh	50	30	20
Jammu & Kashmir	50	30	20
Jharkhand	30	64/60	6/10
Karnataka	30	50	20
Kerala	30	30	40
Ladakh	30	30	40
Madhya Pradesh	30	30	40
Maharashtra	30	30	40
Manipur	30	30	40
Meghalaya	30	30	40
Mizoram	30	30	40
Nagaland	30	30	40
Odisha	30	30	40
Puducherry	30	30	40
Punjab	30	30	40
Sikkim	50	30	20
Rajasthan	30	30	40
Tamil Nadu	30	30	40
Telangana	30	30	40
Tripura	30	30	40
Uttar Pradesh	30	30	40
Uttarakhand	50	30	20
West Bengal	30	30	40

For the pump cost, under component B, the central government will cover 30% of the cost for standalone solar agricultural pumps, with the state government providing at least 30% as well. Farmers are responsible for the remaining 40% at most. However, in few cases, additional support is provided by either centre / state government. For example, for north eastern states, Sikkim, Jammu & Kashmir, Himachal Pradesh and Uttarakhand, Lakshadweep and A&N Islands, CFA of 50% of the benchmark cost or the tender cost, whichever is lower, of the stand-alone solar pump will be provided by the central government taking the subsidy amount to 80% of total pump cost, while the farmers' share is reduced to a maximum of 20%.

8.8.3. PM KUSUM Scheme - Initial Plan and Status of the Scheme

The Government of India launched the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) project in 2019 to promote the use of solar energy in agricultural applications. The initiative aims to provide farmers with financial and water security by building solar pumps and grid-connected solar power plants. It contains three major components:

- Component A: 10,000 MW of solar capacity through installation of small Solar Power Plants of individual plants of capacity upto 2 MW.

- Component B: Installation of 20 lakh standalone Solar Powered Agriculture Pumps.
- Component C: Solarisation of 15 Lakh Grid-connected Agriculture Pumps.

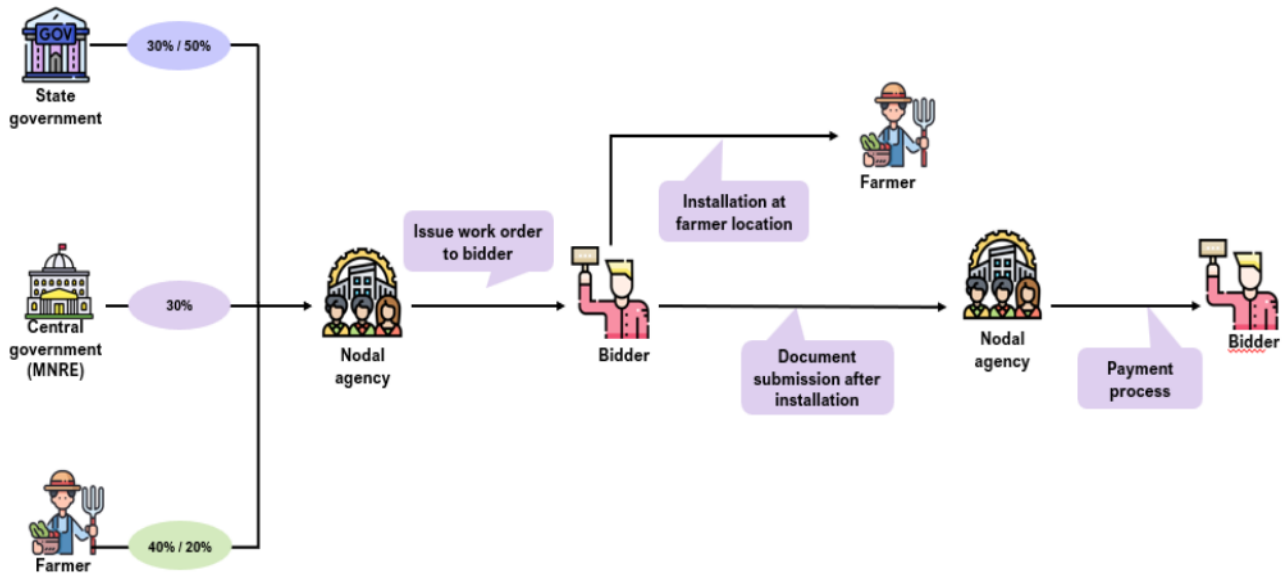
8.8.4. Step-wise Project Execution under the PM-KUSUM Scheme

PM-KUSUM Scheme: Project Execution Process

The PM-KUSUM scheme supports the development of decentralized renewable energy plants, the installation of solar agricultural pumps, and the solarization of existing grid-connected pumps. The project execution follows these structured steps:

1. **Farmer Interest Submission**
   Farmers register their interest in adopting solar solutions and contribute 20–40% of the project cost to the State Nodal Agency.
2. **MNRE Contribution**
   The Ministry of New and Renewable Energy (MNRE), under the Central Government, provides a 30% subsidy to the State Nodal Agency to support project implementation.
3. **State Government Contribution**
   State governments contribute 30–50% of the project cost to the State Nodal Agency and may also assist farmers in securing subsidized loans.
4. **Vendor Empanelment**
   The State Nodal Agency invites bids through a tendering process and empanels vendors based on their qualifications. Once empanelled, farmers can select vendors from the approved list when the portal is open.
5. **Tendering and Work Order Issuance**
   The State Nodal Agency issues a tender and subsequently awards a work order to the selected bidder.
6. **Installation by Bidder**
   The selected bidder supplies the necessary equipment and completes the installation at the farmer's site.
7. **Completion Report Submission**
   After installation, the bidder submits a completion report detailing the materials supplied, installation work completed, and associated payment information.

Funding Structure:
The funding for solar pump installation under the PM-KUSUM scheme is collectively sourced from the State Government (30–50%), the Central Government via MNRE (30%), and farmers (20–40%).



Participation of L2 and L3 Bidders in the Supply Process

In the tendering process, bidders are ranked based on their quoted prices, with **L1**, **L2**, and **L3** representing the lowest, second-lowest, and third-lowest bidders respectively.

- Some states, to ensure greater participation, allow all technically qualified bidders to match the price quoted by the L1 bidder.

This mechanism ensures wider vendor participation, enhances supply chain resilience, and maintains competitive pricing even beyond the L1 bidder.

Further, under the PM Kusum Scheme, a foreign company is neither allowed to participate on a standalone basis nor as a member of a consortium and it is mandatory for bidders to procure essential components integral to solar pumping systems, such as solar pumps with controller, solar module, structures and cables, from domestic sources. Further, under the PM Kusum Scheme, it is mandatory for bidders to procure essential components integral to solar pumping systems, such as solar pumps with controller, solar module, structures and cables, from domestic sources.

8.9. Details of various state nodal agencies under the PM Kusum Scheme

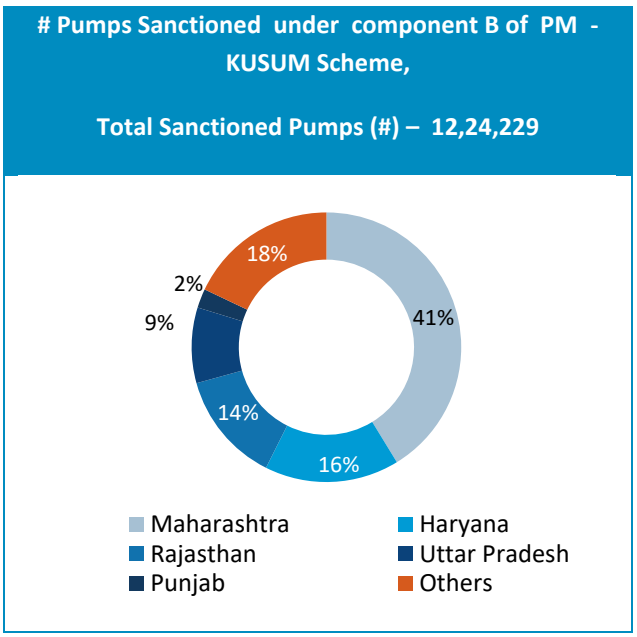
Some of the latest tenders by the state nodal agencies of different states are as follows:

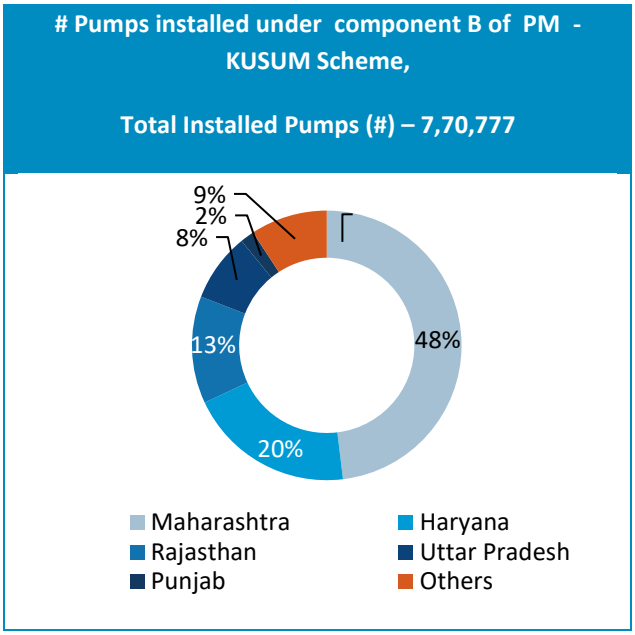
Maharashtra: A tender worth ~ INR 2,421 crores was issued by MEDA in December 2024 for Design, Manufacture Supply transport, installation testing and Commissioning of Off Grid DC Submersible Solar pump of 3 HP, 5 HP and 7.5 HP capacities in the districts of Maharashtra with 5 Years CMC.

Haryana: Haryana Renewable Energy Development Agency (HAREDA) invited bids for the installation and commissioning of 24,484 solar water pumping systems of different capacities in 2024

Chhattisgarh: Tender for bidding for the installation and commissioning of 20,000 submersible solar water pumping systems of different capacities was issued by Chhattisgarh Renewable Energy Development Agency (CREDA) in 2024.

Jharkhand: Bids for the installation and commissioning of 8,000 submersible solar water pumping systems were invited by Jharkhand Renewable Energy Development Agency (JREDA) in 2024.





ource: MNRE, PM -KUSUM, Frost & Sullivan Analysis

As of 31st March 2025, under the PM-KUSUM scheme, a total of 12.24 lakh solar pumping systems have been sanctioned across various states. Of these, 7.71 lakh systems have been installed, representing 62.96% of the total sanctioned systems.

Particulars	As of March 31, 2025			
	2025	**2024**	**2023**	2022
Solar pumps installed under Component B of PM-Kusum Scheme	770,777	314,435	218,539	94,000

Between Fiscal 2023 and Fiscal 2025, an estimated 676,777 solar pumps were installed across various states under the PM Kusum Scheme. Of these, Rotomag Enertec Limited, through both direct and indirect channels, supplied approximately 113,176 solar pumps, accounting for about 16.72% of the total installations by volume during this period.

The PM-KUSUM scheme also focuses on the solarization of 3.50 million existing grid-connected agricultural pumps, offering subsidies to farmers to retrofit their pumps with solar panels. While these

achievements are noteworthy, they represent only a fraction of the overall target of 14 lakh pumps, indicating that the scheme is still in an early stage and highlighting significant untapped potential for agri-solar pump installations.

State-wise Distribution:
States like Maharashtra, Haryana, Rajasthan, Uttar Pradesh, and Punjab account for approximately 87% of the total sanctioned pumps under Component B of the scheme. States such as Jharkhand, Karnataka, Madhya Pradesh, and Gujarat collectively contribute around 8% of the sanctioned pumps. In terms of installed pumps:

- Maharashtra accounts for approximately 30% of installations,
- Haryana and Rajasthan each contribute around 20%,
- Other contributing states include Jharkhand, Madhya Pradesh, Gujarat, and Tamil Nadu.

8.10. Jal Jeevan Mission

Prime Minister Narendra Modi launched the Jal Jeevan Mission on 15th August 2019 to provide Functional Household Tap Connections (FHTCs) to every rural household in India by 2024. Implemented by the Ministry of Jal Shakti, the mission aims to ensure access to safe and adequate drinking water through individual household taps. It emphasizes community participation, water conservation, source sustainability, and local water management practices such as rainwater harvesting and groundwater recharge.

- **Current Status:**
    - India's Jal Jeevan Mission (JJM) has successfully connected 12.20 crore rural households, bringing the total coverage to over 15.44 crore households, ensuring tap water for 79.74% of all rural households in the country as of February 1, 2025.
    - Progress varies across states, with some states like Gujarat, Telangana, and Haryana achieving high coverage, while others like Uttar Pradesh and Jharkhand lag behind.
    - Challenges include funding delays, infrastructure gaps, and coordination issues between central and state agencies.
    - As of March 2025, the mission has achieved significant progress, with the Udupi district reaching 92% completion.

8.11. Comparative analysis of solar water pumps versus other solutions, such as diesel

In India, where water pumping is crucial for agriculture and domestic use, the choice between solar, diesel, and electric water pumps depends on cost, efficiency, environmental impact, and operational requirements. Here's a comparative analysis of these options:

Cost of Operation for 5 HP Submersible Pump Over 10 Years

Table 1: Cost of Operation Without PM-KUSUM Support

Category	Unit	Diesel Pump	Grid-Connected Pump	Solar Pump (No KUSUM Support)	Solar Pump (KUSUM Support)
Initial Equipment Cost	INR	50,000	15,000	2,40,000	2,40,000
Subsidy Percentage	%	0%	0%	0%	60%
Subsidy Value	INR	0	0	0	0
Farmer's Net Cost	INR	50,000	15,000	2,40,000	96,000
Maintenance Cost Over 10 Years	INR	40,000	40,000	30,000	30,000
Energy/Fuel Cost Over 10 Years	INR	12,82,638	2,51,295	0	0
Energy/Fuel Subsidy	INR	0	0	0	0
Farmer's Net Energy/Fuel Cost	INR	12,82,638	2,51,295	0	0
Total Farmer Ownership Cost	INR	13,72,638	3,16,295	2,70,000	1,26,000
Government Cost	INR	0	1,44,000	0	1,44,000
Combined Cost (Farmer + Govt.)	INR	13,72,638	4,60,295	2,70,000	2,70,000

Key Insights:

Diesel pumps are by far the costliest option at ₹13.73 lakh over 10 years, with fuel alone making up over 93% of the total cost, making them financially unsustainable despite their widespread use. Grid-connected pumps cost ₹4.60 lakh, but their shorter 5-7 year lifespan and dependence on reliable electricity supply reduce their appeal. Solar pumps without KUSUM support have negligible running costs but require a steep ₹2.40 lakh upfront investment, though they still cost nearly 90% less than diesel over their lifecycle. With 60% KUSUM support, solar pumps become the most cost-effective choice at just ₹1.26 lakh over 10 years, combining massive savings with a 7–10 year lifespan and zero fuel dependency, making them the most sustainable and future-ready option for farmers.

2. Performance Metrics and Longevity Analysis

Parameter	Solar Pump (SPS)	Diesel Pump	Electric Pump
Lifespan	20-25 years (panels) 10-15 years (pump)	5-7 years (engine)	10-15 years
Operating Hours	Daytime only (unless battery storage)	24/7 (if fuel available)	24/7 (if electricity is available)
Efficiency	High during daylight hours	Lower due to energy losses	High if grid power is reliable
Reliability	Dependent on sunlight (unless battery storage is used)	Reliable but fuel-dependent	Dependent on grid reliability
Environmental Impact	Zero emissions, renewable energy source	High emissions (CO2, NOx, particulate matter)	Indirect emissions (depends on grid power source)
Suitability	Ideal for remote and off-grid areas	Suitable for areas with unreliable electricity	Best for areas with reliable grid connectivity
Government Subsidies	60–90% subsidy under schemes like PM-KUSUM	No significant subsidies	Subsidized electricity for farmers in some states

Key Insights:

- Solar pumps last longer than diesel and electric pumps. Solar Water Pumps offer long-term cost savings and environmental sustainability, making them ideal for off-grid areas.
- While diesel pumps have higher operating hours, their cost & pollution make them unsustainable. Diesel Water Pumps are suitable where diesel is affordable, but they have significant environmental drawbacks.
- Electric pumps are highly efficient and are eco-friendly, but frequent rural power cuts reduce reliability.

8.12. Economic Benefits of Solar Pumps to Negate the Subsidy Syndrome

1. **Reduced Input Costs:**
    - No ongoing fuel expenses → Saves ₹80,000+ per year vs. diesel pumps
    - Minimal maintenance costs
2. **Income Diversification:**
    - Surplus electricity (with grid-connected solar) can be sold back under the PM-KUSUM scheme, creating a secondary income stream.
3. **Higher Agricultural Productivity:**

- A reliable water supply leads to better crop yields and higher profits.

4. **Long-Term Asset Creation:**
   - Unlike diesel pumps (which depreciate quickly), solar panels last 20+ years and provide continuous cost savings.

Addressing the "Subsidy Syndrome"

While subsidies are beneficial for initial adoption, the long-term economic benefits of solar water pumps negate the need for continuous subsidies:

- Government Subsidies: Currently, the Indian government offers subsidies to promote solar water pumps, such as 30% for farmers and 50% for SC/ST farmers.
- Long-Term Viability: Despite high initial costs, solar pumps provide substantial long-term savings and environmental benefits, making them a sustainable choice without relying on perpetual subsidies

Myth	Reality
Solar pumps need subsidies to be viable	**Solar pumps pay for themselves in 3-4 years** due to diesel savings
Diesel pumps are cheaper in the long run	Diesel pumps have **10X higher fuel costs over 10 years**
Electric pumps are the best choice.	Only **if grid power is stable** (which is rare in rural India)

Subsidies are useful for initial adoption, but solar pumps are financially viable even without them due to low operating costs. Farmers recover their investment in 3-4 years (due to diesel savings), making solar pumps self-sustaining. While subsidies seem like financial support to farmers, they actually offset the need for grid extension and maintenance, which is far more capital- and maintenance-intensive.

- Cost of Grid Expansion: To electrify remote agricultural fields, DISCOMs must invest in poles, conductors, transformers, and substations often over several kilometers. Add to this the cost of feeder segregation, capacity upgrades, and voltage regulation systems. These infrastructure investments easily exceed 1.5–2 lakh per connection often higher than the subsidy given for a solar pump.
- Ongoing O&M Burden: Even after the grid reaches a farm, transformer failures, cable thefts, overloading, and subsidized/free electricity create a continuous drain on state finances. Grid supply also remains erratic, especially during peak irrigation seasons.

By contrast, a one-time solar pump subsidy localizes power generation and eliminates the need for such infrastructure. No transmission losses, no transformer burnouts, no AT&C losses.

Summary: Comparative Analysis in the long term.

Parameters	Suitability
Lowest Long-Term Cost	**Solar Pump**
Best for Remote Areas	**Solar Pump** *(no grid dependence)*
Best for Sustainability	**Solar Pump** *(zero emissions, long lifespan)*
Highest Reliability	**Electric Pump** *(only if the power supply is stable)*
Highest Operating Hours	**Diesel Pump** *(but expensive & polluting)*

In conclusion, solar water pumps offer a cost-effective and sustainable solution for irrigation in India, providing long-term financial benefits and environmental sustainability. While initial costs are higher, the absence of operational expenses and government subsidies can make them more viable over time, reducing reliance on subsidies.

8.13. Competitive Landscape of Domestic Companies in Solar Pumps and Allied Solutions

Intense competition among domestic manufacturers with lower production costs can affect market share and pricing strategies. Henceforth, manufacturers have been investing heavily in research & development, as well as technological upgrades, to become key differentiators of solar pumps.

Key Domestic Players - Shakti Pumps (India) Limited, Tata Power Solar Systems Ltd., Rotomag Enertec Limited,, C.R.I. Pumps Private Limited, Oswal Pumps Limited, Ecozen Solutions Private Limited, GK Energy, Sahaj Solar.

The market has gradually consolidated among a few key players, as a significant number of participants exited the industry due to limited profitability and margin pressures.
Rotomag Enertec Limited entered the solar pumping solutions market in 1999 by manufacturing solar pumps and later expanding into BLDC (Brushless DC) solar pumps, and was one of the early participants in the solar products industry. Rotomag Enertec Limited is today recognized as one of the key players in India's solar pumping industry.

8.14. Loan Programs for Farmers under the KUSUM Scheme

The KUSUM Scheme is a government initiative by the Ministry of New and Renewable Energy (MNRE) to encourage the use of renewable energy in agriculture by offering financial support to farmers for installing solar-powered systems and equipment.

Component	Description	Loan/Financial Assistance	Eligibility	Repayment & Loan Providers
Component A - Solarization of Agriculture Pumps	Financial support for farmers to install solar pumps for irrigation, reducing dependence on	Procurement-Based Incentive (PBI) @ 40 paise/kWh or Rs. 6.60 lakhs/MW/year, whichever is less, will be	- Farmers with existing pumps or irrigation systems.	- Interest subsidies are available.

	diesel/electric pumps.	provided for the first five years by MNRE to DISCOMs, for buying the power from farmers/developers		
			- Farmer-Producer Organizations (FPOs) and cooperatives.	- Repayment over multiple years.
				- Loans are available through banks, RRBs, NABARD, and other financial institutions.
Component B - Solar Power Plants for Farmers	Encourages farmers to set up solar power plants to sell electricity to the grid for additional income.	- **Loan facility for capital investment.**	- Farmers, FPOs, and cooperatives.	- Loan repayment through earnings from power generation.
		- Subsidy: Available from the government. Central Financial Assistance (CFA): 30% of the benchmark cost or the tender cost, whichever is lower, of the stand-alone solar Agricultural pump. State Government - 30%, Farmer Contribution – 10%, Bank Finance - 30%	- Available for barren or fallow landowners.	- Loans are available through government banks and financial institutions.
		- Income from selling surplus electricity to the grid helps repay the loan.		
Component C - Solarization of Lift Irrigation Systems	Supports solar-based lift irrigation systems for better water management.	- **Subsidy & loan facility available as per Component B**	- Farmers, FPOs, and cooperative groups with lift irrigation systems.	- Interest subsidies provided.
		- Farmers can finance the remaining costs through bank loans.		- Loan repayment over an extended period.

Chapter 9: Overview of Domestic Solar Inverter Market and Energy Storage Systems

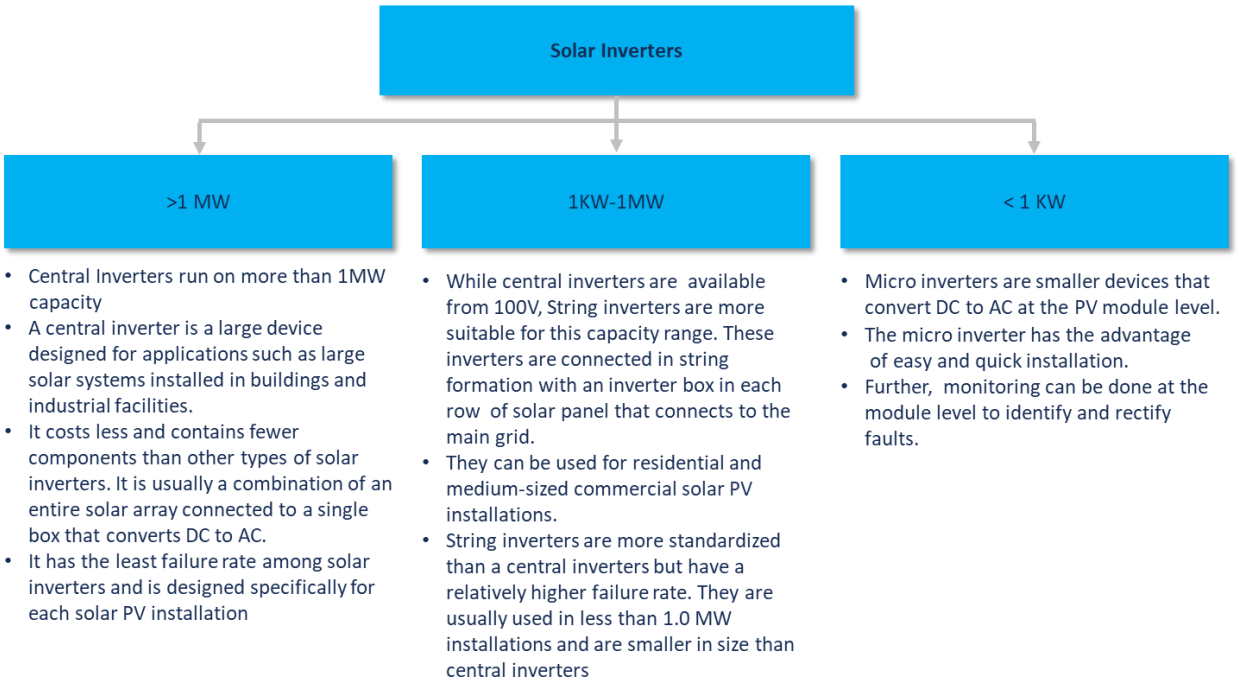
9.1. Solar Inverters – Definition

A solar inverter is a device that converts variable DC from solar PV installations into AC, which can be fed into the electricity grid for commercial and industrial purposes or used in off-grid installations for power supply to a local network.

9.1.1. Solar PV Inverter Classification

Classification	Type	Applications
Based on Connection to Grid	**Grid-Tied Inverter**	Synchronizes with the utility grid, commonly used in residential and commercial solar systems.
	Off-Grid Inverter	Operates independently, uses battery storage, ideal for remote locations.
	Hybrid Inverter	Supports both grid connection and battery storage for backup power.
Based on Phase Type	**Single-Phase Inverter**	Used for small residential or commercial applications (typically up to 10 kW).
	Three-Phase Inverter	Suitable for industrial and large commercial applications with higher power needs.
Based on Power Conversion Technology	**String Inverter**	Connects multiple solar panels in series, widely used in residential and commercial installations.
	Central Inverter	Handles high power loads (MW scale), used in utility-scale solar farms.
	Microinverter	Installed on individual panels, improves efficiency and performance in shaded conditions.
	Power Optimizer	Enhances DC output before feeding into a string inverter (not an inverter but a DC/DC converter).
Based on Topology	**Transformer-Based Inverter**	Uses transformers for voltage conversion, heavier but more reliable.
	Transformerless Inverter	More efficient and lightweight, commonly used in modern solar installations.

9.1.2. Solar Inverter Classification by Power



Note: >1 MW – Central Inverters, 1KW- 1MW - String Inverters, <1 KW – Micro Inverters.

9.2. Key Growth Drivers – Domestic Solar Inverter Market

India's domestic solar inverter market is witnessing significant expansion, driven by key developments in rooftop solar adoption, government initiatives, and increasing renewable energy integration.

1. Surge in Rooftop Solar Installations

India's rooftop solar capacity grew substantially in 2024, adding 3.2 GW—an 86% increase from the previous year—bringing the total to 13.7 GW by December 2024. Residential consumers, supported by government programs, accounted for 74.0% of these installations.

2. Government Broader Policy Support & Investments

The PM Surya Ghar: Muft Bijli Yojana targets rooftop solar installation in 10 million households by FY 2026-27, with a ₹75,021 crore budget. The scheme also incentivizes local bodies to drive adoption at the grassroots level. Beyond the Surya Ghar initiative, the Indian government aims to achieve 40-45 GW of rooftop solar capacity by 2027, as outlined in the Economic Survey 2024-25. Investments in grid modernization, smart metering, and power reliability enhancements further accelerate renewable energy integration.

3. Growing Solar Adoption Across Sectors

India's total installed power capacity reached 456.7 GW in November 2024, with renewables accounting for 47.0% (209.4 GW). The country's push for energy security and carbon reduction has led to increasing solar adoption across residential, commercial, and industrial segments.

4. Local Manufacturing and PLI Schemes

The Production Linked Incentive (PLI) scheme encourages the domestic production of advanced inverters, reducing reliance on imports (especially from China). Companies like Waaree and Jakson are scaling up local manufacturing of smart inverters

5. Shift Toward Smart & String Inverters

Increased demand for string inverters due to their higher efficiency and modular use in rooftop and C&I installations. Rise in smart inverters that support grid stability and storage integration.

India's solar inverter industry is pivotal in its renewable energy journey, driven by technological innovations and a strong push for sustainable energy sources. These factors collectively drive the rapid growth of India's domestic solar inverter market, reinforcing the nation's commitment to sustainable energy.

9.3. Threats and Challenges – Domestic Solar Inverter Market

India's solar inverter market is expanding rapidly, driven by rising solar adoption, government incentives, and declining costs. However, several challenges could hinder its growth:

1. High Initial Costs & Price Sensitivity

- Advanced inverters (hybrid, microinverters) remain expensive, limiting affordability for residential and small-scale users.
- Price-sensitive consumers often opt for low-cost, lower-quality alternatives, impacting on demand for premium brands.

2. Competition from Chinese Manufacturers

- The dominance of Chinese brands (Huawei, Growatt, Sungrow) due to aggressive pricing and economies of scale.
- Indian manufacturers struggle to compete, increasing reliance on imports and slowing domestic production.

3. Grid Integration & Stability Issues

- Intermittent solar power generation requires inverters with advanced grid-support features (e.g., reactive power control).
- Weak grid infrastructure in many states leads to frequent power fluctuations and inefficiencies.

4. Lack of Skilled Workforce & After-Sales Support

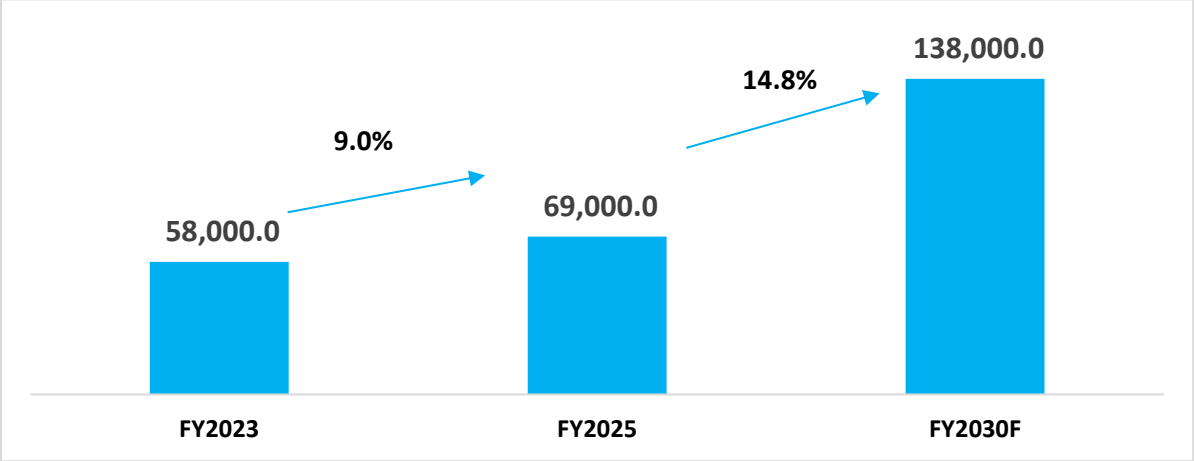
- Limited technical expertise in installing and maintaining advanced inverters, especially in rural areas.
- Poor after-sales service from local players hampers long-term adoption and customer satisfaction.

5. Policy & Regulatory Uncertainty

- Frequent changes in subsidies (e.g., PM Surya Ghar Yojana) and net metering policies create investment risks.
- Import duties (e.g., Basic Customs Duty) raise costs, while inconsistent quality enforcement (BIS certification) allows substandard products into the market.

9.4. Domestic Solar Inverter Market - Market Size and Growth Outlook

Exhibit 9.1: Domestic Solar Inverter , FY2023 - FY2025- FY2030F, INR Million



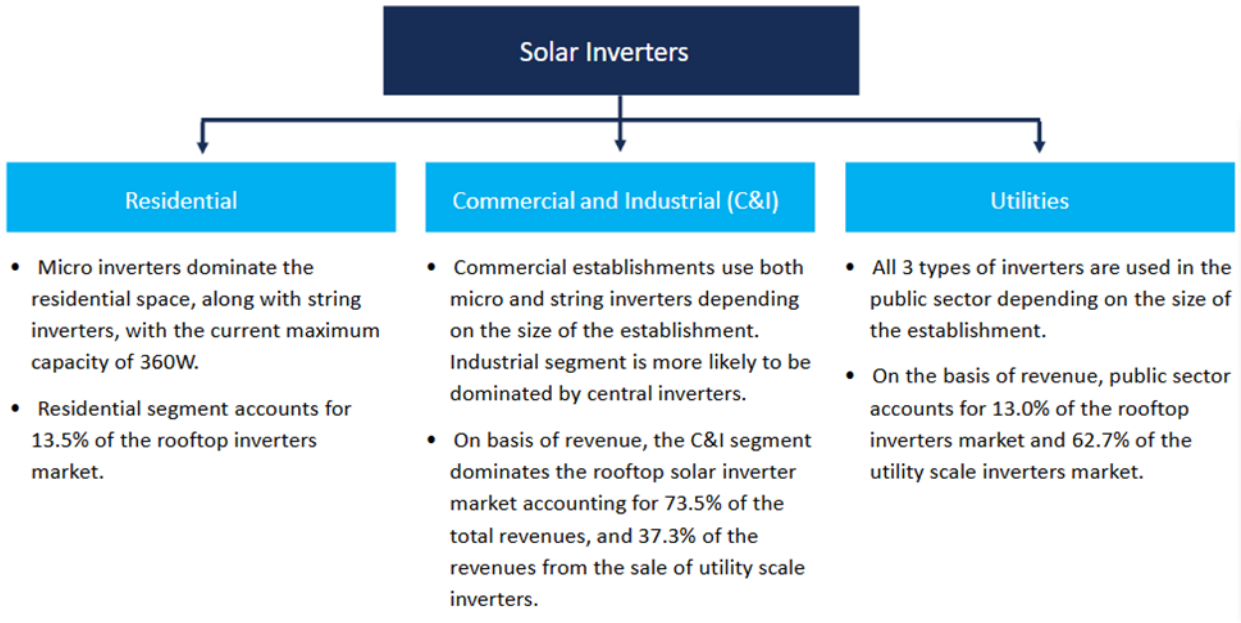
Source: Frost & Sullivan Analysis

The domestic solar inverter market is projected to reach a value of INR 69,000 million by FY2025. With an expected compound annual growth rate (CAGR) of 14.8%, the market is anticipated to double and achieve sales of INR 138,000 million by FY2030.

Key drivers for the growth of Domestic Solar Inverters in the Forecast period

The growth of the India Solar Inverter Market is driven by government policies, rising solar installations, and declining solar PV costs. Grid modernization, industrial solar adoption, rural electrification, and advancements in inverter technology further boost demand. Increasing use of smart, hybrid, and battery-integrated inverters supports efficiency and grid stability.

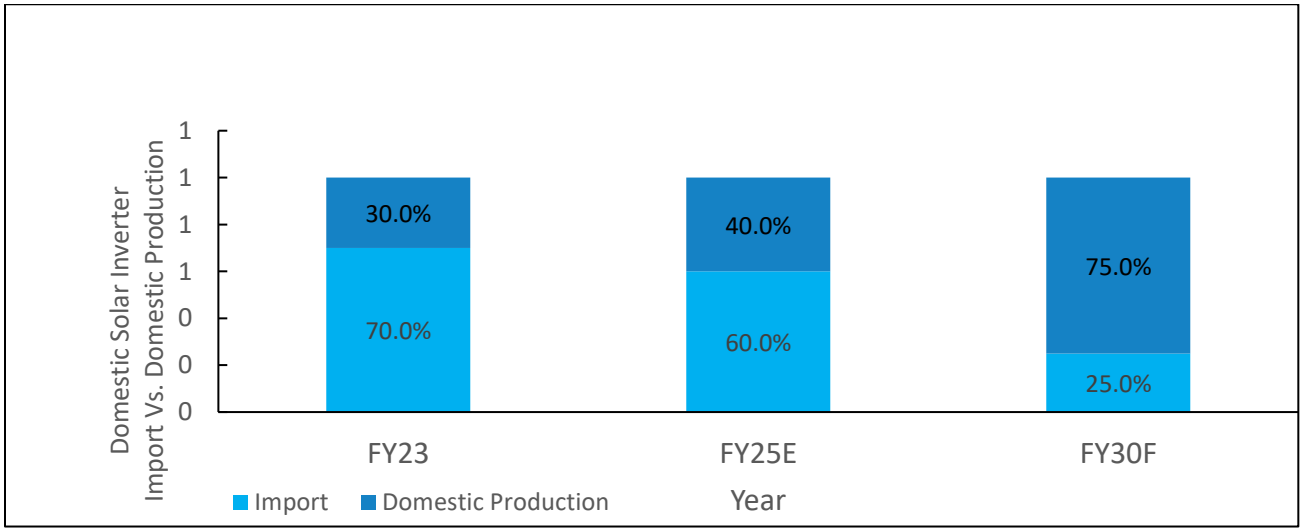
9.5. Domestic Solar Inverter Market - Classification by Application (% market split)



9.6. Domestic Solar Inverter Market – Market Split by Import Vs. Domestic Production

India currently relies heavily on imported solar inverters, with around 95% of its supply coming from Chinese manufacturers like Sungrow, Sineng, TBEA, FIMER, Solis, Deye, Sofar, Polycab, Foxess, SolarEdge and Hopewind due to their cost competitiveness and advanced technology. However, domestic production is expected to rise significantly in the coming years, driven by government policies the imposition of a 20-25% Basic Customs Duty (BCD) on imports, and the Approved List of Models and Manufacturers (ALMM), which mandates the use of domestically manufactured inverters in government solar projects.

Exhibit 9.2: Domestic Solar Inverter , Market Split by Import Vs. Domestic Production , FY2023 - FY2025-FY2030F



Source: Frost & Sullivan Analysis

Note: Imports include CKD / Semi knockdown units.

Additionally, India's ambitious target of 500 GW of renewable energy capacity by 2030 is fueling demand, prompting local players like Delta, Luminous, and Havells to scale up production, while foreign firms like Sungrow are setting up manufacturing plants in India. Geopolitical tensions and supply chain risks further incentivize self-reliance, aligning with the Atmanirbhar Bharat (Self-Reliant India) initiative. As a result, domestic inverter manufacturing is poised for substantial growth, reducing import dependency and strengthening India's solar energy ecosystem.

India's solar sector remains heavily reliant on China for critical components like solar cells and modules due to:

- Cost Competitiveness – Chinese manufacturers benefit from economies of scale, government subsidies, and lower production costs, making their products significantly cheaper than Indian alternatives.
- Integrated Supply Chain – China dominates the solar supply chain, from polysilicon to finished modules, while India lacks domestic capacity in key upstream processes.
- Technological Edge – Chinese firms lead in advanced solar technologies (PERC, TOPCon, HJT), while Indian manufacturers primarily use older technologies.
- High Import Dependency – Despite growing domestic capacity, 70-80% of India's solar modules and cells are imported from China.

To reduce reliance on imports (especially from China) and strengthen its solar supply chain, the Indian government has launched several key initiatives:

Financial (Demand-side) incentives

- PM Surya Ghar (rooftop subsidy): Central subsidy for residential rooftops; biggest driver of 1–10 kW inverter demand.
- PM-KUSUM (agri pumps): Subsidised standalone/grid-connected solar pumps; inverters bundled in BoP.

Production (Supply-side) incentives (manufacturing in India)

- SPECS: 25% capital subsidy for eligible power-electronics CapEx (incl. inverters).
- State ESDM policies: Extra capex/interest/stamp-duty support from leading states (e.g., TN, Gujarat).

Policy & regulatory (mandatory for inverters)

- BIS certification: IS 16221-1/2 (safety), IS/IEC 61683 (efficiency), IS 16169 (anti-islanding).
- CEA grid standards: Must meet LVRT/HVRT, reactive power, frequency/voltage ride-through, anti-islanding.

9.7. Domestic Solar Energy Storage Solutions Market - Overview

India's solar energy storage solutions market is expanding rapidly due to rising renewable energy adoption, government incentives, and the necessity for grid reliability. The market includes battery energy

storage systems (BESS), pumped hydro storage, and new technologies such as hydrogen and thermal storage. The solar energy storage industry in India is expected to increase exponentially as renewable energy expands and supportive regulations are implemented. Lithium-ion batteries will dominate, although new technologies such as sodium-ion and green hydrogen will gain popularity. Cost and regulatory challenges must be addressed to achieve long-term growth.

9.8. Key Growth Drivers – Domestic Solar Energy Storage Solutions Market

The India Solar Energy Storage Solutions Market is experiencing rapid growth, driven by several key factors, including government policies, declining technology costs, and increasing renewable energy integration.

India's solar energy storage market is expanding rapidly due to:

1. **Government Support** – Policies like the National Solar Mission, PLI schemes, and subsidies boost adoption.
2. **Declining Battery Costs** – Cheaper lithium-ion and local manufacturing (via ACC PLI) improve affordability.
3. **Solar Integration Needs** – Storage ensures grid stability as solar capacity grows (500 GW target by 2030).
4. **Industrial Demand** – Businesses use solar + storage to cut electricity costs and ensure reliability.
5. **Rural Electrification** – Off-grid solar storage powers remote areas via schemes like KUSUM.
6. **Tech Advancements** – New battery types (sodium-ion, flow batteries) and hybrid systems enhance efficiency.
7. **Rising Investments** – Major players (Reliance, Adani, Tata) are investing heavily.
8. **EV Growth** – Expanding EV infrastructure supports battery innovation and V2G potential.

The India Solar Energy Storage Solutions Market is poised for exponential growth, driven by policy support, cost reductions, industrial demand, and technological innovation. As India moves toward its net-zero targets, energy storage will play a pivotal role in ensuring grid stability and maximizing solar utilization. With a strong policy push, falling costs, and private sector participation, India's solar storage market is set for major growth.

9.9. Threats and Challenges – Domestic Solar Energy Storage Solutions Market

The battery storage market in India faces several challenges, including high initial costs, financial barriers, and technological limitations. Additionally, policy and regulatory hurdles, supply chain dependence, competition from conventional energy sources, and infrastructure constraints further hinder growth. Environmental concerns related to recycling, a lack of market awareness, a shortage of skilled professionals, and competition from alternative storage solutions also pose significant obstacles.

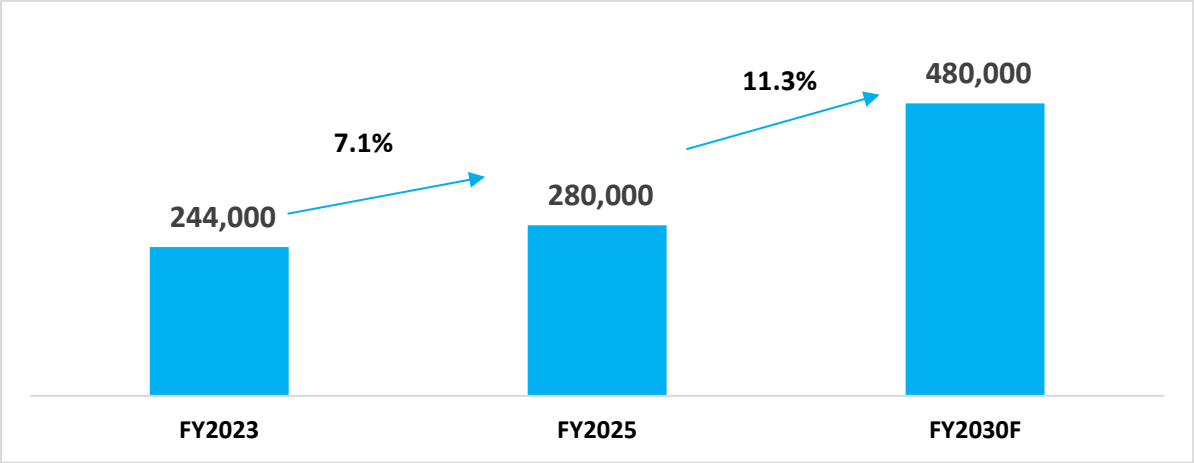
High initial costs for solar and storage systems are due to the high upfront costs of lithium-ion and other advanced battery technologies, capital-intensive projects, and limited financing options. Technological limitations include battery degradation over time, lack of indigenous technology, and thermal and safety concerns. Policy and regulatory challenges, supply chain and raw material dependence, and competition

from conventional energy sources also create significant hurdles. Additionally, weak grid infrastructure, land and logistics issues, environmental and recycling concerns, and resource scarcity further impact the industry's growth.

India's reliance on imported batteries and the lack of standardized policies for energy storage integration with the grid also pose challenges. Additionally, the country relies heavily on imported batteries, which exposes it to geopolitical risks and supply disruptions.

9.10. Domestic Battery Energy Storage Market - Market Size and Growth Outlook

Exhibit 9.3: Domestic Battery Energy Storage Market, FY2023 - FY2025- FY2030F, INR Million

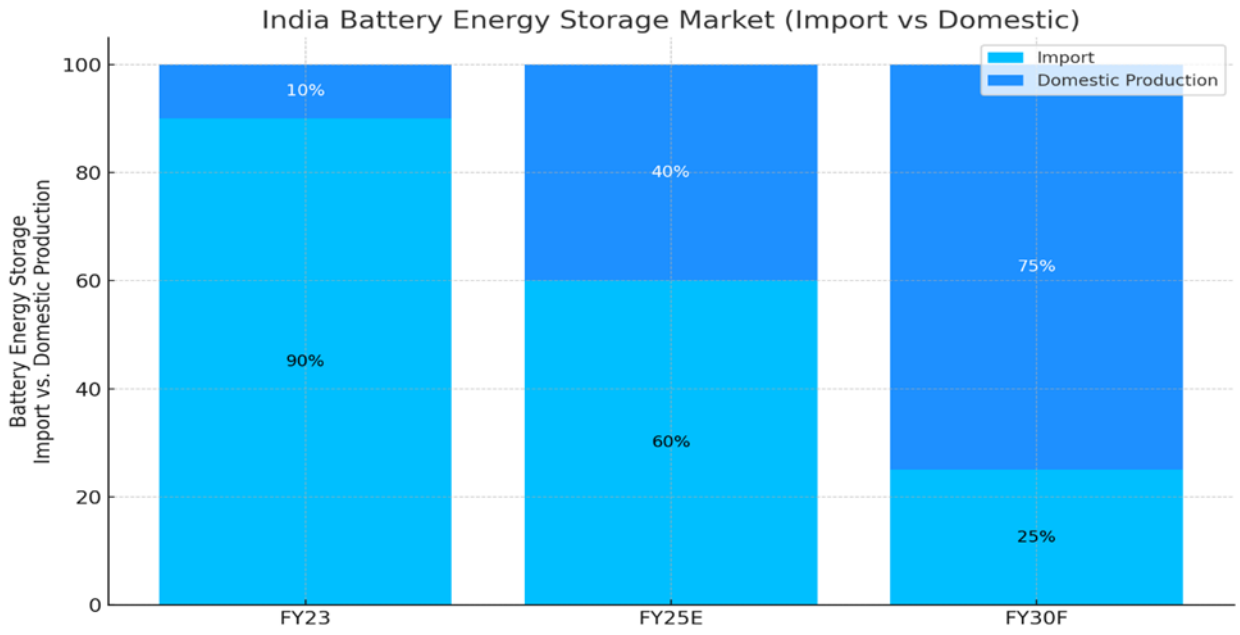


Source: Frost & Sullivan Analysis

The Domestic Battery Energy Storage market was estimated to be worth INR 280,000 Million by FY2025. The market is expected to grow at an 11.3% CAGR and reach INR 480,000 Million at the end of FY2030.

9.11. Domestic Battery Energy Storage – Market Split by Import Vs. Domestic Production

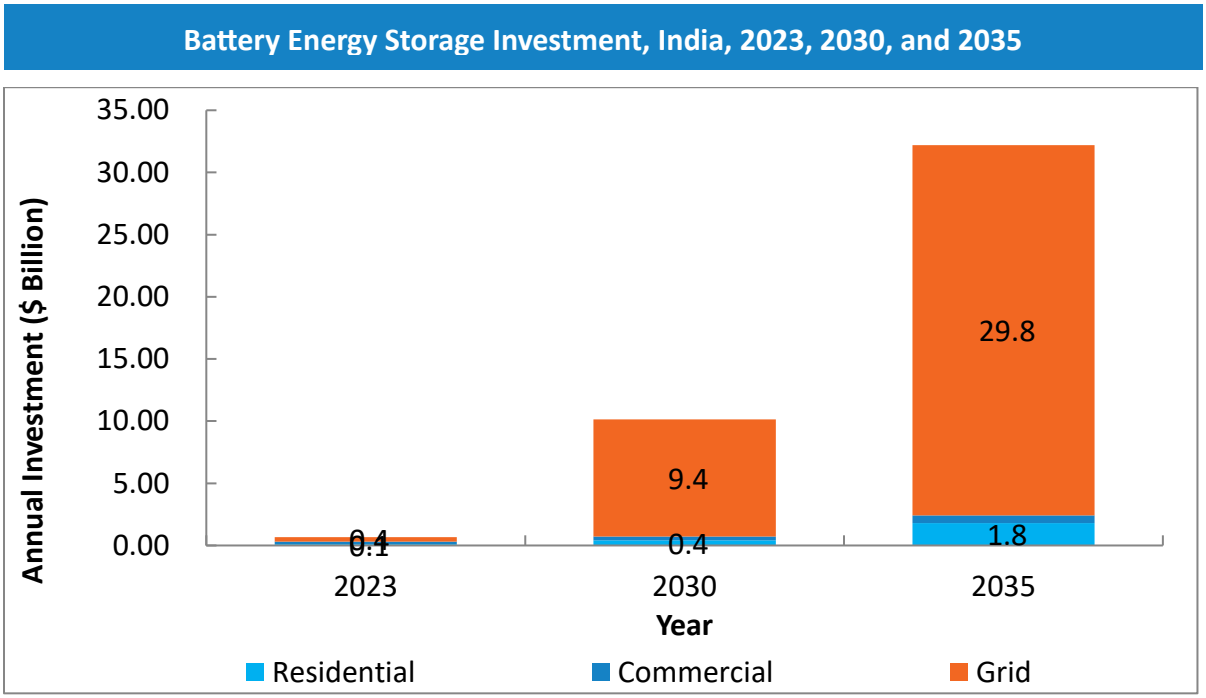
Exhibit 9.4: Domestic Battery Energy Storage, Market Split by Import Vs. Domestic Production , FY2023 - FY2025E- FY2030F



The graph highlights a significant transformation in India's Battery Energy Storage System (BESS) market from FY23 to FY30F, with a clear shift from import dependence to domestic production. In FY23, imports dominated the market with a 90% share, underlining India's heavy reliance on foreign battery technologies—primarily from China, South Korea, and Japan for lithium-ion cells and associated components. This shift of drop in imports is driven mainly by government-led initiatives such as the Production Linked Incentive (PLI) scheme for Advanced Chemistry Cells (ACC), which aims to incentivize local manufacturing capacity of 50 GWh, alongside the entry of private players like Reliance, Ola Electric, and Exide into the battery manufacturing space.

Looking further ahead, the trend becomes more pronounced, with domestic production expected to account for 75% of the market by FY30F. This rapid transition reflects the maturation of India's battery ecosystem, the development of giga-factories, and growing policy momentum under schemes like the Phased Manufacturing Program (PMP). Such localization efforts are critical not only for economic benefits such as job creation and foreign exchange savings, but also for enhancing energy security and reducing vulnerability to global supply chain disruptions.

9.12. Battery Energy Storage Investments, India, 2023, 2030F, 2035F



A growing number of companies want to set up gigafactories in India as the country seeks to reduce its reliance on imports from China and the United States. India intends to become an export hub for next-generation battery technologies as it moves toward incentivizing large-scale battery energy storage production.

- Various public and private participants have or are in the process of commissioning nearly 48 projects that will use different chemistries.
- Most chemistries focus on lithium-ion (LION), flow, vanadium, electrochemical, advanced, and lead-acid batteries (LAB).
- Incentives are at 20% of the sale price of the cell per kWh.
- Future battery chemistries under consideration include sodium-ion and zinc-air.

The PLI – ACC Battery Storage Scheme is a ₹18,100 crore initiative by the Indian government to boost domestic manufacturing of advanced battery cells. Launched in 2021, it targets 50 GWh of production capacity over five years, supporting technologies like lithium-ion and solid-state batteries. Incentives are output-linked and require companies to achieve 60% domestic value addition. Key beneficiaries include Ola Electric, Reliance, and Hyundai. The scheme aims to reduce battery imports, support EV growth, and enable large-scale renewable energy storage in India.

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To boost renewable energy growth, especially in the solar and energy storage sector, the Indian government has introduced several policies, regulatory reforms, and funding mechanisms. These create a favorable environment for companies like BluPine Energy to scale their projects.

India's rooftop solar (RTS) sector

India's rooftop solar (RTS) sector has witnessed remarkable growth, registering a 34% CAGR between 2020 and 2024 to reach nearly 18.4 GW of cumulative capacity. This surge has been driven by supportive government policies and the steady decline in photovoltaic module prices, which have improved project economics. A key accelerator has been the PM Surya Ghar: Muft Bijli Yojana, which provides free electricity to residential consumers and has significantly boosted adoption in the household segment. Together, these factors underscore the strategic rise of rooftop solar in India, propelled by policy momentum, affordability, and consumer incentives, cementing its role as a vital complement to the country's large-scale solar expansion.

Utility Scale and Roof Top Solar - Overview

In fiscal year (FY) 2025, India added an estimated 22.5 GW of new solar capacity, comprising 17.4 GW of utility-scale projects and 5.15 GW of rooftop PV installations. Geographic leadership remained consistent, with Rajasthan contributing 6.5 GW, followed by Gujarat with 3.6 GW and Maharashtra with 2.3 GW. By March 31, 2025, cumulative utility-scale solar capacity had reached 85.6 GW, supported by an additional 68.2 GW in the auction-completed pipeline. Looking ahead, forecasts for FY 2026 indicate the commissioning of around 21.2 GW of utility-scale capacity and 7.2 GW of rooftop and onsite solar.

Overall, FY 2025 reinforced India's strong solar growth trajectory, with balanced additions across segments, emerging supply chain leaders, and a substantial project pipeline setting the stage for sustained momentum in the years ahead.

9.13. Competitive Landscape for Solar Inverter and Energy Storage Solutions Market

Solar Inverter

- Sungrow is a market leader in both the central and string solar inverter markets, with 37.6% market share by value in Fiscal 2025.
- Sineng has a 15.7% market share by value in Fiscal 2025 and has a strong presence in central inverters.
- TBEA, holding a 12.6% market share by value in Fiscal 2025. With over 3GW of supplied inverters and plans for a three-assembly-line local manufacturing facility, TBEA is positioned to remain a key market leader in the string inverter market
- Other key players in the market are FIMER, Deye, Sofar, Polycab, Solis, Hopewind, TMEIC etc.

On the supply side, Waaree Energies emerged as India's leading solar module supplier in FY 2025, securing 13.9% of domestic shipments. In the inverter market, Sungrow dominated central inverters while TBEA led in string inverters, reflecting clear trends in the solar supply chain.

Solar Energy Storage Solution Providers in India

Company	Origin	Solar-Specific Storage Solutions	Key Differentiator
Exide Industries	Domestic	Li-ion solar batteries for homes & grid support	PLI-backed manufacturing, strong distribution
Amara Raja	Domestic	Solar-compatible lead-acid & new Li-ion batteries	30+ years in battery tech, rural penetration
Loom Solar	Domestic	Solar+Li-ion battery kits (1kWh-10kWh)	Most affordable plug-and-play solutions
Waaree Energies	Domestic	Integrated solar storage hybrid systems	India's largest solar panel maker
Su-Vastika (acquired by Rotomag Enertec)	Domestic	Off-grid solar storage with smart energy management	Specializing in microgrids & rural solutions
Delta Electronics	Domestic	Solar battery inverters & storage controllers	High-efficiency power conversion
Okaya Power	Domestic	Solar lithium batteries for homes & telecom	Widest retail network (50k+ outlets)
LG Chem	Korea	RESU solar home batteries (6.5-16kWh)	Premium brand, long lifespan (10+ years)
BYD	China	Solar Battery-Box (LFP) for commercial use	World leader in LFP battery tech
Sungrow	China	DC-coupled solar storage systems	Seamless integration with solar inverters
Huawei	China	Smart solar storage with AI optimization	Best digital energy management
Tesla	USA	Solar Megapack for utility-scale projects	Highest energy density (4 MWh per unit)

Competitive Benchmarking of Key Companies providing Industrial Drive Solutions and Solar Pumping Solutions

Select key players manufacturing industrial drive solutions in India include Rotomag Enertec Limited, Sona BLW Precision Forgings Ltd, Elecon Engineering Company Limited, Shanthi Gears Limited, and Igarashi Motors Limited

- **Rotomag Enertec Limited –** A design-focused manufacturer and supplier of industrial drive solutions (comprising motors, gearboxes and drivetrains) serving diverse applications across multiple industries.
- **Sona BLW Precision Forgings Ltd (Sona Comstar):** An automotive technology company specializing in precision-forged gears, differential assemblies, and drive solutions with a strong presence in EV components.
- **Elecon Engineering Company Limited:** One of India's key manufacturers of industrial gears and material handling equipment, serving sectors such as power, steel, cement, and mining**.**
- **Shanthi Gears Limited:** A subsidiary of Tube Investments of India, specializing in custom-engineered gear solutions across industries including power, textiles, steel, and defense**.**
- **Igarashi Motors Limited:** A manufacturer of micro-motors and drive systems primarily catering to automotive, home appliance, and industrial applications, with a strong export footprint**.**

Select key players manufacturing solar pumping solutions in India include Rotomag Enertec Limited, Kirloskar Brothers Limited, KSB Limited, Shakti Pumps (India) Limited, Oswal Pumps Limited and WPIL Limited

- **Rotomag Enertec Limited :** One of India's key manufacturers of solar products comprising solar pumps, solar pumping systems, inverters, and battery energy storage systems.
- **Kirloskar Brothers Limited:** One of India's key pump manufacturers, providing fluid management solutions for infrastructure projects in water, power, irrigation, oil & gas, and defense sectors.
- **KSB Limited:** A Pune-based company manufacturing power-driven pumps and industrial valves, serving sectors like wastewater, energy, mining, chemicals, and oil & gas**.**
- **Shakti Pumps (India) Limited:** A global player engaged in manufacturing energy-efficient water pumping solutions, specializing in solar and submersible pumps for agriculture and industrial use.
- **Oswal Pumps Limited:** An Indian company manufacturing solar and grid-connected pumps, prominent under India's clean-energy irrigation programs**.**
- **WPIL Limited:** A multinational pump manufacturer with extensive R&D, offering a broad range of pumps and pumping systems with global manufacturing presence.

Financial Benchmarking

Particulars	For the Fiscal Year 2025										
	Rotomag Enertec Limited	Kirloskar Brothers Limited	KSB Limited	Shakti Pumps (India) Limited	Oswal Pumps Limited	WPIL Limited	CG Power & Industrial Solutions Limited	Sona BLW Precision Forgings Ltd	Elecon Engineering Company Limited	Shanthi Gears Limited	Igarashi Motors India Ltd
Financial											
Revenue from Operations (₹ million)	12,649.96	44,922.43	25,330.86	25,162.40	14,303.07	18,068.87	99,086.60	35,460.21	22,269.60	6,046.20	8,384.21
Growth in Revenue from Operations (%)	82.23%	12.27%	12.72%	83.57%	88.55%	8.56%	23.15%	11.34%	14.94%	12.79%	15.64%
EBITDA (₹ million)	2,440.16	6,091.77	3,375.34	6,029.50	4,198.53	2,926.16	13,047.30	9,667.58	5,425.90	1,287.30	950.47
EBITDA Margin (%)	19.29%	13.56%	13.33%	23.96%	29.35%	16.19%	13.17%	27.26%	24.36%	21.29%	11.34%
EBITDA CAGR (Fiscal 2023 to Fiscal 2025)	108.26%	23.56%	16.98%	200.98%	169.47%	4.60%	14.61%	19.66%	26.54%	19.71%	25.46%
Profit/(Loss) for the Year (₹ million)	1,675.19	4,186.93	2,474.75	4,083.70	2,806.13	1,262.01	9,729.80	5,996.88	4,151.00	960.30	241.68
PAT Margin (%)	13.11%	9.17%	9.63%	16.12%	19.58%	6.84%	9.66%	16.29%	18.15%	15.51%	2.87%
Net Fixed Assets Turnover Ratio (times)	9.78x	6.53x	5.14x	9.70x	10.62x	3.57x	5.31x	1.39x	2.49x	7.90x	1.93x

Particulars	For the Fiscal Year 2024										
	Rotomag Enertec Limited	Kirloskar Brothers Limited	KSB Limited	Shakti Pumps (India) Limited	Oswal Pumps Limited	WPIL Limited	CG Power & Industrial Solutions Limited	Sona BLW Precision Forgings Ltd	Elecon Engineering Company Limited	Shanthi Gears Limited	Igarashi Motors India Ltd
Financial											
Revenue from Operations (₹ million)	6,941.82	40,011.99	22,472.38	13,707.40	7,585.71	16,644.04	80,459.80	31,847.70	19,374.20	5,360.50	7,250.45
Growth in Revenue from Operations (%)	-1.43%	7.26%	23.34%	41.65%	97.01%	3.67%	15.40%	19.95%	26.66%	20.28%	10.48%
EBITDA (₹ million)	935.94	5,196.46	2,935.70	2,248.40	1,501.24	2,983.40	11,280.70	9,020.85	4,744.70	1,017.90	740.85
EBITDA Margin (%)	13.48%	12.99%	13.06%	16.40%	19.79%	17.92%	14.02%	28.32%	24.49%	18.99%	10.22%
Profit/(Loss) for the Year (₹ million)	713.76	3,496.80	2,087.33	1,417.30	976.65	1,930.15	8,711.20	5,177.76	3,555.80	822.50	95.73
PAT Margin (%)	10.02%	8.61%	9.16%	10.31%	12.83%	11.40%	10.69%	16.14%	17.95%	14.76%	1.32%
Net Fixed Assets Turnover Ratio (times)	7.88x	6.01x	4.98x	7.30x	7.73x	3.67x	6.98x	1.38x	2.60x	7.80x	1.81x

Particulars	For the Fiscal Year 2023										
	Rotomag Enertec Limited	Kirloskar Brothers Limited	KSB Limited	Shakti Pumps (India) Limited	Oswal Pumps Limited	WPIL Limited	CG Power & Industrial Solutions Limited	Sona BLW Precision Forgings Ltd	Elecon Engineering Company Limited	Shanthi Gears Limited	Igarashi Motors India Ltd
Financial											
Revenue from Operations (₹ million)	7,042.19	37,302.21	18,219.60	9,676.83	3,850.36	16,054.59	69,725.40	26,550.10	15,296.80	4,456.50	6,562.46
Growth in Revenue from Operations (%)	NA	22.00%	21.68%	-17.89%	6.84%	35.91%	27.15%	25.85%	26.22%	32.21%	17.94%
EBITDA (₹ million)	562.61	3,990.00	2,466.49	665.60	578.19	2,674.48	9,933.20	6,752.32	3,388.80	898.30	603.81
EBITDA Margin (%)	7.99%	10.70%	13.54%	6.88%	15.02%	16.66%	14.25%	25.43%	22.15%	20.16%	9.20%
Profit/(Loss) for the Year (₹ million)	554.49	2,357.66	1,827.41	241.32	341.99	1,778.70	7,963.30	3,952.97	2,375.10	670.50	52.38
PAT Margin (%)	7.60%	6.27%	9.80%	2.49%	8.83%	10.92%	11.31%	14.71%	15.33%	14.68%	0.79%
Net Fixed Assets Turnover Ratio (times)	10.31x	6.08x	4.86x	6.53x	4.58x	3.37x	6.91x	1.58x	2.10x	6.84x	1.68x

Notes:

1. Growth in Revenue from Operations is calculated as a percentage of Revenue from operations of the relevant year less Revenue from operations of the preceding year, divided by Revenue from operations of the preceding year.
2. EBITDA is calculated as Profit/(Loss) for the year from continuing and discontinued operations less Other income, Foreign exchange gain (net), Exceptional items, Share of profit/(loss) of associates & joint ventures and Net profit/(loss) after tax for the year from discontinued operations add Finance costs, Depreciation and amortisation and Total tax expenses.
3. EBITDA Margin is calculated as EBITDA divided by Revenue from operations.
4. Profit/(Loss) for the year means Profit/(Loss) for the year from continuing operations.
5. PAT Margin is calculated as Profit/(Loss) for the year from continuing operations divided by Total income.
6. Net Fixed Assets Turnover Ratio is calculated as Revenue from operations for the year divided by Net Property, plant and equipment, Right of use assets, Capital work in progress, Goodwill, Other Intangible assets and Intangible assets under development.

Among the peers considered in this report, Rotomag Enertec Limited registered one of the highest EBITDA CAGRs between fiscals 2023 and 2025 of 108.26%.

In Fiscal 2025, Rotomag Enertec Limited achieved the second-highest Net Fixed Assets Turnover Ratio among peers as part of this report.