PRAGYAWAN act intellect...

INDUSTRY REPORT ON DIVERSIFIED INFRASTRUCTURE AND BUSINESS SERVICES IN INDIA

Industry Report

Submitted to: Pragyawan Technologies Limited

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ABBREVIATIONS USED IN THE REPORT

AC	Alternating Current	**CAGR**	Compound Annual Growth Rate
Bn	Billion	**BU**	Billion Units
CY	Calendar Year	**CEA**	Central Electricity Authority
CII	Confederation of Indian Industry	**CY2030**	Calendar Year (Jan 2030-Dec 2030
EPR	Extended Producer Responsibility	**EPC**	Engineering, Procurement and Construction
FDI	Foreign Direct Investment	**GDP**	Gross Domestic Product
GST	Goods and Services Tax	**GW**	Giga watt
GBS	Gross Budgetary Support	**INR**	Indian Rupee
IEA	International Energy Agency	**kWh**	Kilo watt Hour
Mn	Million	**MoHI**	Ministry of Heavy Industries
MoUD	Ministry of Urban Development	**MW**	Megawatt
MNRE	Ministry of New & Renewable Energy	MoP	Ministry of Power
TWh	Terawatt hour	**US**	United States of America

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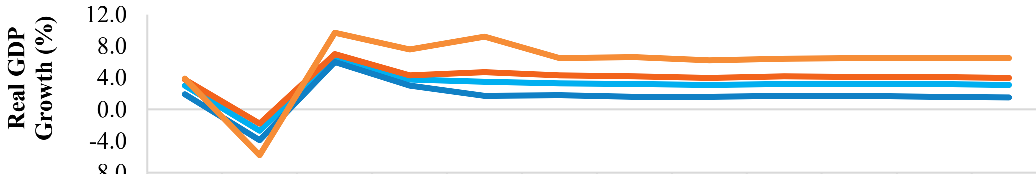
1. GLOBAL MACROECONOMIC OUTLOOK

1.1. Global Gross Domestic Product (GDP) Growth Outlook

After a strong recovery of 6.6% in CY2021, global GDP growth weakened in CY2022 due to the Russia-Ukraine war. Inflationary pressures stemming from supply-chain disruptions led to monetary tightening by central banks worldwide. This weighed on economic activity, leading growth rate to fall further from 3.8% in CY2022 to 3.5% in CY2023. Easing inflation and gradual monetary easing helped moderate the pace of decline in global growth in CY2024. However, elevated trade tensions and a volatile trade and policy environment will weigh on global growth, with CY2025 estimated to experience growth falling further to 3.2%. However, with countries signing regional and bilateral trade agreements and adjusting to global trade volatility, global growth is forecasted to stabilize and grow at an average of 3.2% per year between CY2026-CY2030.

Figure 1.1: Real GDP Growth (%), Global, CY2019-CY2030F



	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025E	CY 2026F	CY 2027F	CY 2028F	CY 2029F	CY 2030F
World	3.0	-2.7	6.6	3.8	3.5	3.3	3.2	3.1	3.2	3.2	3.2	3.1
Advanced Economies	1.9	-3.9	6.0	3.0	1.7	1.8	1.6	1.6	1.7	1.7	1.6	1.5
Emerging Market & Developing Economies	3.8	-1.8	7.0	4.3	4.7	4.3	4.2	4.0	4.2	4.1	4.1	4.0
India	3.9	-5.8	9.7	7.6	9.2	6.5	6.6	6.2	6.4	6.5	6.5	6.5

Note: *E: estimate, F: forecast; CY: Calendar Year; Data is represented in calendar years. For e.g. CY2019 is the 12-month period between 1 January 2019 and 31 December 2019; India's data is represented in fiscal years. For e.g. FY2020 is the 12-month period between 1 April 2019 and 31 March 2020 and corresponds to CY2019; List of Advanced economies and Emerging and Developing economies can be accessed **here**.*

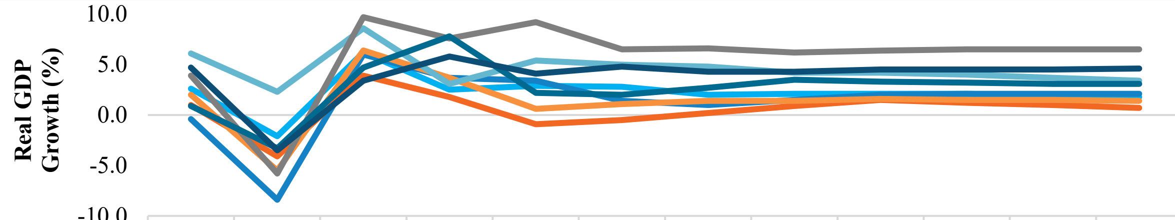
Source: International Monetary Fund (IMF); Frost & Sullivan

Emerging markets are expected to continue to outperform advanced economies over CY2025-CY2030. The former will benefit from greater rebound in consumer demand, economies of scale in manufacturing, competitive labour costs, and easing monetary policies. However, trade tensions and geopolitical risks will require nations to diversify supply chains and pursue sustainable development strategies to build long-term resilience. Advanced economies, on the other hand, will experience slower growth due to high debt levels and rapidly ageing population. Moreover, geopolitical risks and climate challenges will persist as well. Stable inflation and low interest rates will provide some assistance to consumption and investment, but maintaining growth will require targeted structural reforms, innovation, and long-term policy vision.

India, at present, is the fastest growing major economy in the world. India's growth outlook is underpinned by sustained public capital expenditure (CAPEX) (budgeted at INR 11.2 trillion for FY2026), resilient domestic demand, and ongoing structural reforms. Moreover, unlike advanced economies, constrained by high debt and ageing demographics, India benefits from manageable public debt levels (81.6% of GDP in FY2025 compared to 109.1% of GDP in CY2024 for advanced economies), an expanding consumer base and competitive labour costs. While global trade volatility poses near-term risks, India's investment-led growth model and policy continuity position it to outperform both advanced economies and the broader emerging market average.

1.2. Growth Outlook for Major Economies

Figure 1.2: Real GDP Growth (%), Major Economies, CY2019-CY2030F



	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024	CY2025E	CY2026F	CY2027F	CY2028F	CY2029F	CY2030F
US	2.6	-2.1	6.2	2.5	2.9	2.8	2.0	2.1	2.1	2.1	1.9	1.8
Mexico	-0.4	-8.4	6.0	3.7	3.4	1.4	1.0	1.5	2.0	2.1	2.1	2.1
Germany	1.0	-4.1	3.9	1.8	-0.9	-0.5	0.2	0.9	1.5	1.2	1.0	0.7
EU	2.0	-5.5	6.4	3.7	0.6	1.1	1.4	1.4	1.6	1.5	1.5	1.4
China	6.1	2.3	8.6	3.1	5.4	5.0	4.8	4.2	4.2	4.0	3.7	3.4
India	3.9	-5.8	9.7	7.6	9.2	6.5	6.6	6.2	6.4	6.5	6.5	6.5
Middle East	0.9	-3.3	4.7	7.8	2.2	2.0	2.7	3.5	3.3	3.2	3.1	3.1
Southeast Asia	4.7	-3.5	3.4	5.8	4.1	4.8	4.3	4.3	4.5	4.5	4.5	4.6

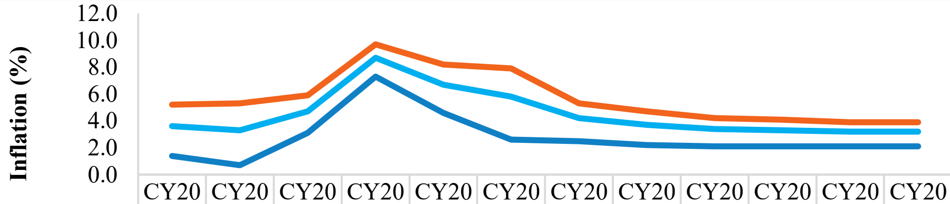
Note: *E: estimate, F: forecast; CY: Calendar Year; Data is represented in calendar years. For e.g. CY2019 is the 12-month period between 1 January 2019 and 31 December 2019; India's data is represented in fiscal years. For e.g. FY2020 is the 12-month period between 1 April 2019 and 31 March 2020 and corresponds to CY2019; Source: IMF; Frost & Sullivan*

The US experienced a slowdown in CY2025 as elevated tariffs continue to increase import costs and weigh on consumer spending. While rate cuts by the US Federal Reserve (Fed) may partially ease these pressures, uncertainties around trade policies remain a key risk. In the European Union (EU), growth will remain muted amid weak manufacturing, sluggish consumption, and high energy costs, further pressured by trade frictions and policy ambiguity. In China, following growth of 5.0% in CY2024, GDP expansion is estimated to moderate to 4.8% in CY2025. The deceleration is driven by continued strain in the property sector, demographic headwinds, and ongoing trade tensions with the US. India's growth momentum, highlighted by strong CAPEX, a large consumer base, cost-competitive labour force, and ongoing structural reforms, will make it third largest economy by the end of the decade. Southeast Asia will record consistent growth from CY2025 to CY2030, averaging 4.5% per year. This will be driven by strong domestic consumption and foreign and domestic infrastructure investments.

Against the backdrop of global supply chain realignment, sustained public infrastructure spending, and increasing investments in industrial, transportation, energy, and urban infrastructure, India is expected to witness continued growth in infrastructure development activity, thereby supporting long-term demand for EPC services across multiple sectors.

Global Inflation Outlook

Figure 1.3: Inflation (%), Global, CY2019-CY2030F



	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024	CY2025E	CY2026F	CY2027F	CY2028F	CY2029F	CY2030F
World	3.6	3.3	4.7	8.7	6.7	5.8	4.2	3.7	3.4	3.3	3.2	3.2
Advanced Economies	1.4	0.7	3.1	7.3	4.6	2.6	2.5	2.2	2.1	2.1	2.1	2.1
Emerging Market & Developing Economies	5.2	5.3	5.9	9.7	8.2	7.9	5.3	4.7	4.2	4.1	3.9	3.9

Note: *E: estimate, F: forecast; CY: Calendar Year; Data is represented in calendar years. For e.g. CY2019 is the 12-month period between 1 January 2019 and 31 December 2019; List of Advanced economies and Emerging and Developing economies can be accessed* ***here****.*

Source: IMF; Frost & Sullivan

Following the Russo-Ukrainian war, as supply chains continued to adapt, and interest rates remained elevated, global inflation declined moderately. While inflation for non-energy goods is likely to ease, headline inflation is expected to remain sticky due to persistent labour market tightness and rising wages. Moving into CY2026, it will remain crucial for central banks worldwide to balance between a consistent monetary policy stance and inflation concerns to support growth.

Inflation in advanced economies is expected to stabilize at 2.5% in CY2025, reflecting a return to target levels. Easing inflation will improve growth prospects for the region, as inflationary pressures in consumer goods and services gradually subside. Inflation in emerging markets is estimated to moderate in CY2025, falling from 7.9% in CY2024 to 5.3%. This decline is largely due to easing supply chain disruptions, stabilizing energy and food prices, and the ongoing impact of restrictive monetary policies.

1.3. Key Economic Predictions for 2026-2027

Global Growth to Slow but Avoids a Hard Landing: Global growth is expected to slow from 3.2% in CY2025 to 3.1% in CY2026, thereby avoiding a hard landing. As CY2025 trade front-loading upsides gradually fade, delayed effects of tariffs and overall policy uncertainty will weigh on investment and trade momentum. With countries signing regional and bilateral trade agreements and adjusting to global trade volatility, global growth is forecasted to stabilize and grow at an average of 3.2% per year between CY2026-CY2030.

Global Inflation to Ease Unevenly, Shaping Cautious Monetary Easing: As OPEC+[1] nations unwind oil production cuts and non-OPEC supply increases, a supply glut is expected to push Brent crude prices lower in Q1 2026. However, with expected production cuts from Q2 2026, oil prices are likely to stabilise. Softer oil prices will partly support moderation in headline inflation, allowing selective rate cuts in some advanced economies, while others remain cautious amid sticky core inflation and domestic fiscal pressures.

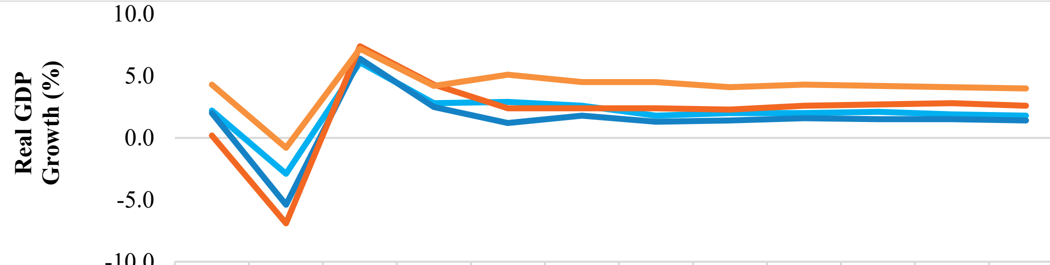
Trade Growth to Slow as Tariff and Supply-Chain Configuration Intensify: Global merchandise trade growth is expected to slow from 2.4% year-on-year (Y-o-Y) in CY2025 to 1.5% Y-o-Y to CY2026. Higher trade barriers, weaker global demand, and ongoing supply-chain diversification are raising costs and uncertainty, posing downside risks for trade-exposed sectors, including packaging. However, shifts toward regionalised production and investment support for setting up manufacturing units are gradually reshaping trade patterns for industrial and consumer packaging.

[1] Organization of the Petroleum Exporting Countries is an organization enabling the co-operation of leading oil-producing and oil-dependent countries to collectively influence the global oil market and maximize profit.

Labour Markets to Stay Tight Despite Slowing Growth: The gap in wages and opportunities between high-skilled and low-skilled jobs is expected to widen. Investment continues to rise in AI infrastructure and software, driving wage growth and strong talent demand for high-skilled roles, giving skilled workers greater negotiating power. In contrast, entry-level mechanical jobs remain at risk, as displacement numbers continue to increase.

1.4. Regional Economic Trends and Outlook

Figure 1.5: Real GDP Growth (%), Major Regions, CY2019-CY2030F



	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024	CY2025E	CY2026F	CY2027F	CY2028F	CY2029F	CY2030F
North America	2.2	-2.9	6.1	2.8	2.9	2.6	1.8	2.0	2.0	2.1	1.9	1.8
Europe	2.0	-5.4	6.4	2.5	1.2	1.8	1.3	1.4	1.6	1.5	1.5	1.4
Latin America and the Caribbean	0.2	-6.9	7.4	4.3	2.4	2.4	2.4	2.3	2.6	2.7	2.8	2.6
APAC	4.3	-0.8	7.2	4.2	5.1	4.5	4.5	4.1	4.3	4.2	4.1	4.0

Note: *E: estimate, F: forecast; CY: Calendar Year; Data is represented in calendar years. For e.g. CY2019 is the 12-month period between 1 January 2019 and 31 December 2019; Source: IMF; Frost & Sullivan*

North America: The US economy is estimated to grow by 2.0% in CY2025 and 2.1% in CY2026. Policy uncertainty around reciprocal tariffs and inflation risks will weigh on investment through CY2026–CY2027 and may prompt the Fed to pause rate cuts through CY2026, constraining consumption. However, the One Big Beautiful Bill Act (OBBBA), along with higher depreciation allowances and R&D expensing, will support household income, investment certainty, and sustain consumption and investment momentum despite trade headwinds. In Canada, real GDP growth is expected to remain modest at around 1.2% in CY2025 before improving to about 1.5% in CY2026, supported by easing financial conditions and targeted fiscal support.

Europe: Europe's economic outlook from CY2025 into the near term remains subdued amid trade uncertainty, with US tariffs weighing on exports and investment. Germany's real GDP growth is expected to remain weak at around 0.2% in CY2025 before improving to about 0.9% in CY2026, supported by higher defence and infrastructure spending despite soft external demand. The UK economy is expected to grow by 1.3% in both CY2025 and CY2026, supported by lower interest rates, rising household wealth, improved confidence, and higher public spending. Trade-related headwinds continue to limit regional momentum even as defence spending rises.

Latin America and the Caribbean: Latin America and the Caribbean's growth outlook remains constrained by US tariff uncertainty and softer global trade, limiting export momentum despite lower direct exposure than other regions. Mexico's real GDP growth is expected to improve from 1.0% in CY2025 to about 1.5% in CY2026, supported by easing monetary and fiscal policy, though reliance on US demand continues to weigh on exports despite United States-Mexico-Canada Agreement (USMCA) protection. Brazil's growth is projected to slow from 2.4% in CY2025 to around 1.9% in CY2026 as tight monetary policy and weak global demand constrain activity.

Asia-Pacific: Asia-Pacific showed resilience in CY2025, supported by export front-loading across economies such as Vietnam, Indonesia, and South Korea amid rising trade uncertainty. Several economies have negotiated lower reciprocal US tariff rates, including Vietnam (20%), Thailand (19%), and Japan (15%), from the higher levels announced in April 2025. Export-oriented economies with higher shares of tariff-exempt products, such as semiconductors, are likely to remain resilient. China's outlook remains weaker, with growth expected to slow from

5.0% in CY2025 to around 4.0% in CY2026, constrained by soft manufacturing activity, deflationary pressures, high debt, property sector stress, and elevated US tariffs of 50% until new trade deals are reached.

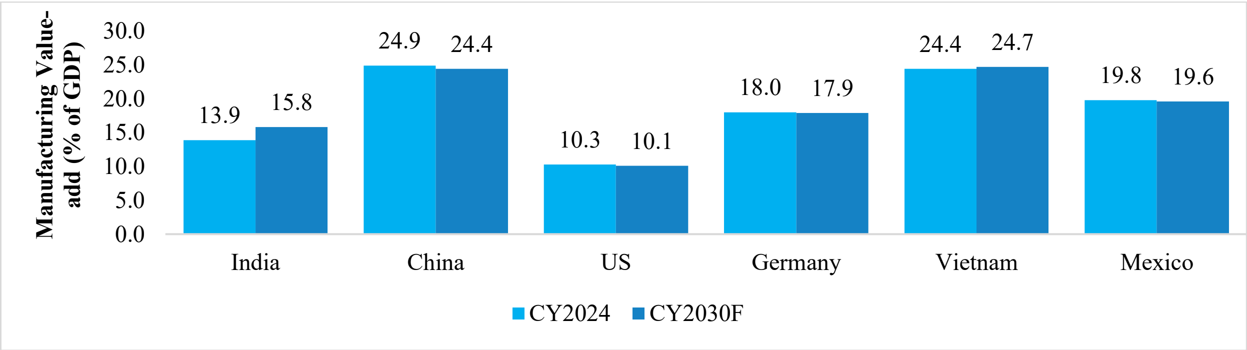
1.5. Global Manufacturing Trends and Outlook

Supply Chain Shifts Continue amid China+1 Strategy: Trade wars, rising costs, and COVID-era supply chain disruptions have reduced China's attractiveness as a sole manufacturing hub. As China+1 strategies accelerate, economies such as India and Vietnam are benefiting from manufacturing relocation and procurement diversification, even as China remains a global manufacturing leader. Middle Eastern economies, including Saudi Arabia and the UAE, are also emerging as manufacturing contenders amid trade- and manufacturing-led diversification efforts.

Adoption of Industry 4.0: Global manufacturers are accelerating investments in Industry 4.0 technologies to enhance resilience and agility. The integration of 5G, artificial intelligence (AI), machine learning (ML), big data, and internet of things (IoT) is enabling real-time data-driven decision-making and improving operational efficiency across manufacturing processes.

Rise of Sustainable Manufacturing: Sustainability is increasingly central to manufacturing strategies, driven by decarbonization commitments, margin pressures, and rising climate-related risks. Companies are adopting circular economy principles and sustainable material design, supporting renewable energy adoption, restoration processes, and the elimination of toxic inputs as linear production models evolve.

Figure 1.6: Manufacturing Value-add (% of GDP), Select Economies, CY2024 and CY2030F



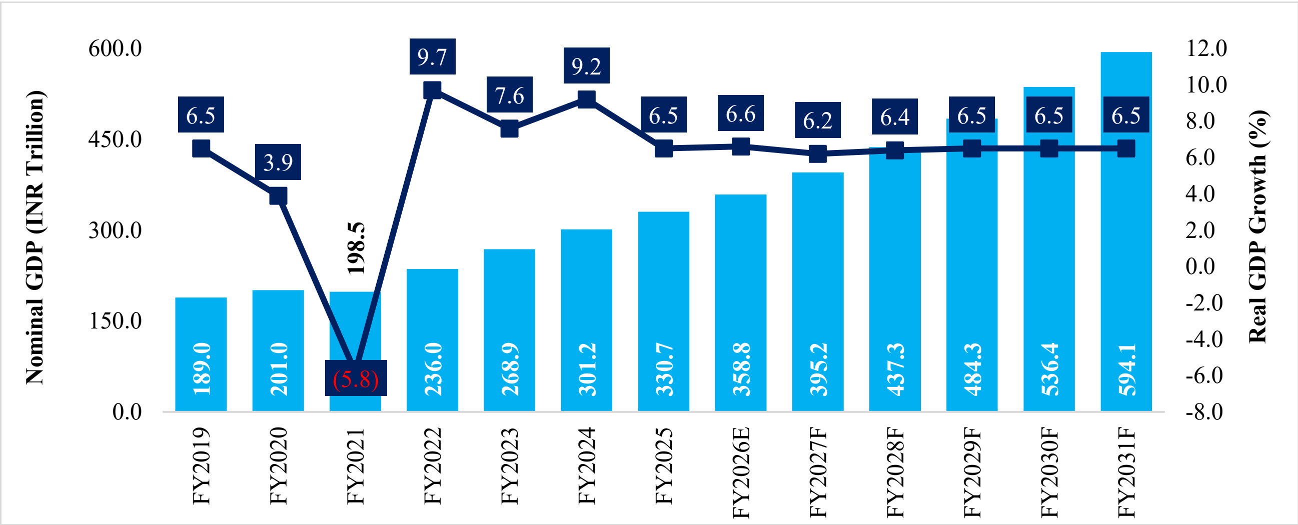
Note: *F: forecast; CY: Calendar Year; India's data is reported in terms of fiscal years (FY). For e.g. FY2024 is the 12-month period between 1 April 2023 and 31 March 2024. For other countries, data is represented in calendar years. For e.g. CY2024 is the 12-month period between 1 January 2024 and 31 December 2024; Source: World Bank, Ministry of Statistics and Programme Implementation (MOSPI) – India; Frost & Sullivan*

Between CY2024 and CY2030, manufacturing shares are projected to rise in emerging beneficiaries of supply-chain realignment, with India increasing from 13.9% to 15.8% and Vietnam edging up from 24.4% to 24.7%. China's share is expected to remain broadly stable, dipping marginally from 24.9% to 24.4%, underscoring its continued manufacturing dominance despite diversification trends. In contrast, developed economies such as the US and Germany are likely to see a modest decline in manufacturing shares, while Mexico's slight dip reflects tariff-related headwinds weighing on new investment inflows.

2. INDIA'S MACRO-ECONOMIC OUTLOOK

2.1. India's GDP Growth Outlook

Figure 2.1: Nominal GDP (in INR Trillion) and Real GDP Growth (%), India, FY2019-FY2031F



Note: *E: estimate, F: forecast; FY: Fiscal Year; Data is represented in fiscal years. For e.g. FY2019 is the 12-month period between 1 April 2018 and 31 March 2019; Source: IMF, MOSPI – India, Frost & Sullivan*

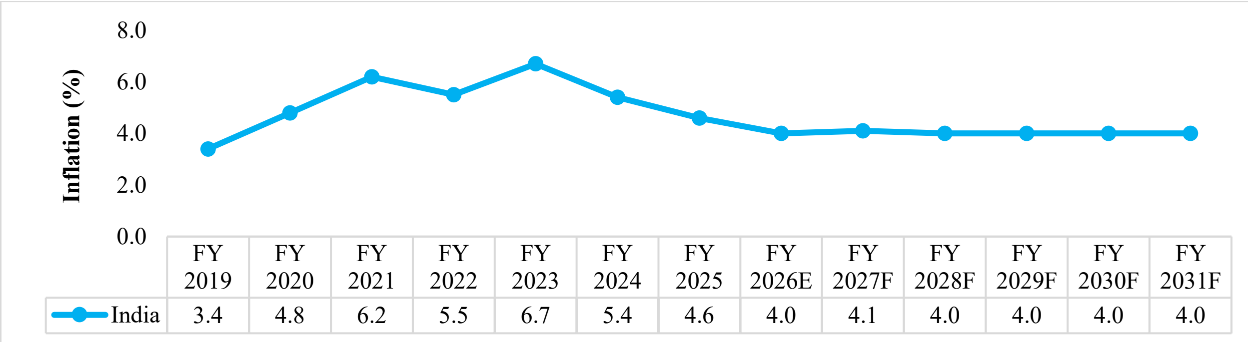
India's real GDP expanded by 9.2% in FY2024, driven by increased CAPEX, private real estate investments, and growth in manufacturing and services sectors. However, growth moderated in FY2025 due to weak private sector investments, retail inflation spike in Q3 FY2025 (October-December 2024) affecting consumption, and global trade uncertainties because of US tariffs. Inflationary pressures and volatility in key industrial and construction-linked inputs such as steel, cement, aluminium, copper, fuel, logistics, and labour also continued to impact project execution costs across infrastructure and EPC sectors during the period. Despite these pressures, accommodative monetary policy and fiscal support in FY2026 are expected to support a strong domestic consumption environment and sustain infrastructure and construction activity despite turbulent global trade conditions.

The 'Make in India' program remains central to the overall growth story. It continues to anchor efforts to expand manufacturing and attract global investors. Alongside, the Production-Linked Incentive (PLI) scheme is channelling investments into high-priority sectors like electronics, pharmaceuticals, and automobiles. Public CAPEX is on a sharp upward trajectory, rising from INR 3.1 trillion in FY2019 to a budgeted INR 11.2 trillion by FY2026, reflecting a compounded annual growth rate (CAGR) of 20.1%. All these efforts underscore the government's bet on infrastructure as the backbone of long-term expansion.

The September 2025 goods and services tax (GST) overhaul cut GST rates on a wide range of consumer and intermediate goods. It streamlined the structure to two main slabs of 5% and 18% and stimulated household consumption with rising demand across multiple sectors. In addition, income tax reforms under the Union Budget 2025–26 raised the tax-free income threshold to INR 1.2 million, increased the standard deduction to INR 75.0 thousand, and narrowed the applicability of the highest tax slab, thereby easing household tax burdens. Together, lower direct and indirect tax burdens are expected to increase disposable income and strengthen household purchasing power. Simultaneously, sustained public CAPEX towards infrastructure development across sectors such as power transmission and distribution, water supply and sanitation, transportation, and urban infrastructure is expected to support higher project activity and drive EPC order inflows, particularly for companies operating in power and water infrastructure segments.

2.2. India's Inflation Outlook

Figure 2.2: Inflation (%), India, FY2019-FY2031F

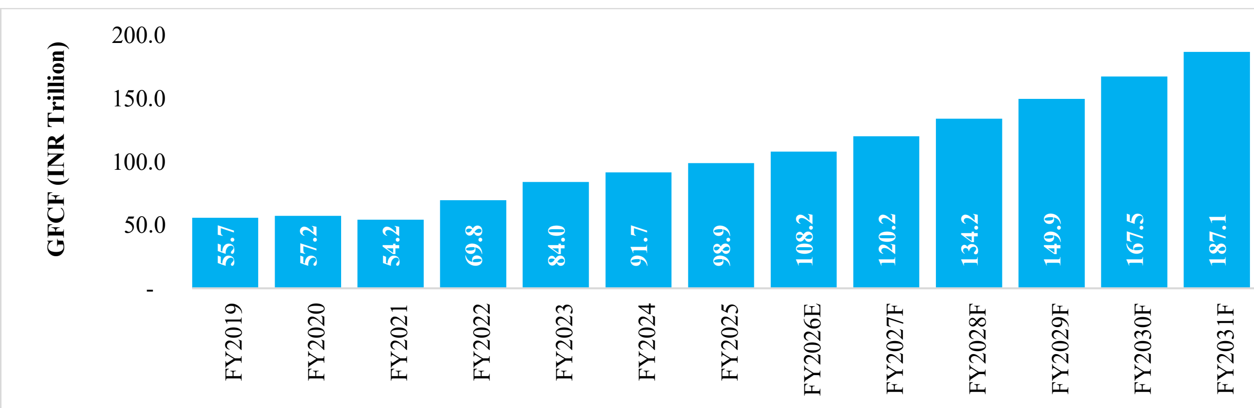


Note: *E: estimate, F: forecast; FY: Fiscal Year; Data is represented in fiscal years. For e.g. FY2019 is the 12-month period between 1 April 2018 and 31 March 2019; Source: IMF, MOSPI – India, Frost & Sullivan*

India's inflation has been on a downward trajectory, falling from a peak of 6.7% in FY2023 to 5.4% in FY2024 and 4.6% in FY2025 as food and energy prices became more stable. This steady decline signals improving price stability, with inflation expected to fall further to 4.0% in FY2026. Over the medium term, inflation is likely to settle near 4.0% through FY2031, pointing to a more predictable price environment within Reserve Bank of India's (RBI's) target range of 2-6% annual inflation. This stability reflects better management of domestic supply chains, prudent fiscal policies, and targeted steps to control food prices, which are particularly sensitive to weather conditions.

2.3. India's Gross Fixed Capital Formation (GFCF)

Figure 2.3: GFCF (INR Trillion), India, FY2019-FY2031F



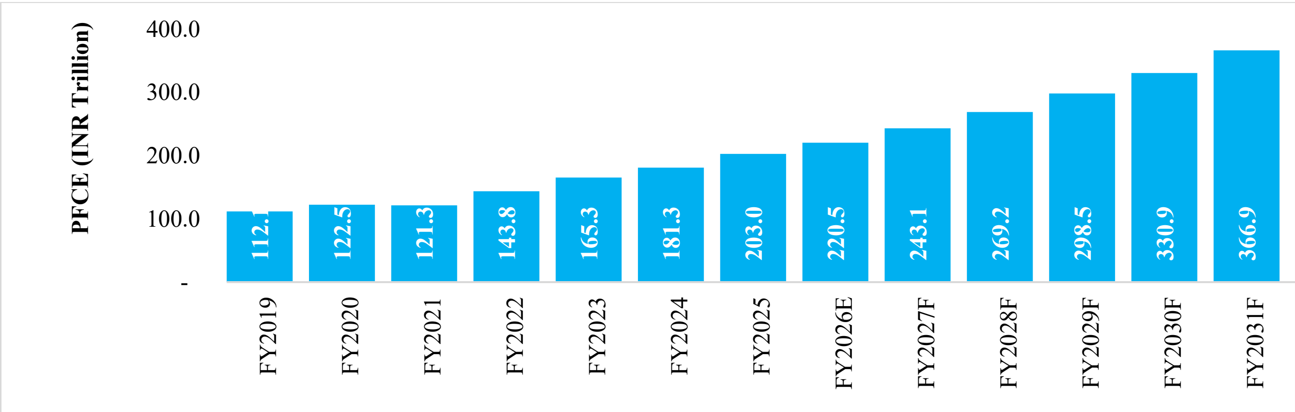
Note: *E: estimate, F: forecast; FY: Fiscal Year; Data is represented in fiscal years. For e.g. FY2019 is the 12-month period between 1 April 2018 and 31 March 2019; Source: IMF, MOSPI – India, Frost & Sullivan*

India's GFCF has shown a steady rise, highlighting strong investment activity in the economy. After falling to INR 54.2 trillion in FY2021 due to the impact of the pandemic, GFCF recovered sharply to INR 69.8 trillion in FY2022 and increased further to INR 84.0 trillion in FY2023. It is estimated to reach about INR 108.2 trillion in FY2026. Looking ahead, investment momentum is expected to remain strong, with GFCF projected to grow at a CAGR of 11.6% between FY2026 and FY2031.

This recovery in GFCF has been supported by higher public and private investment, particularly in infrastructure. Manufacturing growth under initiatives such as Make in India, along with supportive government policies to strengthen domestic production, has also played an important role. A strong focus on CAPEX, reflected in higher public CAPEX allocations in recent budgets, is further driving investment activity. In addition, rising foreign direct investment (FDI) inflows and continued spending on digital and physical infrastructure are expected to sustain GFCF growth over the forecast period. Overall, the steady expansion in GFCF reflects India's strong economic fundamentals and its focus on long-term growth through targeted investment.

2.4. India's Private Final Consumption Expenditure (PFCE)

Figure 2.4: PFCE (INR Trillion), India, FY2019-FY2031F



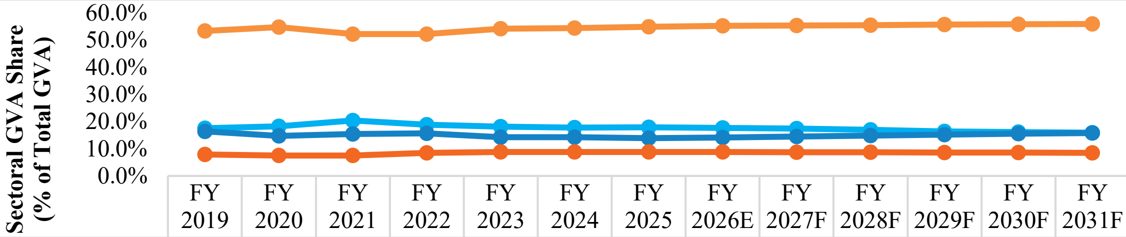
Note: *E: estimate, F: forecast; FY: Fiscal Year; Data is represented in fiscal years. For e.g. FY2019 is the 12-month period between 1 April 2018 and 31 March 2019; Source: IMF, MOSPI – India, Frost & Sullivan*

India's PFCE has been pivotal for maintaining economic stability and driving GDP growth. After a 1.0% decline in FY2021 due to the pandemic, PFCE rebounded strongly with an 18.5% increase in FY2022 and 15.0% in FY2023. Its growth remained strong at 9.7% in FY2025, supported by easing inflation in the final quarter (January-March 2025), strong domestic consumption in rural regions, and improving credit conditions. Looking ahead, PFCE growth is expected to come from household spending, particularly in sectors like food, health, education, and transportation, as well as the expansion of the digital economy and government initiatives focused on infrastructure and financial inclusion.

Per capita PFCE has also grown consistently, reaching INR 1,39,898.8 in FY2025, up from INR 81,513.3 in FY2019, at a CAGR of 9.4%. This points to stronger disposable incomes for people. Looking ahead, per capita PFCE will continue to rise. It is projected to reach INR 2,40,568.3 by FY2031, highlighting an expanding middle class and increasing consumer spending. The monthly per capita consumption expenditure (MPCE) further reinforces this trend. Rural MPCE grew from INR 1,430 in FY2011-12 to INR 4,122 in FY2023-24 (CAGR of 9.2%), while urban MPCE grew from INR 2,630 to INR 6,996 over the same period (CAGR of 8.5%). These trends show a wider and more even rise in consumption across India, with rural spending showcasing stronger growth.

2.5. India's Gross-Value Added (GVA) Outlook

Figure 2.5: Sectoral GVA Share (% of Total GVA), India, FY2019-FY2031F



	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026E	FY 2027F	FY 2028F	FY 2029F	FY 2030F	FY 2031F
Agriculture, forestry and fishing	17.6%	18.3%	20.4%	18.9%	18.1%	17.8%	17.9%	17.7%	17.4%	17.0%	16.4%	16.1%	15.9%
Manufacturing	16.4%	14.7%	15.4%	15.7%	14.3%	14.3%	13.9%	14.1%	14.5%	14.8%	15.2%	15.5%	15.8%
Construction	7.9%	7.5%	7.5%	8.5%	8.8%	8.8%	8.8%	8.8%	8.7%	8.7%	8.6%	8.6%	8.5%
Services	53.3%	54.7%	52.2%	52.2%	54.2%	54.4%	54.9%	55.2%	55.4%	55.5%	55.7%	55.8%	55.9%

Note: *E: estimate, F: forecast; FY: Fiscal Year; Data is represented in fiscal years. For e.g. FY2019 is the 12-month period between 1 April 2018 and 31 March 2019; Source: IMF, MOSPI – India, Frost & Sullivan*

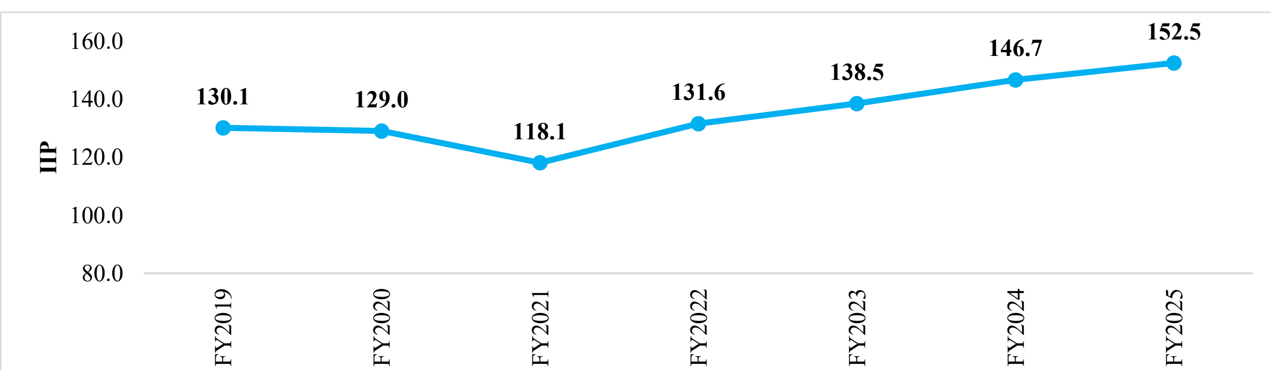
The share of agriculture, forestry, and fishing is projected to decline marginally from 17.6% in FY2019 to 15.9% by FY2031, reflecting a gradual structural shift toward an industrial- and services-led economy. As the economy matures, services continue to expand, supported by rising private investment, digitalisation, financial inclusion, and growth in knowledge-based industries.

Manufacturing-based industries will re-emerge as key long-term growth engines, supported by strong domestic demand, rising investments, expanding export capacity, and India's strategic push toward self-reliance amid shifts in global supply chains. Improvements in logistics efficiency and cost structures are also strengthening India's positioning in higher-value manufacturing. However global trade uncertainty and tariff risks, particularly for manufacturing exports, pharmaceuticals, and IT services, remains near-term challenges.

The services sector will remain the largest contributor to GVA, expanding further on the back of rapid digitalisation, adoption of emerging technologies and Industry 5.0 applications, and India's growing role in global knowledge-based services. Its share of GVA is expected to rise from 54.9% in FY2025 to 55.9% by FY2031, reinforcing services alongside manufacturing as the principal drivers of India's medium- to long-term growth.

2.6. India's Industrial and Manufacturing Growth

Figure 2.6.1: Index of Industrial Production (IIP), India, FY2019-FY2025



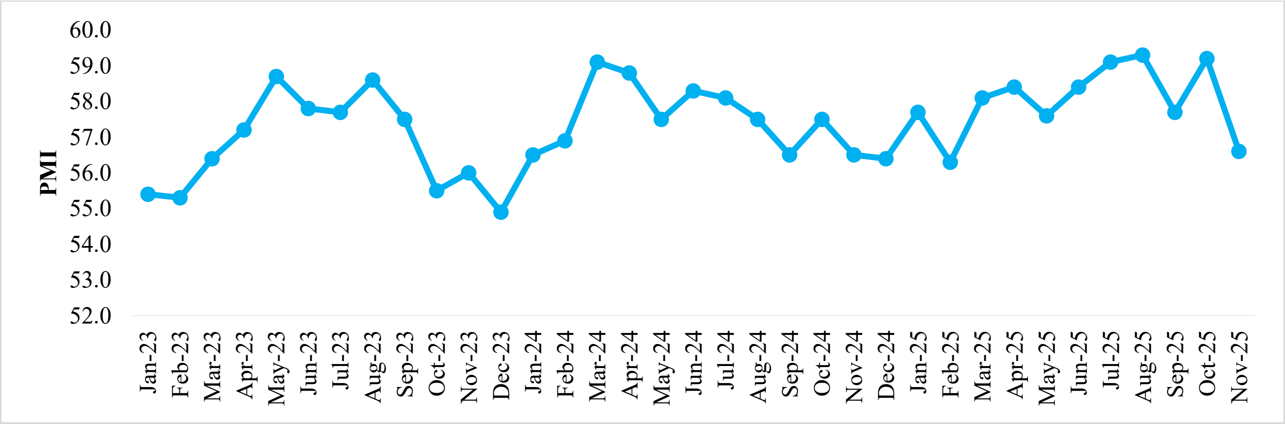
Note: *FY: Fiscal Year; Data is represented in fiscal years. For e.g. FY2019 is the 12-month period between 1 April 2018 and 31 March 2019; Source: IMF, MOSPI – India, Frost & Sullivan*

Between FY2019 and FY2025, India's IIP recorded a CAGR of 2.7%, driven by favourable socio-economic factors such as a large demographic dividend, rising disposable incomes, and supportive government policies. Contributing to this momentum are increased government CAPEX and initiatives like the Rapid mission, 'Make in India,' Atmanirbhar Bharat, and the PLI schemes, which aim to boost domestic manufacturing and promote innovation, positioning India as a global manufacturing hub.

Recent data shows a notable rise in the manufacturing sub-index of the IIP, supported by strong consumer demand and recovery in sectors like automotive, electronics, and pharmaceuticals. The government's focus on digital infrastructure and Industry 4.0 technologies is anticipated to further enhance manufacturing productivity and competitiveness.

Improved logistics and targeted resource policies further strengthen India's growth-oriented industrial framework, paving the way for sustained economic expansion. Additionally, India's commitment to sustainable practices and green technologies is expected to build a more resilient industrial base, attract foreign investment, and drive long-term growth in the IIP, contributing to broader economic expansion over the next decade.

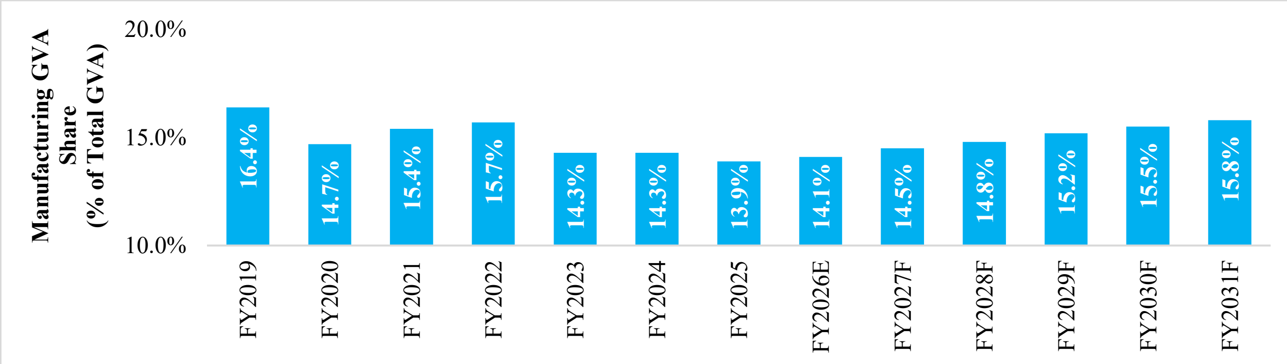
Figure 2.6.2: Purchasing Manager's Index (PMI), India, FY2019-FY2025



Note: A PMI reading above 50 signifies an expansion in the manufacturing sector compared to the previous month, while a reading below 50 indicates a contraction. A PMI of exactly 50 reflects a balance, where the number of manufacturers experiencing improved business conditions is equal to those facing a decline. Source: S&P Global, Frost & Sullivan

India's manufacturing sector has sustained strong momentum, supported by controlled inflation, a reduced fiscal deficit, an improving current account balance, competitive labour costs, high employment, and robust FDI inflows, reflected in PMI readings consistently above 55 through 2023, 2024, and into November 2025. While the imposition of 50% US tariffs softened PMI growth in recent months and remains a key headwind amid risks of further escalation, resilient domestic demand and steady export demand from non-US markets have offset tariff-related pressures. The September 2025 GST rate cut lifted business sentiment and is expected to support manufacturing by lowering input costs, simplifying compliance, and boosting new orders and production. Continued infrastructure investment, a favourable business environment, and initiatives such as Make in India and PLI schemes are expected to keep medium-to long-term sentiment positive.

Figure 2.6.3: Manufacturing GVA (% of Total GVA), India, FY2019-FY2031F



Note: *E: estimate, F: forecast; FY: Fiscal Year; Data is represented in fiscal years. For e.g. FY2019 is the 12-month period between 1 April 2018 and 31 March 2019; Source: IMF, MOSPI – India, Frost & Sullivan*

The upswing in India's manufacturing GVA has been driven by major policy measures like Make in India, the PLI scheme, and the National Manufacturing Mission. Such broad national initiatives and targeted government schemes for sectors such as electronics, food processing, and consumer goods have supported capacity expansion and boosted demand for downstream packaging materials in the near to medium term. A higher manufacturing GVA therefore signals not only stronger domestic production but also a widening export base, especially in electronics, auto components and pharmaceuticals, supporting sustained growth in India's goods exports.

The 50% US tariffs imposed in CY2025 pose a near-term headwind for some export-oriented manufacturing segments like textiles and jewelry. However, the overall impact on India's manufacturing GVA is expected to be manageable as India's manufacturing growth remains supported by strong domestic demand, diversification of export markets toward Europe, West Asia, and emerging Asia, and continued policy support under PLI schemes. As a result, while tariffs may temper export growth at the margin, they are unlikely to derail the broader manufacturing expansion or the medium-term trajectory of manufacturing GVA growth.

2.7. Factors Making India an Attractive Manufacturing Destination

Infrastructure Boom and Geographic Advantages: India's location offers a clear strategic advantage, supported by well-established shipping routes that provide access to markets across Asia, the Middle East, Europe, and Africa. The country has more than 200 ports and 137 airports, including 21 international and 10 customs airports. During FY2025, India's major ports handled 855 million tonnes of cargo while India's airports cumulatively handled 3.4 million tonnes of cargo in FY2024. Strong policy support for infrastructure and logistics, along with proximity to key end-user markets, is helping position India as an increasingly attractive base for manufacturing.

Manufacturing is a Critical Growth Driver: India has adopted a manufacturing-led growth approach to build a cost-efficient domestic production base and strengthen its export capacity. Policy initiatives such as Make in India, Atmanirbhar Bharat, the Rapid Mission, the Industrial Corridor Development Programme, and the PLI schemes are expected to remain central to supporting manufacturing expansion. Moreover, India's spending on research and development has increased sharply, more than doubling between 2010-11 and 2020-21 to exceed USD 14.4 billion. Higher investment in innovation is helping accelerate technological change and strengthening India's capabilities in higher value-added manufacturing.

Demographic Dividend and Large Workforce: India's large and growing base of young, working-age people continue to be a key driver of manufacturing growth. In CY2024, India's median age was 28.2 years, much lower than China's 39.6 years and Europe's 44.7 years. Higher fertility rates are also expected to support the expansion of the young and working-age population, with the share of people aged 15-59 projected to rise to over 65.1% by CY2030, up from 61.4% in CY2011. India's labour force reached 607.7 million in CY2024. This is far larger than in peer economies such as Bangladesh at 77.3 million and Vietnam at 57.1 million. Although China's labour force was higher at 773.9 million in CY2024, its fast-aging and declining population limits future labour availability.

RBI's Regulatory Pivot Supporting Seamless Trade: In August 2025, the RBI announced that Special Rupee Vostro Accounts (SRVAs), which are used by domestic importers to settle trade payments, will no longer require prior approval. Authorized Dealer banks can now open these accounts directly. This change is expected to simplify cross-border transactions and shorten import and delivery timelines for manufacturers by easing regulatory processes. The decision is part of the RBI's broader effort to encourage the use of the Indian rupee for settling international trade. At present, 22 countries have arrangements in place for SRVAs, including the UAE, Russia, the UK, and Germany, allowing trade transactions to be settled in INR.

Promising Export Potential: Under its 2023 Foreign Trade Policy, India has set a goal of reaching USD 2 trillion in exports by CY2030. The policy focuses on creating a supportive environment for exporters, encouraging collaboration across industries, and speeding up duty refunds. Several factors are expected to strengthen India's export competitiveness, including access to a large talent base, low labour costs, scale advantages in manufacturing, improving transport networks and multimodal logistics, and a more business-friendly regulatory framework. In addition, the expansion of Special Economic Zones, wider export incentive schemes, and strong digital infrastructure are likely to support export growth and drive a broader transformation in India's trade landscape.

2.8. India's Agriculture Sector Policies

According to the Economic Survey 2024-25, India's agricultural sector recorded strong and sustained growth between FY2017 and FY2023, growing at an average annual rate of 5%. This steady performance has reinforced agriculture's role as a key pillar of India's socio-economic development.

The Economic Survey 2022-23 highlights that India has the world's largest number of organic farmers, at 44.3 lakh, with nearly 59 lakh hectares brought under organic cultivation by FY2021-22. To scale up organic farming at the ground level, the government is implementing schemes such as the Paramparagat Krishi Vikas Yojana (PKVY) and the Mission Organic Value Chain Development for North-Eastern Region (MOVCDNER). These programmes aim to promote chemical-free and pesticide-free farming practices, strengthen organic value chains, and improve the environmental sustainability of agriculture and allied activities. The PKVY scheme, since its inception in 2015, has brought 1.5 million hectares under organic farming, benefiting around 2.5 million farmers.

The wider adoption of advanced technologies is expected to majorly transform Indian agriculture. Increasing digitalisation and the rise of agri-tech firms are reshaping farming value chains by encouraging farmer-focused solutions, expanding direct-from-farm market linkages, and lowering input costs related to seeds, agrochemicals, and fertilisers.

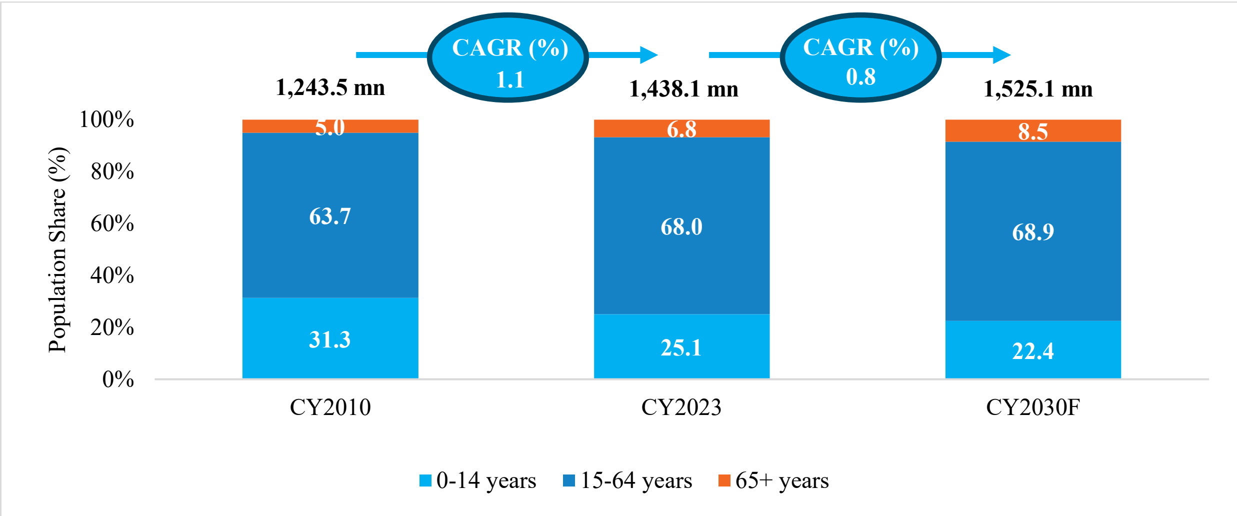
Some initiatives announced by the Indian government to bolster the productivity of the agricultural sector are:

- **The Mission for Aatmanirbharta in Pulses:** This scheme aims to raise domestic pulses output to 350 lakh tonnes and expand cultivation to about 3.1 million hectares between FY 2025-26 and FY2030-31. With an outlay of INR 114.4 billion, the mission will support measures including distribution of 8.8 million free seed kits and state procurement of pulses, improving access to quality seeds, strengthening price support, and enhancing productivity and incomes for millions of pulse farmers.
- **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY):** This scheme was launched in 2015 to expand irrigation coverage and improve water use efficiency through micro-irrigation (drip/sprinkler) and watershed development. From 2016 till date, the scheme has improved irrigation facilities over 3.5 million hectares of agricultural land.
- **KCC (Kisan Credit Card):** This scheme, launched in 1998, continues to provide farmers with timely and affordable institutional credit to meet their crop cultivation, allied activities, and working capital needs. As of March 2024, India has 7.75 crore operational Kisan Credit Card (KCC) accounts with a loan outstanding of INR 9,180 billion.

2.9. India's Demographic Outlook

2.9.1. Total Population, Proportion of Population By Age Groups

Figure 2.9.1: Age-wise Population Share (%) and Total Population (million), India, CY2010, CY2023, and CY2030F



Note: F: Forecast, Numbers may not add up to 100 due to *rounding*.

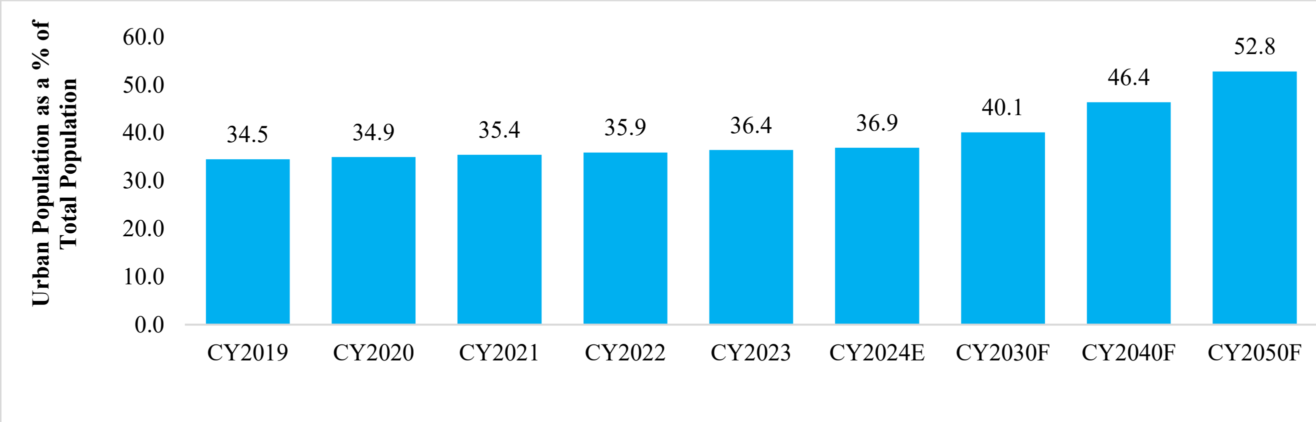
Source: UN, Frost & Su

In CY2023, India became the world's most populous nation, with a population of about 1,438.1 million, of which nearly 68.0% falls within the working-age group of 15-64 years. This favourable demographic profile, alongside improving education levels and expanding employment opportunities, positions India well for growth in high-skill and knowledge-intensive industries. By CY2030, the share of the working-age population is expected to rise to around 68.9%, further reinforcing India's economic potential. India is capitalising on this by prioritising skill development, job creation in emerging sectors like renewable energy, electronics manufacturing and electric vehicles, and sustained investment in public infrastructure. By aligning education and training with industry needs and expanding infrastructure capacity, the country is building a strong base for long-term growth and global competitiveness.

2.9.2. Rural-Urban Population

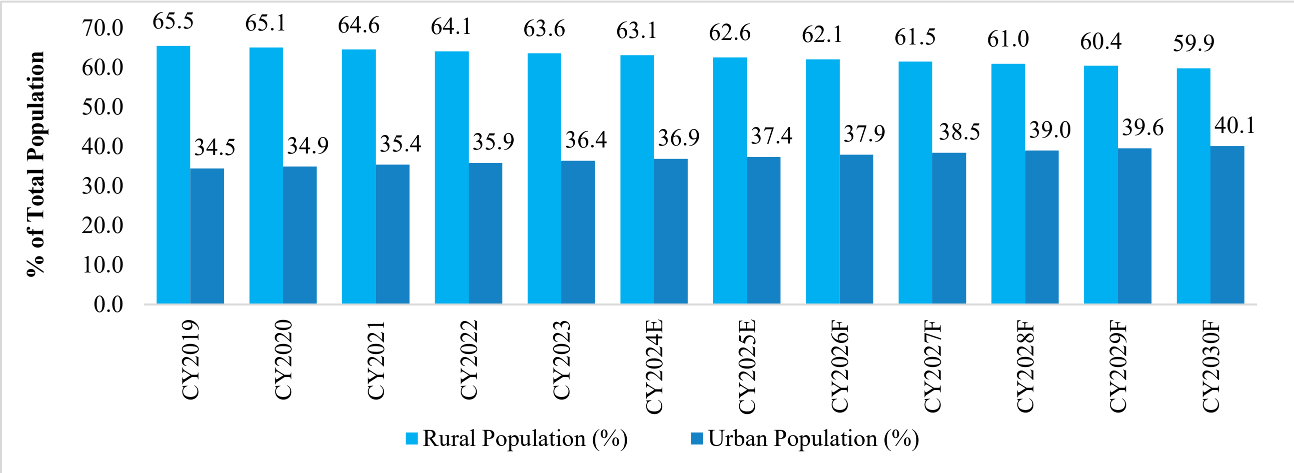
India is set to undergo a significant phase of urban expansion over the next decade, supported by strong economic growth and development. The rise of mega cities and smart cities is expected to push the urban share of the population beyond 40%, or around 625 million people, by CY2030. Steady income growth, improving living standards, and greater employment opportunities in cities are accelerating urbanisation. In response, this rapid population shift is creating a strong and sustained need for better urban infrastructure and housing, opening up long-term opportunities for planned urban development and investment.

Figure 2.9.2: Urban Population (%), India, CY2019-CY2024, CY2030F, CY2040F, CY2050F



Note: E: Estimate F: Forecast; Source: World Bank, Frost & Sullivan

Figure 2.9.3: Rural vs Urban Population (%), India, CY2019-CY2030F



E: Estimate F: Forecast. Source: World Bank, World Urbanization Prospects – United Nations Population Department, Frost & Sullivan

3. OVERVIEW OF THE POWER SECTOR IN INDIA

3.1. Key Terminologies and Their Definitions

This section outlines the key electricity-related terminologies used in the chapter.

- **Peak Demand:** The highest level of electricity demand recorded on the grid during a specific period, expressed in MW or GW.
- **Peak Deficit:** The shortfall between peak electricity demand and available supply during a specific period, expressed in MW/GW or as a percentage.
- **Energy Deficit:** The percentage gap between total electricity required and the electricity actually supplied during a specific period.
- **TWh (Terawatt-hour):** A unit of energy equal to one trillion watt-hours, used to measure electricity generated or consumed over time.
- **GW (Gigawatt):** A unit of power equal to one billion watts, commonly used for installed capacity or peak demand.
- **BU (Billion Units):** This unit is equivalent to 1,000 million kilowatt-hours (kWh); commonly used for reporting electricity consumption or generation.

3.2. India's position in the global power sector

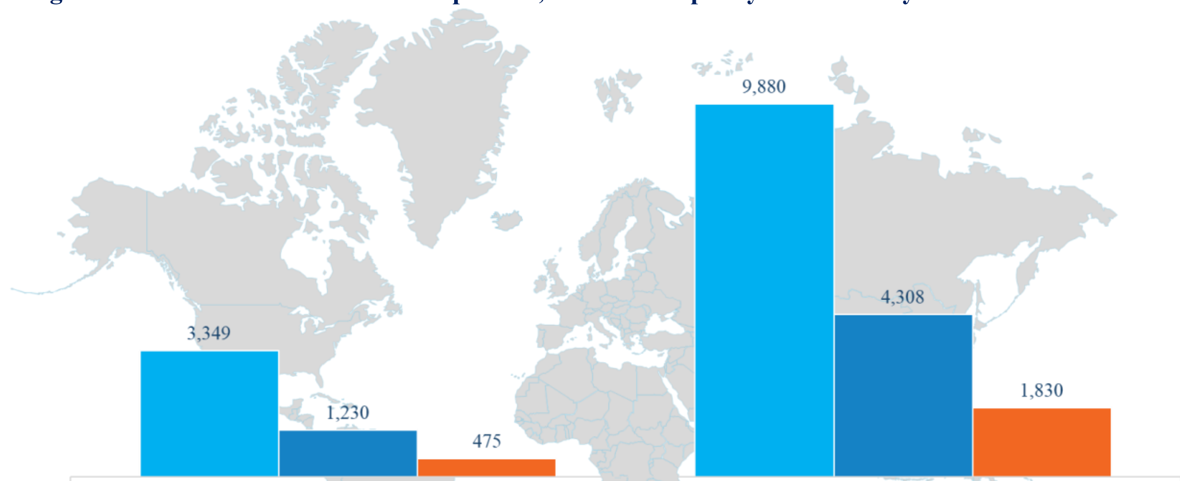
India's growing influence in the global power sector was proven through record-setting achievements across key metrics. In FY2025, India's total installed power capacity reached 475 GW, ranking third globally after China (3,349 GW) and the US (1,230 GW). Approx. 93% of the total installed capacity (475 GW) is contributed by coal-based generation (221.8 GW) and renewable energy sources (220.09 GW), highlighting both the continued dependence on coal and India's significant progress toward clean energy adoption.

Global installed power generation capacity is expected to grow at 4.8% CAGR till CY2050 to reach approximately 33,000 GW[2]. Electricity generation in India exceeded 1,800 TWh in FY2025, ranking India third globally behind China (9,880 TWh) and the US (4,308 TWh). Within domestic consumption patterns, the industrial sector has appeared as the highest consumer, showing robust industrial activity and economic development.

According to projections by the International Energy Agency (IEA), global renewable energy installed capacity is expected to cross 7,300 GW by CY2028. Share of renewables in global electricity generation is expected to increase from 28.5% in CY2020 to 72.3% by CY2050 from approximately 5,700 TWh in CY2020 to 51,000 TWh in CY2050 at a CAGR of 6.5%. In India, share of Renewables (including large Hydro) in electricity generation was 20.7% in FY2024. As per the climate actions presented by the Indian government during COP-26, 50% of the country's energy requirement would be met from Renewable sources by CY2030. This rapid scale-up in installed capacity and accelerated electrification directly translates into higher demand for EPC services, including project design, construction, grid integration, and balance-of-plant works. Moreover, the distributed and project-heavy nature of renewable deployment is expected to significantly boost subcontracting opportunities across civil, electrical, commissioning, and O&M activities.

[2] https://eneroutlook.enerdata.net/forecast-electricity-capacity-data.html

Figure 3.1: Global Power Sector Comparison, Installed Capacity vs Electricity Generation FY2025

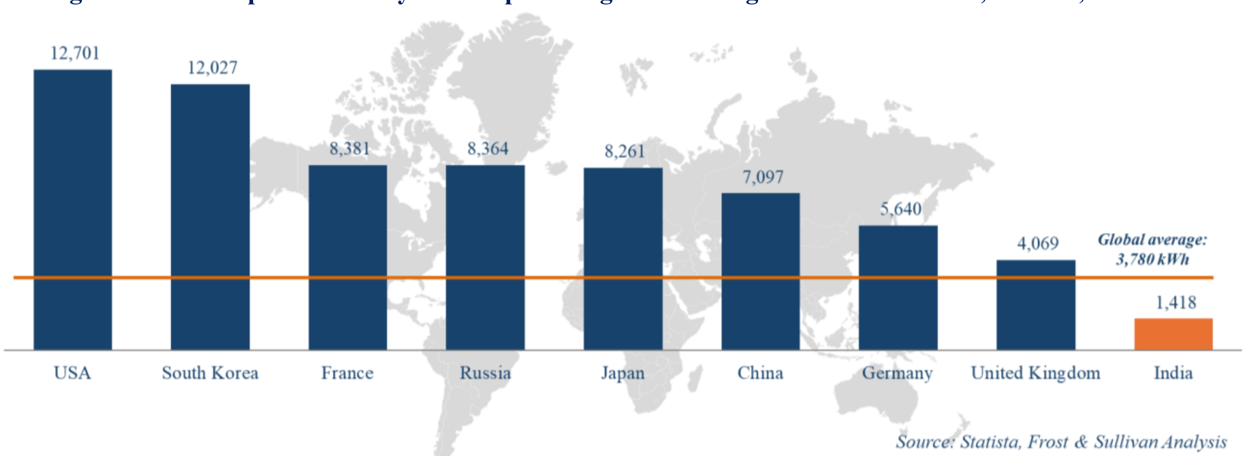


	Total Installed Capacity (in GW)	Electricity Generation (in TWh)
China	3,349	9,880
US	1,230	4,308
India	475	1,830

Note: China and USA values are for CY2024, whereas the values for India correspond to FY2025

Source: Statista, BEE,USEIA, Frost & Sullivan Analysis

Figure 3.2: Per capita electricity consumption of global leading economies vs India, in kWh, CY2024



Source: Statista, Frost & Sullivan Analysis

Driven by its sustainability goals, India is expected to account for nearly 30% of the projected global growth in energy demand by 2035, with a significant portion of this demand being met through greener and more sustainable energy solutions. The IEA World Energy investment report 2025[3] acknowledges India's advancements in enhancing grid reliability, extending energy access in rural regions, and reducing dependence on imported energy sources. The IEA report emphasizes that infrastructure development, accelerated renewable energy deployment, skilled workforce creation, and improved financing frameworks are key drivers for the advancement of India's energy transition.

3.3. India's installed power generation capacity by fuel source: historical trends and future outlook

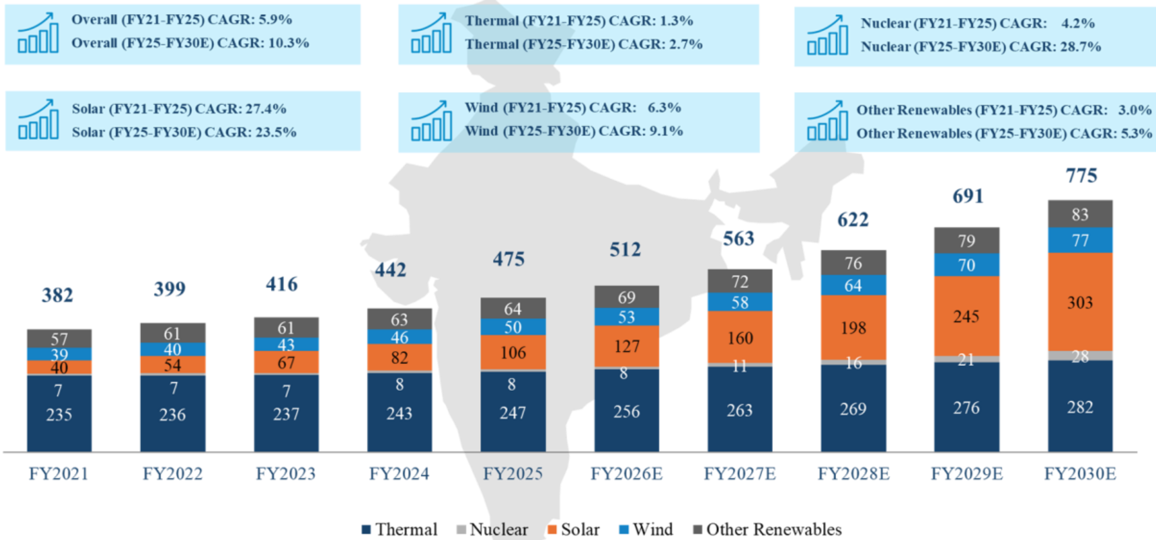
India's total installed power generation capacity reached 475 GW in FY2025. Based on generation capacity addition plans of the government and projects on ground, an additional 300 GW of power generation capacity is expected to be added by FY2030, taking the country's total installed power generation capacity to 775 GW. Approximately 65-66% of this capacity would be added through Solar – this would take the country's installed Solar capacity from 106 GW in FY2025 to 303 GW by FY2030.

Thermal power accounted for more than 50% of the country's installed capacity at the end of FY2025. The share of Solar is around 22% of the total installed capacity. As solar capacity additions are expected to accelerate in the coming

[3] *https://www.iea.org/reports/world-energy-investment-2025*

years, this mix is expected to see a drastic change. By FY2030, the share of solar energy in India's power mix is projected to rise significantly to approximately 39%, while the share of thermal power is expected to decline to around 36%. Historically, solar has been the fastest-growing energy source in the country, and this trend is set to continue. Within the renewable energy segment, solar is expected to lead growth with a robust compound annual growth rate (CAGR) of 27.5% from FY2021 to FY2025, followed by a strong 23.5% CAGR from FY2025 to FY2030.

Figure 3.3: India's installed power generation capacity by fuel sources, GW, FY2021 – FY2030E



**Other Renewables include Large Hydro, Small Hydro Power Plants and Bio Power Plants*

Source: CEA, Frost & Sullivan Analysis

3.4. India's power demand & consumption by sector

Peak demand in the country is expected to reach 366 GW by FY2032 – however, India will have more than 800 GW of base load and RE to meet this demand

India's power demand surged to unprecedented levels in FY2025, with peak demand reaching a record 230.99 GW in May 2025 and daily energy consumption ranging between 4,289 and 5,142 million units. This sharp rise was fueled by rapid industrialization, urban expansion, and seasonal spikes, particularly during the hotter months.

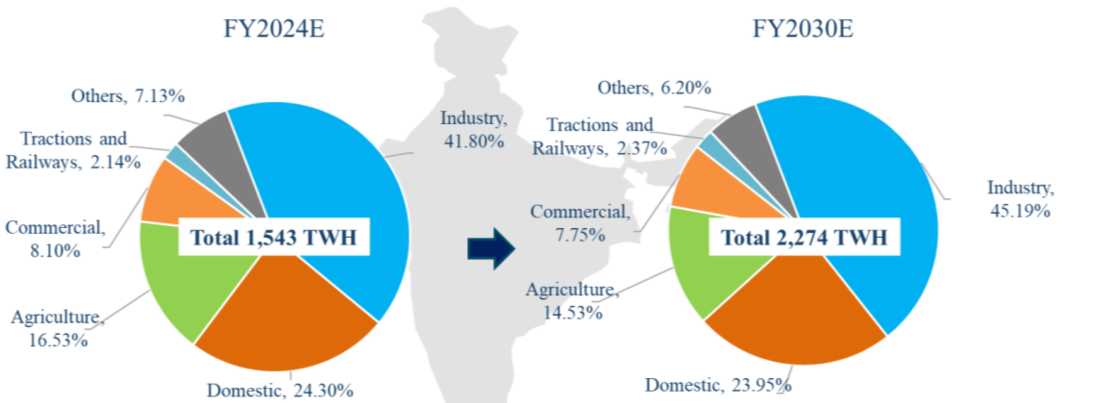
In terms of power consumption, Ministry of Statistics [4] estimated total energy consumption of 1,543 TWH in FY2024 with the Industry sector accounting for 41.80% share followed by the domestic sector with a 24.30% share, driven by increasing electrification and household appliance usage. Agriculture consumed 16.53%, largely due to irrigation and water extraction needs. The commercial sector, supported by the growth of retail, office infrastructure, and hospitality, accounted for 8.10%. Electricity use by traction and railways stood at 2.14%, while other categories such as public lighting and utilities contributed the remaining 7.13%.

India's electricity consumption is projected to grow from 1,543 TWh in FY2024 to 2,274 TWh in FY2030E, reflecting a CAGR of 6.68%. The industrial sector is expected to remain the dominant consumer, accounting for 45.19% of total demand (1,027.62 TWh), followed by the domestic sector (544.62 TWh) and agriculture (330.41 TWh). Commercial usage is projected at 176.24 TWh, while traction and railways will consume around 53.89 TWh. Other sectors will contribute 140.99 TWh to the total demand.

This outlook highlights the growing energy needs across all segments, driven by economic expansion, urbanization, and infrastructure development, with industrial demand continuing to lead the growth trajectory. The concentration of demand growth in the industrial segment necessitates significant expansion and strengthening of transmission and distribution infrastructure, including substations, transmission lines, and grid modernization. This, in turn, is expected to create sustained EPC and subcontracting opportunities for infrastructure contractors and sub-contractors across power evacuation, network augmentation, and system integration works.

[4] *https://mospi.gov.in/sites/default/files/publication_reports/Energy_Statistics_2025/Energy%20Statistics%20India%202025_27032025.pdf*

Figure 3.4: Comparison of Consumption of Electricity by Sectors in India during FY 2024E and FY2030E



Note: CEA is yet to publish data for FY2025, FY2024 estimated numbers are taken from MOSPI Energy Statistics

Source: 20th Electric Power Survey of India, MOSPI Energy Statistics 2025, Frost & Sullivan Analysis

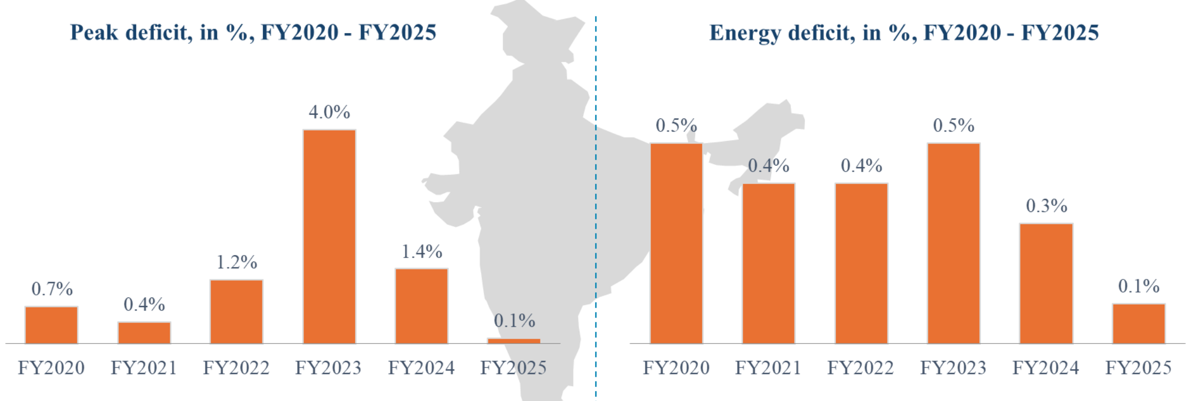
3.5. Peak deficit and energy deficit trend in India

India's power sector has shown a progressive reduction in peak power deficit over recent years, supported by generation and transmission capacity augmentation, complimented with improved grid management. The peak deficit, which stood at 2.0% in FY2018, declined to 0.4% by FY2021. However, in FY2022 and FY2023, the deficit increased to 1.2% and 4.0% respectively, primarily due to a sharp rise in peak demand, which reached 203 GW in FY2022 and 216 GW in FY2023, while the maximum demand met was 201 GW and 207 GW, respectively.

The sudden spike in electricity demand during the monsoon months, coupled with limited firm capacity additions, i.e., assured generation capacity from projects that have achieved financial closure and are under construction, may have contributed to the higher peak deficit. However, peak deficit dropped significantly to 1.4% in FY2024 due to improved fuel management. This improvement was driven by power plants gaining easier access to coal and gas, along with optimized logistics.

This trend reflects the sector's enhanced ability to respond to peak load requirements through timely capacity additions, improved operational efficiency, and effective demand-side interventions. Batteries, UPS systems, and inverters are playing a crucial role in bridging India's power deficit and mitigating the impact of frequent outages, especially in underserved and rural areas, by ensuring uninterrupted access to electricity for homes, businesses, and critical infrastructure. The near elimination of peak deficit in FY2025 is indicative of a structurally more resilient power system, which is expected to support uninterrupted industrial activity and contribute to a stable and predictable operating environment.

Figure 3.5: Peak deficit in percentage, India, FY2020 – FY2025



Source: CEA, Frost & Sullivan Analysis

To avoid the high peak deficit situation in future, Indian Govt. has decided to add nearly 88 GW capacity of base load thermal power plants to meet 295 GW and 366 GW of peak power demand by FY2028 and FY2032, respectively. Besides, converting the RE plants to Round-The-Clock (RTC) plants would also mitigate the risks of higher deficits in the coming years.

Energy availability remained closely aligned with demand, resulting in a progressive reduction in the energy deficit—from 0.7% in FY18 to 0.1% in FY25, reflecting a sustained focus on capacity expansion, grid efficiency, and operational reliability.

Between FY2023 and FY2025, the energy requirement rose from 1,513 BU to 1,694 BU. During this time, the energy deficit narrowed from 0.5% in FY2023 to 0.3% in FY2024, and further to 0.1% in FY2025. This improvement occurred alongside a near-proportional increase in energy availability, with supply figures reaching 1,692 BU in FY2025 against a requirement of 1,694 BU.

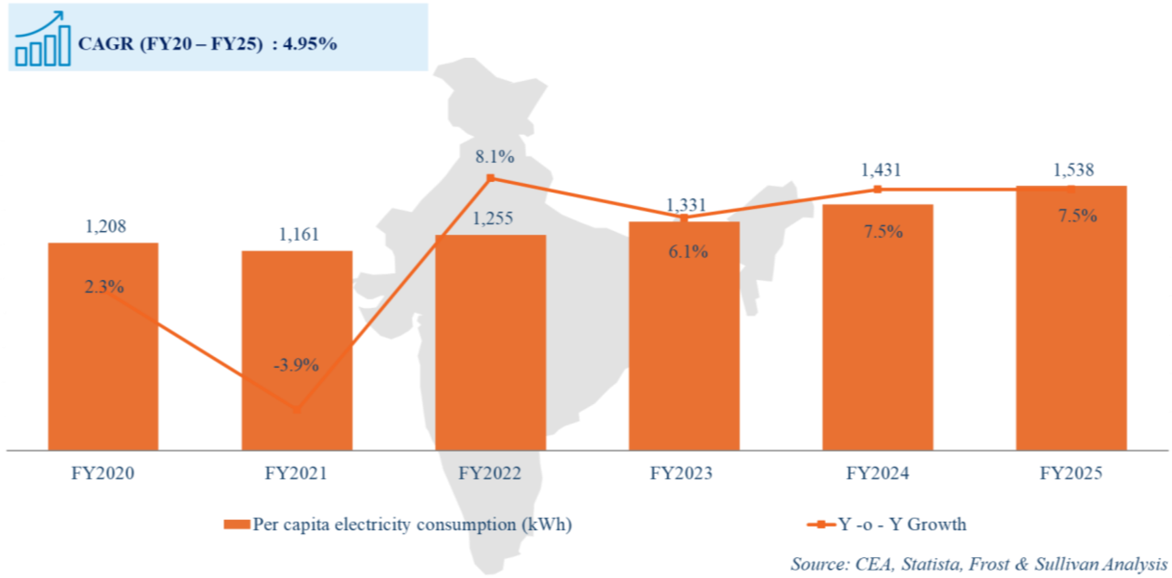
The declining deficit trend over this period highlights the sector's growing resilience and ability to meet incremental demand through timely capacity additions and improved system planning. This improvement further reflects increased renewable energy integration, enhanced grid efficiency, and the impact of energy efficiency measures. Additionally, subdued demand due to cooler weather and unseasonal rainfall contributed to easing supply pressures.

3.6. India's per capita electricity consumption

India's per capita electricity consumption has steadily increased in recent years, reflecting growing energy demand fueled by population growth, urbanization, industrial development, and the rising use of household appliances and gadgets such as AC, washing machines. etc.

In FY2020, per capita consumption stood at 1,208 kWh. This increased to 1,538 kWh in FY2025 marking a CAGR of approximately 4.95% from FY2020 to FY2025, showing continued improvement in access to electricity and living standards.

Figure 3.6: Per Capita Electricity Consumption in India, (In kWh), FY2020 – FY2025



Source: CEA, Statista, Frost & Sullivan Analysis

3.7. Household electrification in India

Household electrification in India has made noteworthy progress in recent years, driven by government initiatives like the Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA), which was launched by the Government of India in October 2017 with the aim of achieving universal household electrification. Under the scheme, electricity connections were to be provided to all willing un-electrified households in rural areas and to all willing poor households in urban areas across the country.

Approximately 28.60 million households were electrified under SAUBHAGYA from its start until FY2022 (Upto March).

Some of the key states benefiting from the Saubhagya scheme include:

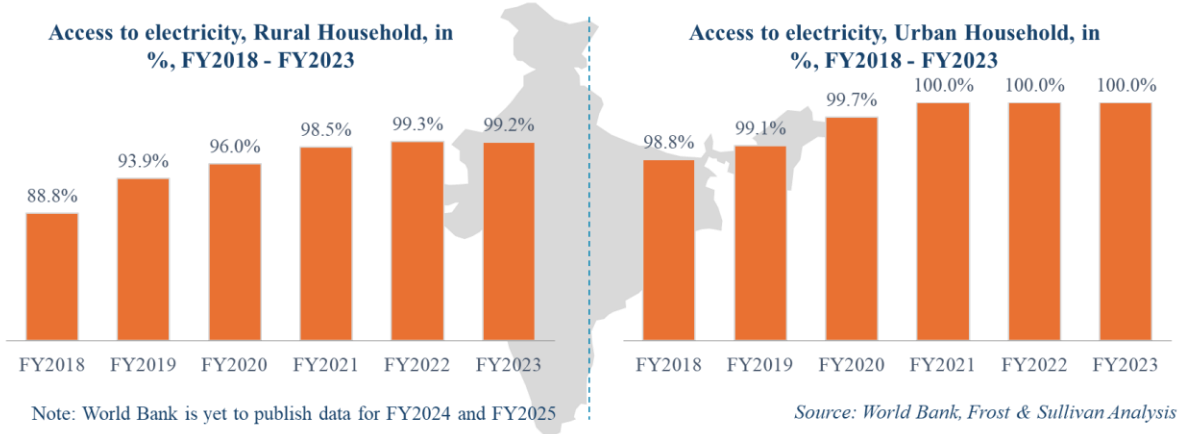
- **Uttar Pradesh** – 91,80,571 households (primarily rural grid connections, with a small share of off-grid solar connections in the remote areas).
- **Bihar** – 32,59,041 households (majority rural grid, few urban poor households)
- **Odisha** – 24,52,444 households (significant off-grid solar connections for remote tribal regions)
- **Rajasthan** – 21,27,728 households (mix of rural grid and off-grid connections for desert areas)
- **Madhya Pradesh** – 19,84,264 households (mostly rural grid connections, limited off-grid solar connections).

All sanctioned works under SAUBHAGYA have been successfully completed, and the scheme was officially closed on FY2022 (Upto March).

Additionally, the Revamped Distribution Sector Scheme (RDSS), support is being extended by the Government of India to states for electrifying households that were previously left out under the SAUBHAGYA scheme.

Additionally, RDSS funding is being provided for on-grid electricity connections to Particularly Vulnerable Tribal Group (PVTG) households identified through the PM-JANMAN initiative. By July 2024, a total of 73,544 households had been electrified under RDSS, while 64,253 households had been electrified under PM-JANMAN.

Figure 3.7: Access to electricity, in % of household, Rural and Urban India, FY2018 – FY2023



Note: World Bank is yet to publish data for FY2024 and FY2025

Source: World Bank, Frost & Sullivan Analysis

3.8. Long term drivers for growth

3.8.1. Government initiatives and regulation to enhance power distribution network and Rural Electrification

A. Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY):

- **Key Objectives:** To ensure 24×7 electricity in rural India by strengthening sub-transmission and distribution infrastructure and separating agricultural and non-agricultural feeders.
- **Key Highlights:**
  - Budget: INR 430.33 billion (INR 334.53 billion as Government support)
  - Villages Electrified: 7,543 (2015–2016)
  - Nodal Agency: Rural Electrification Corporation (REC)
- **Impact of the scheme:**
  - **Socio-Economic Upliftment**: Improved access to electricity has enhanced rural livelihoods, especially in education, healthcare, and banking services (e.g., ATM availability).
  - **Reduced Migration**: Electrification has curbed rural-to-urban migration by enabling local employment and entrepreneurship.
  - **Agricultural Efficiency**: Feeder separation has allowed better scheduling of power for irrigation, boosting crop yields.
  - **Environmental Benefits**: Shift toward cleaner energy sources and reduced reliance on diesel generators.

B. Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA)

- **Key Objectives:** To achieve universal household electrification by providing free electricity connections to poor households.
- **Key Highlights:**
  - Budget: INR 163.2 billion (INR123.2 billion GBS)
  - Households Electrified: Over 28.6 million[5]
- **Impact of the scheme:**

[5]https://www.pib.gov.in/PressReleasePage.aspx?PRID=2157549

- **Improved Quality of Life:** Electrified homes reported increased use of appliances, better indoor air quality, and more time for education and work.
- **Health & Safety:** Reduced kerosene use led to fewer respiratory issues; lighting improved safety, especially for women and children.
- **Economic Inclusion:** Enabled small businesses and digital banking; supported government schemes like PM-JANMAN for tribal electrification.
- **Challenges Overcome:** Remote terrain, forest clearances, and Left-Wing Extremism areas were addressed through innovative deployment strategies.

C. National Smart Grid Mission and Upgradation of existing power distribution eco system

- **Overview:** National Smart Grid Mission (NSGM), launched in 2015 under the Ministry of Power (MoP), serves as the institutional framework for planning, monitoring, and implementing Smart Grid initiatives across India. It coordinates with key stakeholders such as DISCOMs, regulators, equipment manufacturers, and the Central Electricity Authority, while also engaging other ministries like MNRE, MoUD, and MoHI.

  NSGM follows a three-tier governance structure:

  - **Tier 1 – Governing Council:** Headed by the Minister of Power, this apex body has functional and financial autonomy within the allocated budget to oversee Smart Grid deployment nationwide.
  - **Tier 2 – Empowered Committee:** Chaired by the Secretary (Power), this level manages project approvals, budget allocation, and consultant recruitment for implementation.
  - **Tier 3 – Technical Committee:** Led by the Chairperson of CEA, it provides technical expertise, including technology selection, standards formulation, and review of project deliverables.
- **Key Objectives:** Modernize India's power distribution system using smart grid technologies for improved reliability, efficiency, and sustainability.
- **Key Highlights:**
  - Smart Meters Installed: Over 40 million
  - Budget Allocation:
    - Phase 1: INR 9.80 billion,
    - Phase 2: INR 9.90 billion,
    - Phase 3: INR 1.37 billion
- **Impact of the scheme:**
  - **Grid Resilience:** Smart grids reduce outages through automated fault detection and faster restoration.
  - **Consumer Empowerment:** Real-time energy tracking and dynamic pricing encourage efficient usage.
  - **Renewable Integration:** Facilitates solar and wind energy adoption through distributed generation and microgrids. NSGM strengthens grid infrastructure to support distributed solar

generation through smart metering, bi-directional power flow, and real-time monitoring, contributing to India's renewable energy targets.

D. Revamped Distribution Sector Scheme (RDSS)

The Revamped Distribution Sector Scheme (RDSS), launched by the Ministry of Power in July 2021, is a reforms-based and results-linked scheme aimed at improving the operational efficiency and financial sustainability of power distribution utilities across India. The scheme focuses on reducing Aggregate Technical & Commercial (AT&C) losses, narrowing the gap between Average Cost of Supply (ACS) and Average Revenue Realised (ARR), and strengthening distribution infrastructure through smart metering and network modernization initiatives. The scheme has a total outlay of approximately INR 3.04 trillion, including Government Budgetary Support (GBS) of INR 976.31 billion, and is being implemented over FY2022 to FY2026 through nodal agencies including Power Finance Corporation (PFC) and Rural Electrification Corporation (REC).

Under RDSS, financial assistance is provided to DISCOMs for prepaid smart metering, feeder and distribution transformer metering, loss reduction works, and modernization of distribution infrastructure. As of March 2026, projects worth approximately INR 2.83 trillion had been sanctioned under the scheme, including approximately INR 1.31 trillion towards smart metering and INR 1.53 trillion towards distribution infrastructure strengthening and loss reduction works. Smart metering projects sanctioned under RDSS cover approximately 197.9 million consumer meters, 2.11 lakh feeder meters, and 52.53 lakh distribution transformer meters across multiple states and union territories.

The scheme is expected to drive investments in distribution infrastructure modernization, including feeder segregation, substation augmentation, replacement of aging conductors and transformers, deployment of SCADA and Distribution Management Systems (DMS), and integration of digital monitoring technologies. In addition, the large-scale rollout of prepaid smart meters under RDSS is expected to improve billing efficiency, energy accounting, and revenue realization for DISCOMs. The scale and phased implementation of RDSS are also expected to create business opportunities for EPC contractors, system integrators, smart meter manufacturers, Advanced Metering Infrastructure Service Providers (AMISPs), and other companies operating across the power distribution value chain.

3.9. OVERVIEW OF POWER TRANSMISSION AND DISTRIBUTION SECTOR IN INDIA

3.9.1. Importance of Power Transmission and Distribution Infrastructure in India

The transmission and distribution (T&D) network constitute the backbone of India's electricity system, ensuring that power generated at plants is delivered efficiently and reliably to end consumers across the country. As India is the third-largest producer and consumer of electricity globally, the scale and complexity of its grid are immense, spanning vast geographies, diverse demand centers, and a rapidly evolving generation mix. Over the years, India has developed one of the world's largest interconnected power systems, with a unified national grid that allows seamless transfer of electricity across regions, thereby improving reliability and resource utilisation.

The importance of T&D infrastructure has grown significantly in recent years, driven by the twin imperatives of meeting rising electricity demand and integrating large volumes of renewable energy. Transmission lines, operating at higher connectivity that ensures power reaches households, businesses, and industries, underpinning socio-economic development.

Strengthening and modernizing India's T&D network is also critical for addressing persistent challenges such as technical and commercial losses, reliability gaps in rural areas, and the need for digital and automated grid operations. With the Government of India targeting 500 GW of non-fossil fuel-based power capacity by 2030 and universal electricity access, significant investments in both transmission and distribution infrastructure are expected. This expansion will not only improve grid stability but also support India's broader objectives of energy transition, industrial growth, and sustainable development.

3.9.2. Definitions and Scope

In the Indian context, the power network is broadly divided into transmission and distribution segments, based on voltage levels:

Transmission network: Refers to systems operating at 132 kV and above, covering 132 kV, 220 kV, 400 kV, 765 kV, and high-voltage direct current (HVDC) lines. This segment is primarily used for bulk power transfer across long distances and between states/regions.

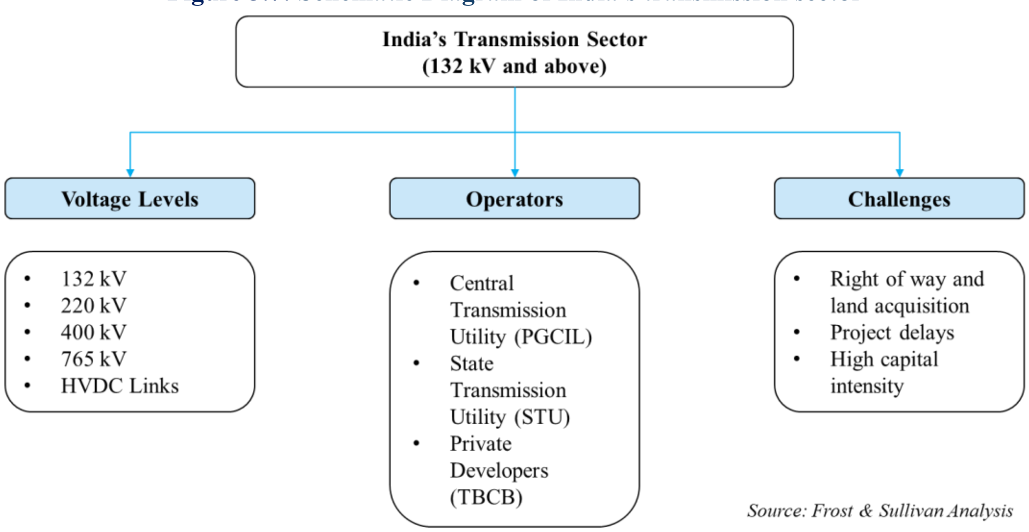
- **Sub-transmission**: Lines operating at 66 kV and 110 kV, which act as an intermediate link between transmission and distribution. The classification varies across states—some treat 66 kV as part of distribution, while others include it under transmission.
- **Distribution network**: Covers systems operating at 33 kV and below, including 22 kV, 11 kV, and low-tension (LT) lines, which step power down to levels suitable for industrial, commercial, and residential consumption.

3.9.3. Overview of the Transmission Sector in India

India's transmission sector forms the backbone of the power system, linking electricity generation with consumption centres. It comprises interstate transmission, managed primarily by Power Grid Corporation of India Limited (PGCIL) for transferring bulk power across states, and intrastate transmission, handled by the State Transmission Utilities (STUs) for delivering power to distribution networks.

Private sector participation through tariff-based competitive bidding (TBCB) has helped expand capacity and improve efficiency. Key drivers for the sector include the integration of renewable energy, the need to maintain grid reliability, and the modernisation of infrastructure through high-voltage and HVDC technologies to facilitate long-distance power transfer and minimize losses.

Figure 3.7: Schematic Diagram of India's transmission sector

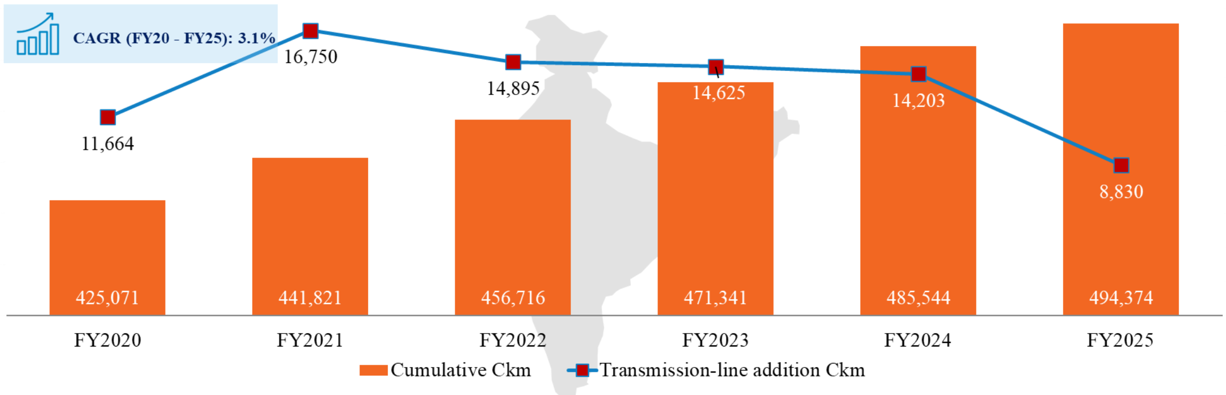


Source: Frost & Sullivan Analysis

3.9.3.1. Transmission Sector: Current line length

India's transmission network, operating at 132 kV and above, enables bulk power transfer from generation to load centres. As of FY2025, the cumulative line length stood at approximately 494,374 Ckm, encompassing 132 kV, 220 kV, 400 kV, 765 kV, and HVDC links.

Figure 3.8: Transmission line length in India, in Ckm, FY2020 – FY2025



Source: National Electricity Plan, Frost & Sullivan Analysis

The network is primarily operated by PGCIL for interstate transmission, with STUs managing intrastate lines, and private developers increasingly contributing through tariff-based competitive bidding (TBCB) projects. Key growth drivers include renewable energy evacuation, interstate transfer strengthening, and grid stability. The sector's challenges include right-of-way issues, regulatory and environmental clearances, project delays, and high capital requirements.

3.9.3.2. Transmission sector: Expansion Policies

The Government of India has launched several policy initiatives and funding programmes to strengthen the transmission infrastructure, particularly to support the rapid integration of renewable energy into the national grid. These initiatives focus on expanding transmission lines, developing substations, and enhancing grid stability to ensure efficient power evacuation from generation hubs to demand centres. Key programmes such as the Green Energy Corridor, the National Electricity Plan, and budgetary allocations from the Ministry of New and Renewable Energy (MNRE) continue to play an important role in driving investment and scaling up India's transmission network over the coming decade.

Figure 3.9.1: Transmission Line Expansion Policies: Funding & Impact Overview

POLICY INITIATIVE	FUNDING & TIMELINE	IMPACT ON TRANSMISSION	POLICY INITIATIVE
Green Energy Corridor (GEC) Phase I	INR 101.4 billion; completion by FY2025	~9,700 Ckm lines and 22,600 MVA substations to integrate ~24 GW renewable capacity	Green Energy Corridor (GEC) Phase I
Green Energy Corridor (GEC) Phase II	INR 120.3 billion; FY2022–FY2026	~10,750 Ckm lines and 27,500 MVA substations to integrate ~20 GW renewable capacity	Green Energy Corridor (GEC) Phase II
National Electricity Plan 2023–2032	INR 4,900.0 billion; FY2027–FY2032	Adds ~191,000 Ckm lines and 1,270 GVA transformation capacity by FY2032 to support 500 GW renewable integration by FY2030	National Electricity Plan 2023–2032
MNRE Budget Allocation 2024–25	INR 191.0 billion	Supports transmission projects including GEC; enhance renewable evacuation and grid stability	MNRE Budget Allocation 2024–25

3.9.3.3. Transmission sector: Expansion Plans

India's power transmission sector is undergoing rapid expansion to support the growing electricity demand, integrate renewable energy, and strengthen inter-regional connectivity. Several major transmission line projects are currently underway or in the pipeline across the country, spanning multiple states and grid regions. These projects are critical to evacuating power from renewable energy zones, enhancing grid stability, and ensuring reliable electricity supply to consumers. The table below provides an overview of some of the key upcoming transmission line projects in India, highlighting their locations, line lengths, and tentative completion timelines.

Figure 3.9.2: Major Transmission Line Expansion Projects in India

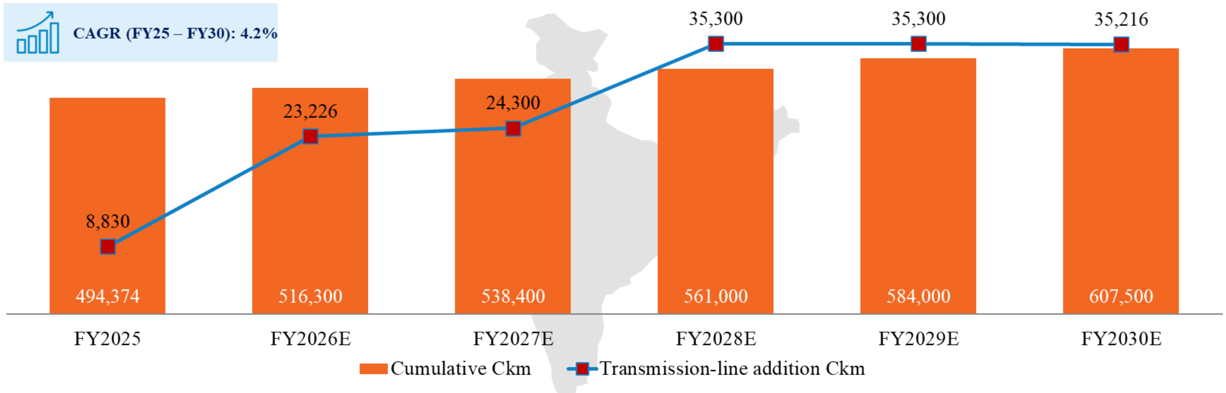
PROJECT NAME	LOCATION	LINE LENGTH	TENTATIVE COMPLETION DATE	DETAILS
Bhadla–Fatehpur HVDC Link	Rajasthan to Uttar Pradesh	950 km	Not specified	A ±800 kV, 6 GW bi-directional HVDC transmission system to evacuate renewable energy from Bhadla Solar Park to Fatehpur, enhancing grid stability and capacity.
Kurnool-IV to Kurnool-III 765 kV Line	Andhra Pradesh	Not specified	23 months from April 2025	A 765 kV double circuit line supporting 4.5 GW of renewable energy integration, awarded to Bajel Projects.
Inter-Regional Strengthening (SR-WR Grid)	Karnataka and Maharashtra	Not specified	Not specified	Power Grid to develop 765 kV double circuit transmission lines to enhance power transfer capacity between Southern and Western Grids.
Transmission System for RE Projects in Morena SEZ (Phase I)	Madhya Pradesh	Not specified	Not specified	A transmission system to evacuate 2,500 MW of power from renewable energy projects in the Morena SEZ.
Transmission System for RE Projects in Rajgarh (Phase II)	Madhya Pradesh	Not specified	Not specified	A transmission system to evacuate 1,000 MW of power from renewable energy projects in the Rajgarh area.

Note: *The information presented in this table is indicative and not an exhaustive listing of all upcoming transmission line projects in India.*

3.9.3.4. Transmission Sector: Future Sector Outlook

India's transmission sector is poised for significant expansion over the next five years, driven by growing electricity demand, large-scale renewable energy integration, and the need to strengthen interstate and intrastate power networks. The planned growth emphasises both the addition of new transmission lines and the enhancement of system capacity to ensure reliable and efficient power delivery.

Figure 3.9.3: Projected Transmission line length in India, in Ckm, FY2026E – FY2030E



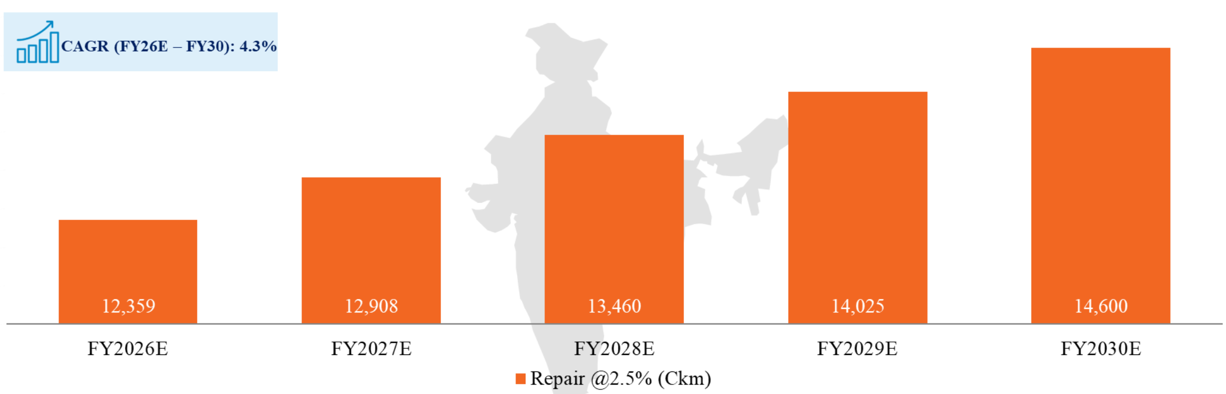
Source: National Electricity Plan, Frost & Sullivan Analysis

Beyond capacity addition, the sector is also entering a structurally important phase where repair and refurbishment activity emerges as a steady parallel market to new line construction. Based on an annual intervention rate of 2.5% of the opening cumulative network, refurbishment volumes are estimated to rise from 12,359 Ckm in FY2026E to 14,600 Ckm by FY2030E, aggregating to 67,352 Ckm over FY2026E to FY2030E.

The 2.5% assumption corresponds to a 40-year major rehabilitation cycle, which is conservative in the context of India's transmission asset base. A significant portion of the network was commissioned during the rapid expansion phase post-2005, while older lines are now operating under materially higher loading conditions, increasing mechanical and thermal stress.

Refurbishment projects differ fundamentally from greenfield EPC execution. They typically involve conductor replacement, re-stringing, tower strengthening, insulator replacement, and limited foundation repair, without fresh right-of-way acquisition, full civil works, or route surveys. As a result, refurbishment costs are structurally lower and typically range between 20–30% of new-build line costs. Using INR 5 million per Ckm, equivalent to 25% of a INR 20 million per Ckm new-build benchmark, is consistent with prevailing industry practice.

Figure 3.9.4: Projected Transmission Transmission Repair and Refurbishment Outlook (FY2026E–FY2030E), in Ckm



Source: Expert interactions, Frost & Sullivan Analysis

3.9.3.5. Translation of policy pipeline into market opportunity

Policy-driven transmission expansion, particularly through programmes such as Green Energy Corridor and the National Electricity Plan, is translating into a visible and structured project pipeline. These projects typically move through a defined lifecycle consisting of planning, bid-out through tariff-based competitive bidding or regulated routes, Engineering, procurement and construction (EPC) award, and subcontracting execution.

- Tendering activity: A significant share of upcoming transmission projects is being bid out under tariff-based competitive bidding, resulting in a steady flow of large EPC packages across HVDC corridors, interstate lines, and renewable evacuation systems
- Engineering, procurement and construction (EPC) conversion: Each awarded project converts into turnkey EPC contracts covering tower supply, civil works, erection, stringing, and commissioning, forming the primary monetisation layer
- Subcontracting volumes: Approximately 30% to 35% of EPC value is executed through subcontractors across activities such as foundation works, tower erection, and stringing, creating sustained demand for regional execution partners

As a result, policy announcements translate directly into executable order books, supporting medium-term revenue visibility for EPC contractors and subcontractors.

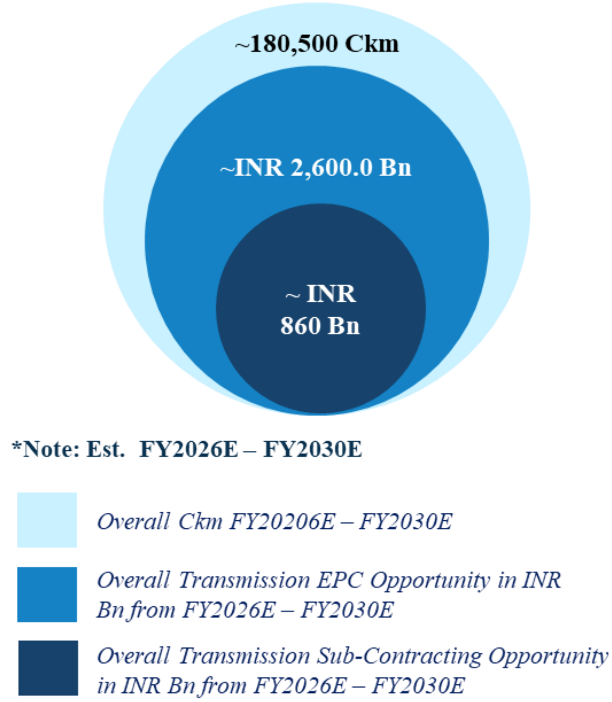
From a market perspective, this creates a dual opportunity. Large-scale greenfield expansion is complemented by a recurring refurbishment market characterised by lower risk, shorter execution cycles, and relatively better working capital dynamics. As India's transmission network expands, refurbishment demand is expected to scale alongside it, making it a predictable component of sector capex rather than a discretionary spend.

3.9.3.6. Key Market Assumptions Underpinning Transmission Outlook

- Asset age profile: A large share of India's transmission network was commissioned after 2005, alongside older assets that continue to operate and require periodic intervention
- Stress loading conditions: Increasing renewable integration and higher power flows are resulting in elevated thermal and mechanical loading, accelerating refurbishment needs
- Refurbishment rate differentiation: Transmission assets operate under more controlled conditions and are designed for longer life, resulting in a lower intervention rate of approximately 2.5%, compared to distribution networks which face higher environmental and operational stress
- Cost assumptions: Benchmarks of INR 20 million per Ckm for new lines and INR 5 million per Ckm for refurbishment are based on industry averages and are presented in nominal terms without explicit inflation escalation

3.9.3.7. Transmission Sector: Transmission line Sub-Contracting Market

Figure 3.9.5: Transmission line Sub-Contracting market opportunity, value in INR Bn, FY2026E – FY2030E (cumulative)



India's transmission network is projected to expand from approximately 516,300 circuit kilometres (Ckm) in FY2026E to nearly 607,500 Ckm by FY2030E. This represents an addition of about 113,126 Ckm of new transmission lines during the period.

New-build transmission EPC opportunity

Using an average new-line construction cost of INR 20 million per Ckm, the cumulative value of new transmission line Engineering, procurement and construction (EPC) projects during FY2026E–FY2030E is estimated at INR 2,262.5 billion. Transmission line development in India is largely executed through turnkey EPC contracts, covering tower supply, foundations, erection, stringing, and project management. Accordingly, this value represents the addressable EPC opportunity from greenfield transmission expansion over the forecast period.

Repair and refurbishment opportunity

In parallel, repair and refurbishment activity— estimated at 2.5% of the opening cumulative network annually, is projected to total ~67,352 Ckm over FY2026E–FY2030E. Refurbishment typically includes conductor replacement, re-stringing, tower strengthening, insulator replacement, and limited foundation repairs, without fresh right-of-way acquisition or full civil works.

The 2.5% annual intervention rate is a modelled assumption based on asset life-cycle considerations and industry operating practices. Transmission lines are typically designed for a technical life of 35 to 40 years, with major refurbishment required once during this cycle. This implies an intervention range of approximately 2% to 3% of the network annually, with 2.5% adopted as a midpoint assumption.

This lower intervention rate, relative to distribution networks, reflects the structural characteristics of transmission assets:

- Operation under controlled loading and grid conditions
- Lower exposure to external damage, theft, and weather-related disruptions
- Higher design standards and preventive maintenance practices

By contrast, distribution networks are more decentralised, pole-based, and exposed to environmental and operational stress, resulting in a higher modelled intervention rate of approximately 5% annually.

Using an average refurbishment cost of INR 5 million per Ckm, equivalent to approximately 25% of new-build costs, the repair Engineering, procurement and construction (EPC) opportunity over the period is estimated at INR 336.7 billion.

Total Engineering, procurement and construction (EPC) market size

Combining new-build and refurbishment activity, the total transmission Engineering, procurement and construction opportunity during FY2026E–FY2030E is estimated at INR 2,599.3 billion. Annual Engineering, procurement and construction execution is projected to rise steadily from INR 500.3 billion in FY2026E to INR 543.0 billion by FY2030E, driven by both incremental network expansion and the scaling up of lifecycle-driven refurbishment work.

Subcontracting opportunity

Transmission EPC execution typically involves extensive use of subcontractors for civil foundations, tower erection, stringing, right-of-way clearance, and other site-intensive activities. On average, ~33% of EPC value is executed through subcontracting arrangements. Based on this assumption, the subcontracting opportunity over FY2026E–FY2030E is estimated at ~INR 857.8 billion, indicating a large and sustained pipeline of work for regional and specialized execution partners.

Market implications

The coexistence of large-scale greenfield expansion and a rising refurbishment base indicates a structurally stable transmission execution market. While new-line EPC continues to be driven by capacity addition and grid expansion, refurbishment introduces a recurring, lower-risk, brownfield execution stream with shorter project cycles and lower right-of-way exposure. Together, these trends support sustained activity across EPC contractors, subcontractors, and equipment suppliers over the medium term, reducing volatility typically associated with pure greenfield infrastructure cycles.

3.9.4. Overview of the Distribution Sector in India

The electricity distribution sector forms the last-mile link in India's power system, delivering electricity to over 250 million consumers across households, industries, agriculture, and commercial establishments. It is dominated by state-owned discoms, which account for nearly 90% of the consumer base, supported by private operators in cities like Delhi and Mumbai, and franchisees that manage smaller service areas.

India has achieved universal household electrification, and supply reliability has improved to 20–24 hours in urban areas and 18–20 hours in most rural regions. Rising demand pushed peak power requirements beyond 250 GW in FY2024, underscoring the importance of a robust distribution network.

Operationally, the sector is improving. Aggregate Technical & Commercial (AT&C) losses have declined from 21.9% in FY2021 to 17.6% in FY2024, aided by reforms under the INR 3 Trillion Revamped Distribution Sector Scheme (RDSS), which is driving smart meter adoption and network modernisation. The financial gap between the Average Cost of Supply (ACS) and Average Revenue Realised (ARR) has narrowed from INR 0.69 per unit in FY2021 to below INR 0.25 in FY2024, though discom debt remains above INR 6–7 trillion.

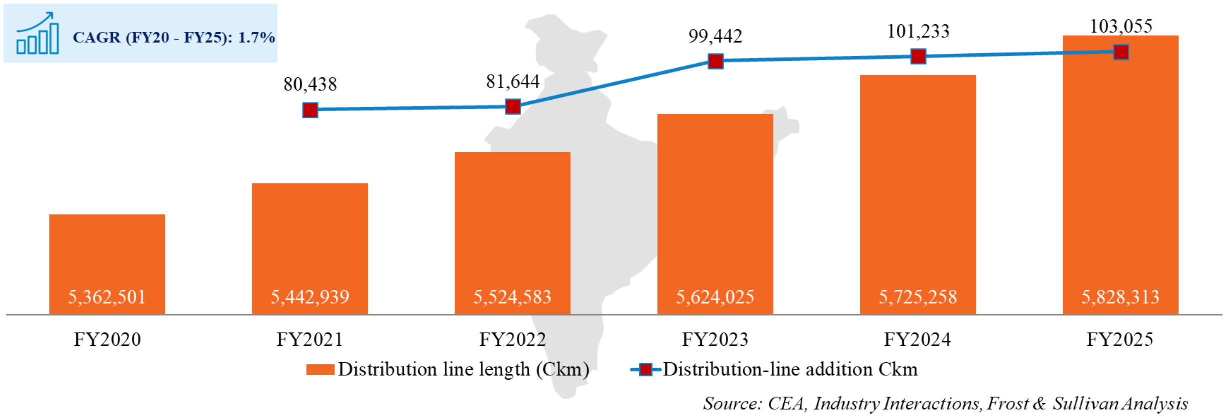
Despite these challenges, distribution is becoming more efficient and better equipped to integrate renewables, digital systems, and private participation. Given this backdrop, a critical lens of analysis is the distribution infrastructure itself — particularly the length and capacity of distribution lines, which determine the sector's ability to meet rising demand and ensure last-mile connectivity.

3.9.4.1. Distribution Sector: Current line length

India's electricity distribution network has experienced significant growth, with the total distribution line length reaching approximately 5.83 million Ckm by FY2025. This expansion is driven by a combination of state-level initiatives and national policies aimed at enhancing infrastructure, integrating renewable energy, and improving service delivery.

Uttar Pradesh continues to expand its transmission and distribution infrastructure to support rising electricity demand across both urban and rural areas. Tamil Nadu is strengthening its network to integrate additional renewable energy capacity, supported by ongoing grid modernisation programmes. Odisha has undertaken a series of distribution system upgrades under state-led reform initiatives aimed at improving reliability and reducing technical losses. Gujarat's Jyotigram Yojana has enabled 24-hour, three-phase power supply in rural areas, while Maharashtra's Mukhyamantri Saur Krushi Vahini Yojana is progressing toward large-scale decentralised solar deployment. Telangana has achieved full solarization in Kondareddypalli village, and Andhra Pradesh's Eastern Power Distribution Company is leveraging digital tools, including AI-based pole monitoring, to enhance operational efficiency.

Figure 3.9.6: Distribution line length in India, in Ckm, FY2020 – FY2025



Source: CEA, Industry Interactions, Frost & Sullivan Analysis

National policies such as the Revamped Distribution Sector Scheme (RDSS) aim to modernise the distribution network, reduce losses, and roll out smart metering at scale. The Green Energy Corridor initiative facilitates the transmission of renewable energy from generation centres to demand centers, supporting the integration of renewable energy into the grid. These combined efforts are poised to create a more resilient and sustainable power distribution system across India.

3.9.4.2. Distribution Sector: Current line length by voltage

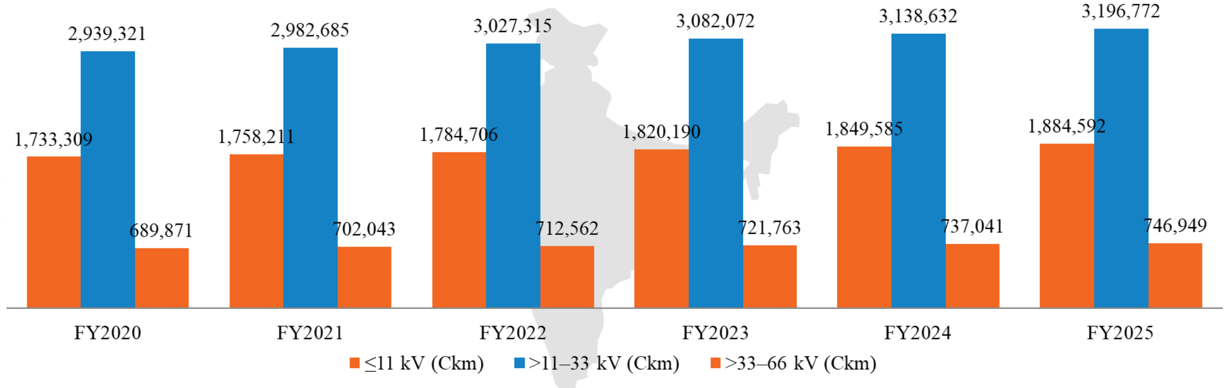
Between FY2020 and FY2025, India's electricity distribution network witnessed steady but modest growth, with total line length increasing from 5.36 million Ckm to 5.83 million Ckm, representing a CAGR of roughly 1.68%. The growth during this period was influenced by several factors: the COVID-19 pandemic caused supply chain disruptions and slowed infrastructure execution in FY2021, while policy measures and programmatic investments helped stabilise growth in subsequent years.

The ≤11 kV lines, which primarily serve low-voltage residential and rural areas, maintained a stable share of ~32%, reflecting consistent last-mile electrification efforts.

The >11–33 kV lines, which connect distribution substations to feeder networks, contributed the largest share (~55%), reflecting ongoing urban and semi-urban distribution strengthening. The >33–66 kV lines, though smaller in proportion (~13%), were critical for connecting larger feeders and supporting emerging renewable generation zones.

During this period, key policies like the Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) and SAUBHAGYA drove rural electrification, while the Revamped Distribution Sector Scheme (RDSS) and Smart Meter National Programme (SMNP) laid the foundation for modernised, efficient distribution. States like Gujarat, Maharashtra, Bihar, Madhya Pradesh, and Tamil Nadu were particularly active in upgrading distribution networks, improving feeder reliability, and rolling out smart meters. Despite challenges, these investments strengthened the backbone of India's distribution system, enabling better load management and reducing technical and commercial losses.

Figure 3.9.7: Distribution line length in India, in Ckm, by kV rating, FY2020 – FY2025



Source: Frost & Sullivan Analysis

3.9.4.3. Distribution sector: Expansion Policies

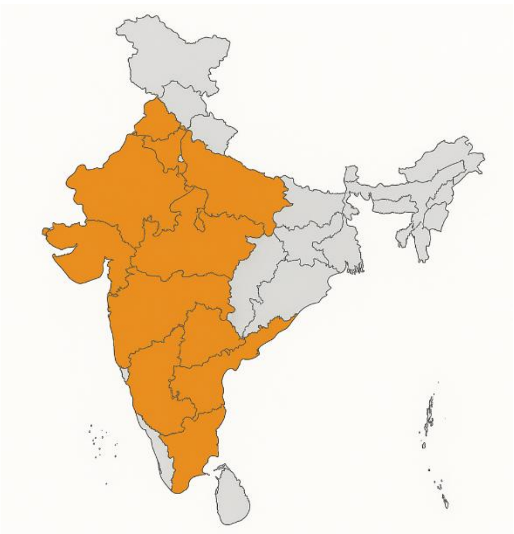
India's electricity distribution network has been steadily expanding to meet growing demand, improve reliability, and integrate renewable energy sources. This growth is being driven by a combination of national policies, state-level initiatives, and investment in modern technologies such as smart meters and solarised feeders. Key programs focus on reducing losses, strengthening infrastructure, and enabling more efficient power delivery across urban and rural areas.

Figure 3.9.8: Distribution Line Expansion Policies: Funding & Impact Overview

POLICY INITIATIVE	FUNDING & TIMELINE	IMPACT ON DISTRIBUTION NETWORK
Revamped Distribution Sector Scheme (RDSS)	INR 3,040 billion; FY2021–26 (extended to FY2027–28)	Targets loss reduction (AT&C to 12–15%), installation of 250 million smart meters, and infrastructure strengthening.
Smart Meter National Programme (SMNP)	INR 976.3 billion under RDSS	Rollout of 250 million prepaid smart meters, improving billing efficiency and grid reliability.
National Smart Grid Mission (NSGM)	Launched in 2015; ongoing	Supports deployment of smart grids and IT/OT integration to modernize distribution, reduce outages, and manage demand.
Upgradation of Existing Distribution System	Part of RDSS & state DISCOM programs; ongoing	Focuses on feeder segregation, strengthening substations, underground cabling, and digitalization of networks.
Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA)	INR 163.2 billion; launched 2017, near completion	Achieved near-universal household electrification, adding millions of last-mile connections and expanding rural distribution lines.
Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY)	INR 758.9 billion; launched 2014; ongoing legacy impact	Strengthened rural feeders, improved rural network reliability, and supported agricultural load separation.
PM KUSUM Scheme	INR 344.2 billion; ongoing	Solarization of agricultural feeders to reduce distribution stress and enhance grid stability.
PM Surya Ghar Yojana	Part of RDSS; ongoing	Promotes rooftop solar integration, reducing distribution losses and empowering consumers.

GST Reduction on Renewable Energy Equipment	GST cut from 12% to 5%; announced in 2025	Reduces cost of renewable-linked distribution upgrades, saving DISCOMs ~INR 30.0 billion annually.
Odisha Distribution System Strengthening Programme (ODSSP) and RDSS-linked Distribution Upgrades	State capex: INR 22.27 billion in FY24–25 and INR 29.08 billion in FY25–26; RDSS request: INR 30.69 billion; ongoing	Expansion of HT/LT distribution lines, feeder augmentation, loss-reduction initiatives, and strengthening of rural and peri-urban networks.
Tamil Nadu – Distribution Network Strengthening under RDSS and State DISCOM Capex Programme	RDSS-approved distribution reforms and infrastructure works: ~INR 170–180 billion. Ongoing state-funded capex through TANGEDCO for HT/LT network enhancement (annual allocations in the INR 40–50 billion range).	Strengthening and augmenting HT/LT distribution lines, implementing feeder segregation and bifurcation to improve reliability, upgrading sub-transmission systems to support renewable integration, and reducing technical losses through reconductoring and replacement of ageing infrastructure.

3.9.4.4. Relevance of the Smart Meter National Programme (SMNP) to PTL



The Smart Meter National Programme (SMNP), implemented under the Revamped Distribution Sector Scheme (RDSS), is one of the largest distribution-sector reforms in India, targeting the deployment of 250 million prepaid smart meters. Deployment priorities have been determined based on AT&C loss levels, consumer density, legacy meter prevalence, and the need for enhanced grid visibility. As illustrated in the map, the highest deployment volumes are concentrated in Uttar Pradesh, Maharashtra, Odisha, Tamil Nadu, Andhra Pradesh, Bihar, and Rajasthan, which collectively form the core implementation corridor for the programme.

Several of these priority states, particularly Uttar Pradesh, Odisha, Tamil Nadu, and Maharashtra, overlap directly with PTL's operational presence. These states account for a significant proportion of sanctioned meters due to their large consumer bases, prevalence of electromechanical and early-generation static meters, and ongoing digitalisation initiatives. This geographic alignment positions PTL within some of the most active smart metering markets in the country.

The rollout of prepaid smart meters in these states requires a broad set of distribution network upgrades that extend beyond meter replacement. Key associated works include replacement of service lines, feeder-level metering, integration of meter data management systems (MDMS), communication module configuration, and strengthening of last-mile infrastructure to support functionalities such as remote disconnection, reconnection, load control, and real-time consumption monitoring. These activities increase the need for field execution support, installation manpower, and site-level coordination, reinforcing the operational relevance of SMNP to PTL's capabilities.

In addition, the programme's emphasis on billing efficiency, revenue assurance, and consumer-side digitalisation is expected to lead to expanded subcontracting requirements across several execution tasks. These include meter installation, communication hardware integration, geotagging, site surveys, exception management, and maintenance support—functions typically outsourced to specialised implementation partners. Given PTL's existing on-ground presence in several high-deployment districts, the company is well-positioned to be part of this expanding contractor ecosystem.

Overall, the Smart Meter National Programme represents a multi-year, high-volume opportunity with direct implications for distribution network strengthening and operational modernisation. For PTL, the programme is strategically relevant due to its strong alignment with the company's service areas, field execution strengths, and established presence in states identified as key deployment zones under SMNP

3.9.4.5. Distribution sector: Expansion Plans

India's electricity distribution sector is undergoing significant expansion to meet the growing power demand and to enhance the reliability of supply across the nation. Several distribution line expansion projects are currently in progress or planned, aiming to improve infrastructure, reduce transmission losses, and ensure equitable access to electricity in underserved regions. The table below highlights some of the key upcoming distribution line expansion projects, detailing their locations, scope, and expected timelines.

Figure 3.9.9: Major Distribution Line Expansion Projects in India

PROJECT NAME	LOCATION	SCOPE	EXPECTED COMPLETION DATE
Northeastern Region Power System Improvement Project	Assam, Manipur, Mizoram, Meghalaya, Tripura, Nagaland	Upgradation of distribution infrastructure, substations, and feeders under a multi-state modernisation effort	Ongoing
Jharkhand Power System Improvement Project	Jharkhand	Enhancement of metering, billing, and collection systems; network strengthening	Ongoing
West Bengal Electricity Distribution Grid Modernisation Project	West Bengal	Introduction of advanced distribution technologies and modernisation of legacy infrastructure	Ongoing
Maharashtra Distribution Network Strengthening Project	Maharashtra	Strengthening of HT/LT distribution networks to improve reliability and reduce losses	Not specified
Uttarakhand Rural Electrification Project	Uttarakhand	Electrification of rural regions to support 24×7 power supply and enhanced service delivery	Not specified
Bihar Distribution System Improvement Project	Bihar	Upgradation of distribution infrastructure to improve service quality and reduce technical losses	Not specified
Odisha Distribution System Strengthening Programme	Odisha	Expansion of HT/LT lines, feeder strengthening, rural	Ongoing

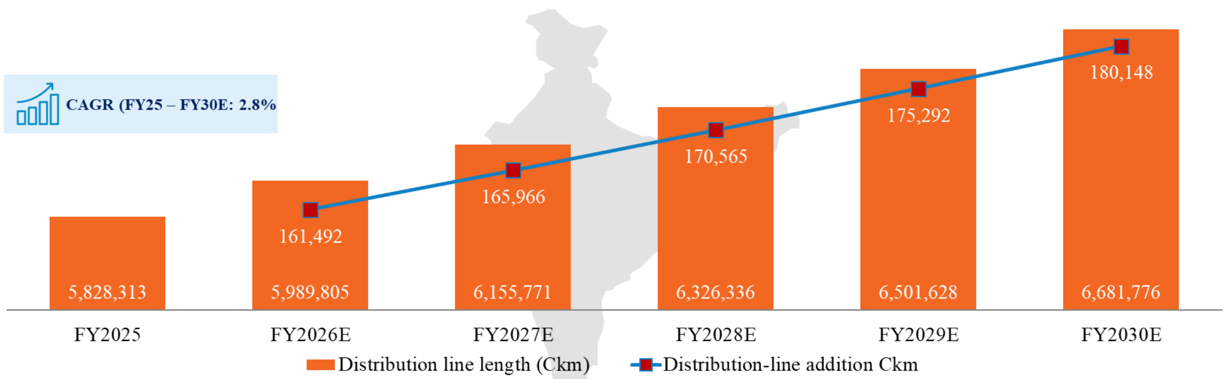
(ODSSP & RDSS-linked Upgrades)	network augmentation, and prepaid metering under RDSS

Note: *The information provided in this table is indicative and not an exhaustive listing of all upcoming distribution line expansion projects in India.*

3.9.4.6. Distribution Sector: Future Sector Outlook

India's electricity distribution network is poised for significant expansion, with projections indicating a steady increase in line length from 5.83 million circuit kilometres (Ckm) in FY2025 to approximately 6.68 million Ckm by FY2030. This growth trajectory reflects a compound annual growth rate of around 2.8%, driven by national policies, state-level initiatives, and technology-led grid modernisation aimed at improving reliability, integrating renewable energy, and strengthening last mile delivery service.

Figure 3.9.10: Projected Distribution line length in India, in Ckm, FY2026E – FY2030E



Source: CEA, Industry Interactions, Frost & Sullivan Analysis

RDSS as the primary driver of distribution capex and execution: The Revamped Distribution Sector Scheme (RDSS), with an outlay of INR 3,040 billion, is the central driver of distribution infrastructure investment in India over the current decade. The scheme focuses on improving the operational and financial performance of DISCOMs through targeted interventions in network strengthening, loss reduction, and digitalisation.

Key objectives under RDSS include:

- Reduction of Aggregate Technical and Commercial (AT&C) losses to 12% to 15%
- Narrowing the ACS-ARR gap to zero
- Deployment of 250 million prepaid smart meters under the Smart Meter National Programme
- Strengthening of distribution infrastructure through feeder segregation, reconductoring, substation upgrades, and system modernisation

These interventions are directly translating into a large, programmatic pipeline of EPC projects across states.

From an execution standpoint, RDSS is driving demand across multiple workstreams:

- **Network strengthening:** Reconductoring, feeder bifurcation, HT and LT line augmentation, and pole replacement
- **Metering infrastructure:** Installation of prepaid smart meters, feeder and distribution transformer metering, and integration with meter data management systems
- **System upgrades:** Substation augmentation, SCADA integration, and loss-reduction infrastructure

A significant share of this activity is executed through EPC contracts, with a high degree of subcontracting due to the decentralised and labour-intensive nature of distribution works. Activities such as line erection, service connections, meter installation, field surveys, and system integration are typically outsourced to regional contractors, creating a sustained subcontracting opportunity linked directly to RDSS rollout.

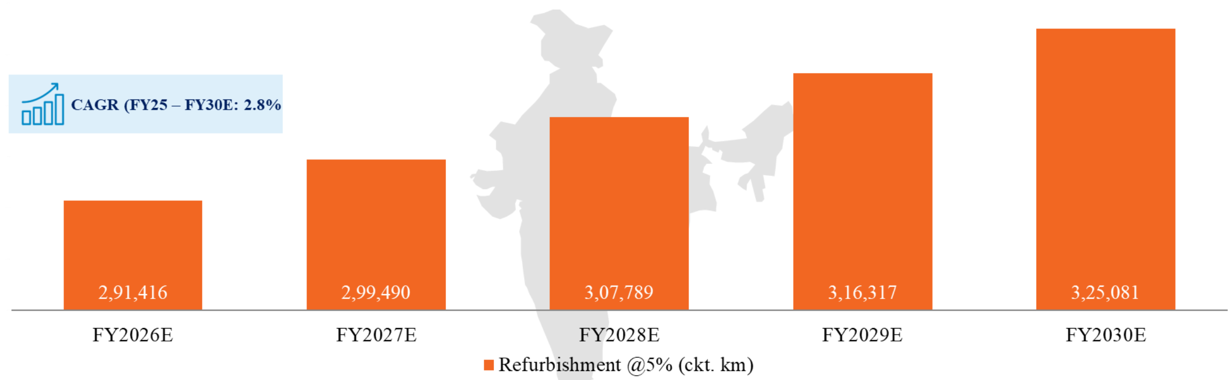
Other initiatives such as SAUBHAGYA and DDUGJY continue to have residual impact, particularly in rural electrification and feeder strengthening. However, RDSS remains the dominant framework shaping current and near-term distribution capex.

Refurbishment and strengthening outlook: Refurbishment and strengthening requirements in India's distribution network are structurally higher than in transmission, reflecting the pole-based and highly decentralised nature of assets, greater exposure to environmental and operational stress, and the prevalence of legacy conductors designed for lower load levels. In addition, distribution reform programmes increasingly prioritise reconductoring, feeder bifurcation, pole replacement, and system strengthening, which are capitalised as line execution despite limited expansion in physical route length.

Accordingly, refurbishment activity for distribution lines is modelled at 5% of the opening cumulative network annually, significantly higher than the corresponding assumption for transmission. Based on this approach, annual refurbishment volumes are estimated to rise from approximately 291,000 ckm in FY2026E to approximately 325,000 ckm by FY2030E, aggregating to approximately 1.54 million ckm over FY2026E to FY2030E. These volumes represent the extent of the network requiring strengthening or upgrading rather than new line additions.

Actual execution is lower than the modelled refurbishment requirement due to funding phasing, DISCOM implementation capacity, and scheme prioritisation. Reported execution trends indicate that refurbishment and strengthening account for a majority of on-ground distribution line activity, even as total executed lengths remain below the theoretical requirement. This gap highlights a persistent refurbishment backlog and reinforces the structurally recurring nature of distribution capex, which is driven more by asset quality improvement and loss reduction than by physical network expansion.

Figure 3.9.11: Projected Distribution refurbishment outlook, India, in Ckm, FY2026E – FY2030E



Source: Industry Interactions, Frost & Sullivan Analysis

3.9.4.7. Distribution Sector: Distribution line Sub-Contracting Market

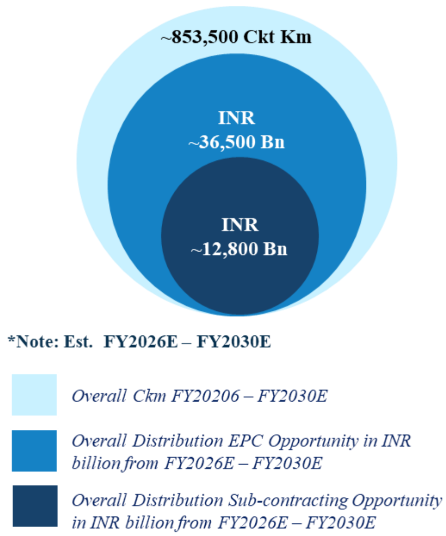
India's electricity distribution network is expected to expand significantly between FY2026E and FY2030E, supported by ongoing system-strengthening measures, loss-reduction programmes, feeder modernisation, and last-mile electrification efforts. By FY2030E, the cumulative distribution network is projected to reach approximately 853,500 circuit kilometers (ckm). Based on representative cost benchmarks for HT and LT network development, the overall opportunity during this period is estimated at INR ~36,500 billion.

Sub-contracting constitutes a substantial share of distribution EPC execution due to the highly decentralised, labour-intensive nature of field implementation. Approximately 35% of the total EPC value is typically delivered through sub-contractors, translating to a sub-contracting opportunity of INR ~12,800 billion over FY2026E–FY2030E. This reflects the large-scale construction, installation, and network-modernisation activities required across urban, semi-urban, and rural networks.

A key driver of this opportunity is the broad expansion expected across voltage segments:

- ≤11 kV distribution network: This segment, serving predominantly residential, rural, and agricultural consumers, will remain a major focus area. Investments will be channelled into last-mile electrification, feeder segregation, conductor replacement, pole-top metering, and system modernisation under central and state programmes.
- >11–33 kV network: This segment is expected to account for the largest share of additions, driven by rising load growth in urban and semi-urban areas, industrial expansion, and service quality requirements. Strengthening of 11/33 kV substations and associated feeders will form a major part of distribution EPC works.
- >33–66 kV network: Expansion in this segment will be driven by the need to evacuate renewable energy, reinforce the backbone distribution system, and improve interconnection between regional and industrial load centres.

Figure 3.9.12: Distribution line subcontracting market opportunity, value in INR Bn, FY2026E to FY2030E (cumulative)



States such as Gujarat, Maharashtra, Madhya Pradesh, Bihar, and Karnataka are likely to lead EPC demand, given their scale of renewable capacity addition, urbanisation, and proactive distribution reforms.

The EPC market opportunity extends beyond new line construction to include associated infrastructure works such as feeder augmentation, substation strengthening, and the rollout of smart grid systems. This broadens the scope of participation for contractors and positions the EPC segment as a central enabler of India's distribution sector modernisation.

Overall, the period from FY2026E to FY2030E is expected to reflect a policy-driven, programmatic expansion of distribution infrastructure, with emphasis on reliability, efficiency, and integration of renewable power into the grid.

3.9.4.8. Distribution line EPC: Growth drivers, Challenges, and Restraints

A. Growth Drivers

1. **Government Policy Support and Funding:** Government initiatives remain the backbone of growth in the distribution EPC sector. Schemes such as the Revamped Distribution Sector Scheme (RDSS), Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), SAUBHAGYA, and the National Smart Grid Mission (NSGM) are injecting substantial capital into the distribution network. These programs focus on feeder segregation, rural electrification, smart meter rollouts, and modernisation of ageing networks, creating a consistent pipeline of EPC projects across urban and rural areas. The clear policy direction and dedicated funding reduce execution risks and encourage EPC players to invest in capacity expansion.

2. **Rising Renewable Energy Integration and EV Adoption:** The rapid addition of renewable energy capacities, particularly solar and wind, is driving demand for a stronger and more reliable distribution network. Distribution lines, substations, and feeders need upgrades to handle variable renewable output, which directly translates into EPC work. At the same time, the increasing penetration of electric vehicles necessitates the deployment of new charging infrastructure and upgrades to local grids. These evolving requirements are creating a sustained demand for EPC services to ensure efficient energy delivery and grid stability.

3. **Urbanisation and Rural Electrification:** The ongoing urbanisation across tier-2 and tier-3 cities, coupled with efforts to achieve 100% rural electrification, is another critical growth driver. Rapid population growth in urban and semi-urban areas demands expansion of medium-voltage lines and substations, while rural areas require last-mile connections through low-voltage lines. The combination of urban infrastructure needs and rural electrification programs ensures that EPC contractors have projects across multiple voltage levels, supporting steady business growth.

   Smart Grid and Digitalisation Push: Digitalisation and smart grid initiatives are transforming traditional distribution networks, providing new avenues for EPC engagement. Investments in smart meters, SCADA systems, and automation technologies require the integration of physical network upgrades with digital monitoring and control. EPC players are therefore increasingly engaged not just in line construction, but also in installing and integrating digital infrastructure, creating a higher-value and technologically complex segment of the distribution market.

B. Challenges

1. **DISCOM Financial Stress:** A major challenge for the distribution EPC market is the financial weakness of state-owned distribution companies. High aggregate technical and commercial (AT&C) losses, delayed tariff adjustments, and mounting debts often result in late payments to EPC contractors. This financial strain slows down project execution and can affect the profitability and cash flow of EPC players, especially for large-scale projects.

2. **Execution Hurdles:** EPC projects frequently encounter delays due to land acquisition, right-of-way (RoW) issues, and lengthy regulatory approvals. Urban expansion, renewable energy lines, and densely populated areas are particularly susceptible to these execution bottlenecks. Such delays increase project timelines and costs, posing operational challenges for contractors.

3. **Supply Chain and Workforce Constraints:** The distribution EPC sector is heavily dependent on materials such as steel, copper, and conductors. Volatility in these raw material prices can squeeze EPC margins due to limited price pass-through mechanisms in contracts. In addition, the industry faces a shortage of skilled manpower, particularly for high voltage works, underground cabling, and digital grid integration, which can impact project quality and timeliness.

4. **Technological Complexity:** The growing adoption of smart grids, digital meters, and automated controls introduces complexity in EPC execution. Contractors are required not only to construct physical networks but also to integrate advanced digital systems, which demand specialized skills, project planning, and coordination with technology vendors.

C. Restraints

1. **Policy and Regulatory Uncertainty:** Frequent changes in tariff policies, subsidy mechanisms, and approval processes create uncertainty for EPC contractors. These regulatory shifts can delay projects, complicate financial planning, and reduce investor confidence in certain states or regions.

2. **Capital Intensity and Payment Cycles:** EPC contracts require significant upfront investment for equipment, labour, and logistics. Coupled with long payment cycles from financially stressed DISCOMs, this capital intensity restricts participation by smaller players and can constrain the scale at which EPC companies operate.

3. **Regional Disparities in Growth:** While states such as Gujarat, Maharashtra, and Karnataka are aggressively expanding their distribution networks, weaker states face institutional, financial, and operational bottlenecks. This uneven growth across regions limits the overall market potential and makes project opportunities geographically concentrated.

4. **Competition and Margin Pressure:** The sector has become increasingly competitive, with multiple private and public EPC contractors vying for the same projects. Coupled with input cost volatility and fixed-price contracts, this competition puts pressure on margins and profitability.

5. **Gap Between Tier-I and Tier-II Contractors**: A significant capability and capacity gap persists between Tier-I and Tier-II EPC firms. While Tier-I players possess the resources to execute large, multi-state packages, most Tier-II and Tier-III contractors lack comparable financial strength, technical expertise, and manpower depth. This disparity limits competition for larger tenders and restricts scalability for smaller contractors.

6. **Lack of Rationalisation in Project Size and Contractor Eligibility**: In many states, the size of distribution EPC packages is not aligned with local contractor capacity. Overly large packages deter smaller firms, while fragmented packages in other regions reduce efficiency for larger contractors. The absence of a rationalised project-size framework creates mismatch in market participation and affects timely implementation.

3.10. OVERVIEW OF THE RENEWABLE ENERGY SECTOR IN INDIA

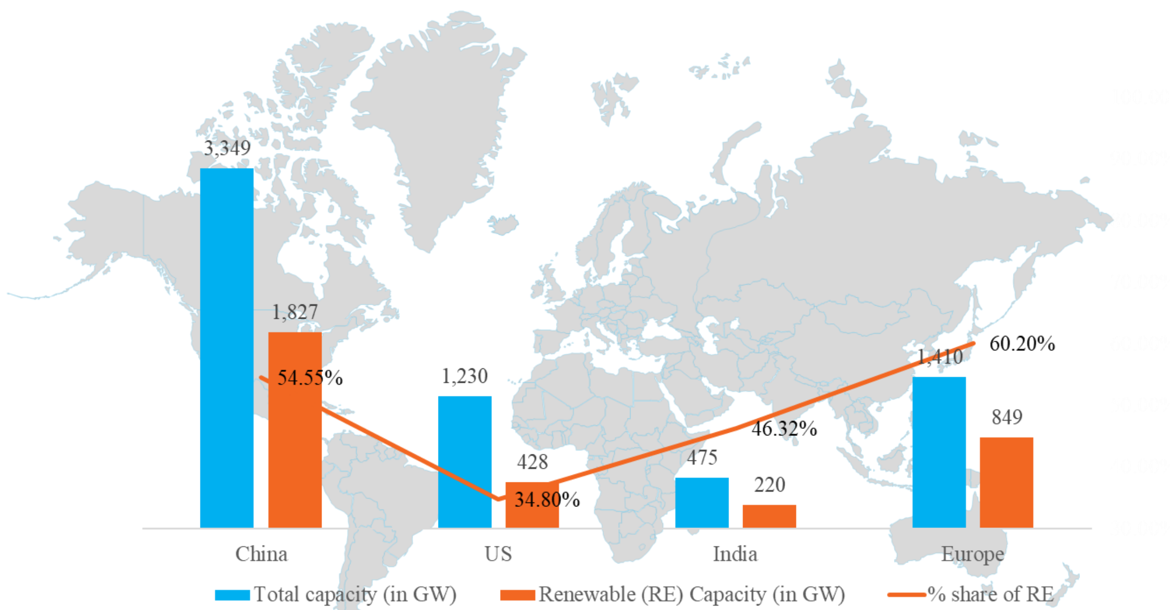
3.10.1. Renewable energy contribution to total power demand in India vs other key economies

As the world accelerate their transition toward cleaner energy sources, renewable energy contribution has become a cornerstone of global power generation strategies. The increasing urgency to address climate change, coupled with rising energy demands and international climate commitments, has spurred significant investments and policy initiatives to scale up renewable energy capacity worldwide.

The share of renewables in a country's total power mix reflects varying levels of ambition, policy support, and grid integration capabilities across economies. Some countries have achieved substantial penetration of renewables, while others continue to rely heavily on conventional sources due to infrastructure or policy constraints.

These disparities are often shaped by factors such as natural resource availability, regulatory frameworks, maturity of domestic manufacturing ecosystems, and access to financing. Understanding the global distribution of renewable energy capacity, both in terms of scale and percentage contribution, offers valuable insights into the pace and direction of energy transitions across regions.

Figure 3.10.1: Renewable energy contribution to total power demand, India vs Major economies, GW, CY2024



Note: China and US values are for CY2024, whereas the values for India correspond to FY2025

Source: IRENA, Frost & Sullivan Analysis

Globally, China leads total power generation capacity with an installed base of approx. 3,349 GW in CY2024, of which 1,827 GW is from renewable energy sources, translating to a renewable share of approx. 55%. This reflects China's sustained policy focus and investments toward decarbonization and energy transition.

In CY2024, the total installed power generation capacity of the US was 1,230 GW, with renewables accounting for 428 GW, contributing approx. 35% share in CY2024. While the absolute renewable capacity in the US remains substantial, the relative share indicates room for further policy and market interventions to accelerate clean energy adoption.

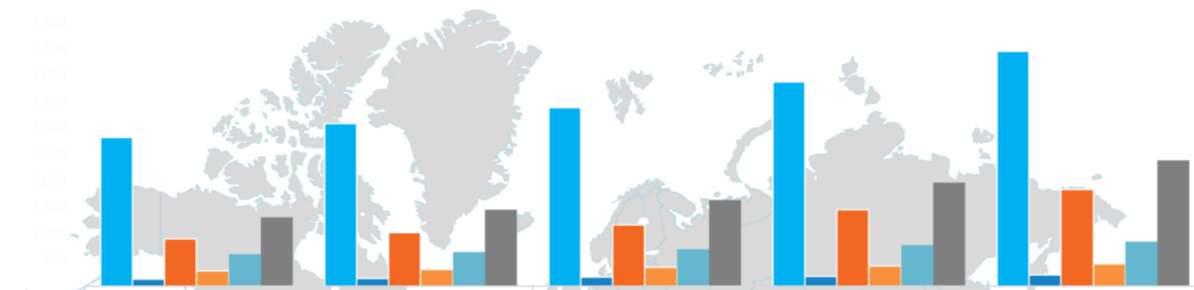
India demonstrated notable progress as a developing economy in FY2025, with a total installed power generation capacity of 475 GW, of which 220 GW comes from renewables. The renewable share in India was 46%, positioning it competitively among emerging markets and reflecting its ambitious national renewable energy targets.

Europe region had a total installed power capacity of 1,410 GW in CY2024, with 849 GW from renewables, representing approx. 60% share. Backed by the European Green Deal and REPowerEU plan, the region continues to lead in clean energy through a diversified mix of solar, wind, biomass, and hydropower, though challenges like grid integration and permitting delays remain.

3.10.2. Renewable capacity additions in India vs major economies

The global renewable energy industry has maintained strong momentum, fuelled by ambitious decarbonization targets, rapid technological progress, and favourable policy support. As shown in the figure 3.10, global renewable energy cumulative capacity additions recorded a compound annual growth rate (CAGR) of 12.1% between CY2020 and CY2024, rising from approximately 2,813 GW in CY2020 to 4,448 GW in CY2024.

Figure 3.10.2: Renewable energy cumulative capacity additions, India vs Major economies, GW, CY2020 – CY2024



	CY2020	CY2021	CY2022	CY2023	CY2024
World	2,813	3,076	3,379	3,863	4,448
India	137	155	171	191	220
China	896	1,018	1,156	1,454	1,827
US	294	327	354	385	428
Europe	606	647	705	779	849
Asia	1,301	1,456	1,631	1,961	2,382

World	India	China	USA	Europe	Asia
CAGR (CY20-24): 12.1%	CAGR (FY21-25): 12.7%	CAGR (CY20-24): 19.5%	CAGR (CY20-24): 9.9%	CAGR (CY20-24): 8.8%	CAGR (CY20-24): 16.3%

Source: IRENA, Frost & Sullivan Analysis

China remains the leader in renewable capacity additions, reflecting its significant investments in solar and wind projects, and its strong domestic manufacturing ecosystem. Between CY2020 and CY2024, China's annual additions grew at a CAGR of 19.5%, from 896 GW to 1,827 GW, underscoring its commitment to achieve carbon neutrality by 2060. Asia (including China and India) has emerged as a strong contributor to renewable energy growth, with cumulative capacity additions rising from 1,301 GW in CY 2020 to 2,382 GW in CY 2024 at a CAGR of 16.3% between CY2020 and CY2024. Notably, Japan (132 GW), Vietnam (49 GW), and South Korea (36 GW) played key roles in driving this expansion across Southeast Asia region.

India, while contributing a smaller absolute share of cumulative renewable capacity additions compared to China and the broader Asian region, recorded a healthy CAGR of 12.7%, outpacing some developed nations as it grew from 137 GW in FY2021 to 220 GW in FY2025. This growth in the renewable energy capacity addition reflects India's focused efforts under its Nationally Determined Contributions (NDCs)[6] and the government's target of achieving 500 GW of installed non-fossil fuel capacity by 2030. The consistent pace of additions is driven by policy measures such as competitive auctions for renewable energy projects and improving cost economics, despite challenges related to land acquisition and grid integration.

[6] https://unfccc.int/sites/default/files/NDC/2022-06/INDIA%20INDC%20TO%20UNFCCC.pdf

Among developed economies, Europe and the US Figure comparatively moderate growth rates of 8.8% and 9.9%, respectively. Europe's renewable additions increased from 606 GW in CY2020 to 849 GW in CY2024, while the US renewable additions increased from 294 GW in CY2020 to 428 GW in CY2024 over the same period, reflecting a continued but more incremental trajectory reflecting the maturity of these markets and ongoing challenges related to grid modernization.

3.10.3. Overview of Solar energy sector in India

Evolution of Solar Power in India

India possesses significant solar energy potential, with an estimated 5,000 trillion kWh of solar radiation falling annually across its landmass. Most regions receive between 4 to 7 kWh of solar energy per square meter per day, making solar a highly viable resource for the country. Solar Photovoltaic (PV)based power can be harnessed at a utility scale and also on distributed basis to meet demand for power, heating, and cooling in both rural and urban areas. This also provides energy security in the current geopolitical scenario due to its abundant availability.

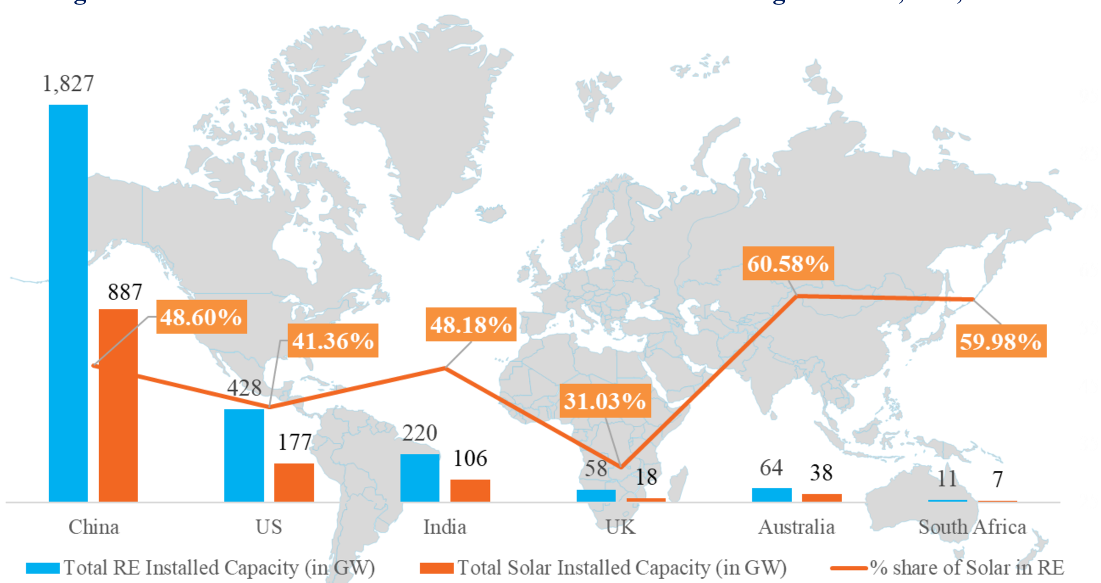
There has been a visible impact of solar energy in the Indian energy scenario - millions of people have benefitted from Solar in Indian villages by meeting their cooking, lighting, and other energy needs. Further, Solar has emerged as the fastest growing power generation technology.

National Institute of Solar Energy (NISE) has assessed the country's solar potential of about 749 **Gigawatt peak** (GWp) assuming 3% of the waste land area to be covered by Solar PV modules. In FY2025, the top five states Rajasthan, Jammu & Kashmir, Maharashtra, Madhya Pradesh, and Andhra Pradesh account for approximately 56% of this potential.

Solar energy is a core pillar of India's low carbon development strategy and a key enabler for Net Zero Emissions achievement by CY2070

3.10.4. Solar contribution in Renewable energy sector in India vs Other leading countries

Figure 3.10.3: Solar contribution in RE in India vs Other leading countries, GW, CY2024



Note: China and US values are for CY2024, whereas the values for India correspond to FY2025

Source: IRENA, Frost & Sullivan Analysis

In CY 2024, China leads with 1,827 GW of total renewable capacity, of which 887 GW is solar installed capacity, accounting for approx. 49%. In FY2025, India shows a similar trend with solar contributing approx. 48% of its 220 GW renewable portfolio, driven by strong policy support. The US recorded approx. 41% solar share within 428 GW installed capacity of renewable energy, indicating moderate penetration. Australia and South Africa stand out with the highest solar contribution in total renewable installed capacity with 60.58% and 59.98%, respectively, reflecting heavy reliance on solar due to abundant sunlight and limited alternative resources. The UK, at 31.03%, has the lowest solar share in its renewable energy installed capacity among these countries, highlighting regional differences in resource availability and energy strategies. Overall, the data highlights solar's growing dominance, particularly in sun-rich regions and emerging markets.

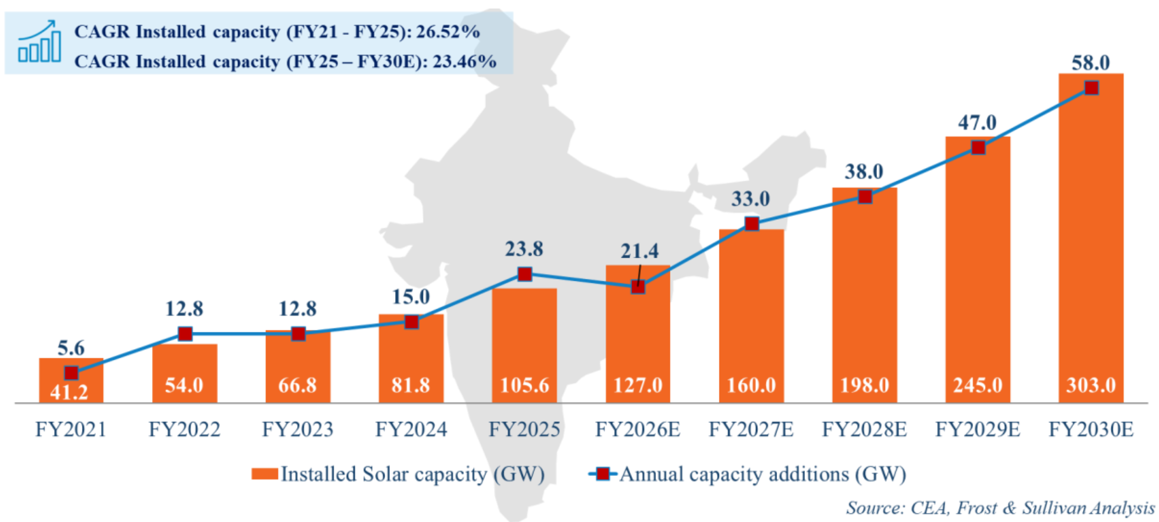
3.10.5. Assessments of Solar capacity additions in India

India's Solar installed capacity has grown nearly 2.6 times in the past five years, expected to reach nearly 303 GW by FY2030

India's strategic location in the solar belt, spanning from 40 Degree North to 40 Degree South, positions it as one of the world's prime recipients of solar energy, boasting abundant availability of sunlight throughout the year. The nation's commitment to solar energy is evidenced by a remarkable increase in installed solar capacity, which has grown from 41 GW in FY2021 to 106 GW in FY2025.

The transition to solar energy has not only contributed to environmental sustainability but also yielded significant economic benefits. Based on various demand and supply side measures, the country is well on course to achieve nearly 303 GW of Solar capacity at the end of FY2030.

Figure 3.10.4: Growth in Solar installed capacity, India, GW, FY2021 – FY2030E



Source: CEA, Frost & Sullivan Analysis

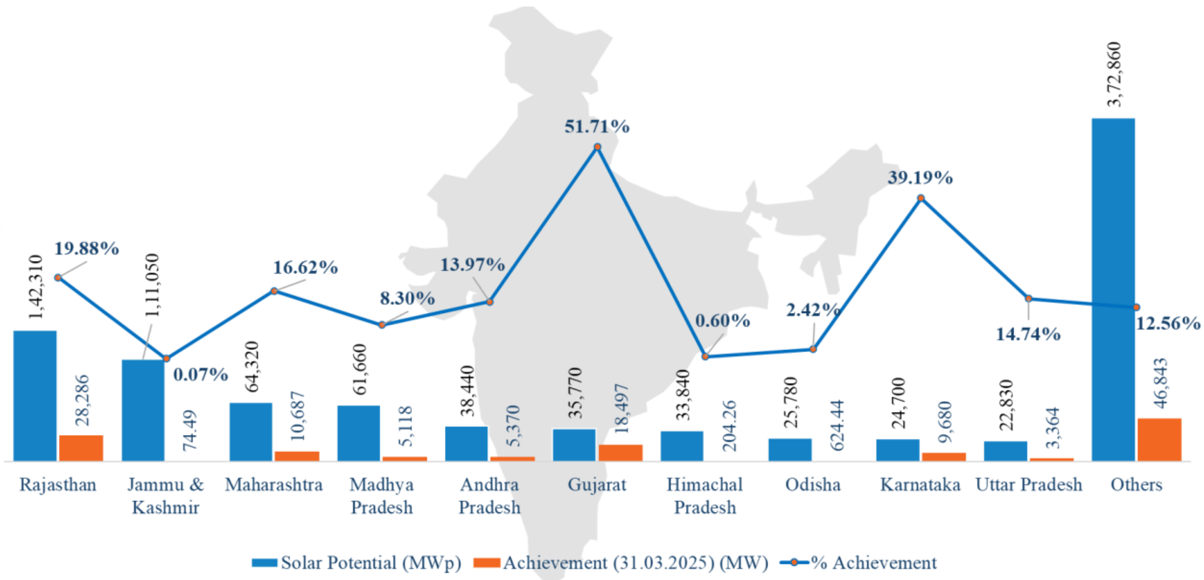
3.10.6. Growth in India's solar capacity additions

Rajasthan, Gujarat, Maharashtra, Karnataka, and Tamil Nadu collectively contribute over 70% of India's total installed solar capacity as on FY2025, highlighting their leadership in the country's solar journey.

As per the recent data published by CEA on March 31, 2025, Rajasthan and Gujarat have emerged as frontrunners, leveraging their vast arid landscapes and high solar irradiance to scale utility-scale solar projects. However, when it comes to actual utilization of estimated solar potential, Tamil Nadu leads with a 57% realization rate in FY2025, driven by well-developed solar parks and strong industrial demand for clean energy. In FY2025, Gujarat follows closely at 52%, reflecting sustained investment and policy support whereas Punjab has achieved around 51% of its potential, thanks to innovative project models and efficient land use. Haryana, with a focus on distributed solar, has reached 45%, while Karnataka, despite its early leadership in solar adoption, stands at 39% in FY2025

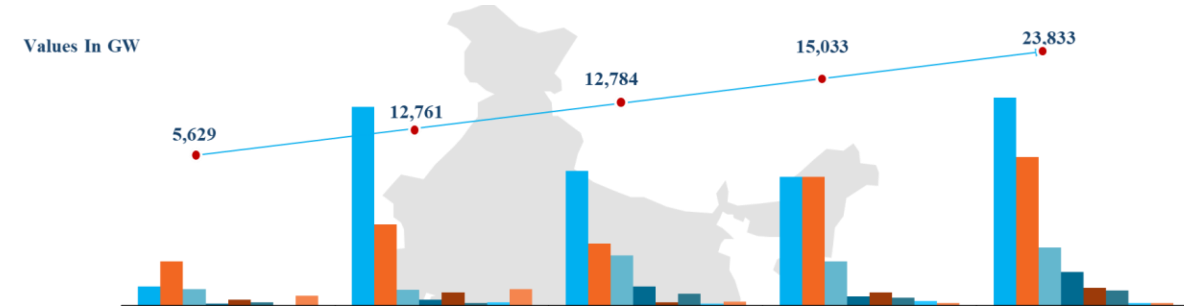
These figures highlight India's proactive approach to expanding solar energy, supported by ambitious national targets and state-level initiatives. This momentum not only strengthens energy security but also plays a critical role in reducing emissions and advancing climate goals

Figure 3.10.5: Solar energy potential and achievement of Top 10 States at the end of March 2025



Source: MNRE,PIB, Frost & Sullivan Analysis

Figure 3.10.6: Key States Contributing to Solar Power Expansion in India



	FY2021	FY2022	FY2023	FY2024	FY2025
Rajasthan	650	6,639	4,491	4,292	6,939
Gujarat	1,483	2,710	2,075	4,290	4,952
Tamil Nadu	566	540	1,669	1,475	1,942
Karnataka	78	207	651	303	1,135
Haryana	209	438	119	447	589
Kerala	115	86	398	261	516
Punjab	21	118	67	157	97
Telangana	332	559	146	92	84

Source: MNRE, Frost & Sullivan Analysis

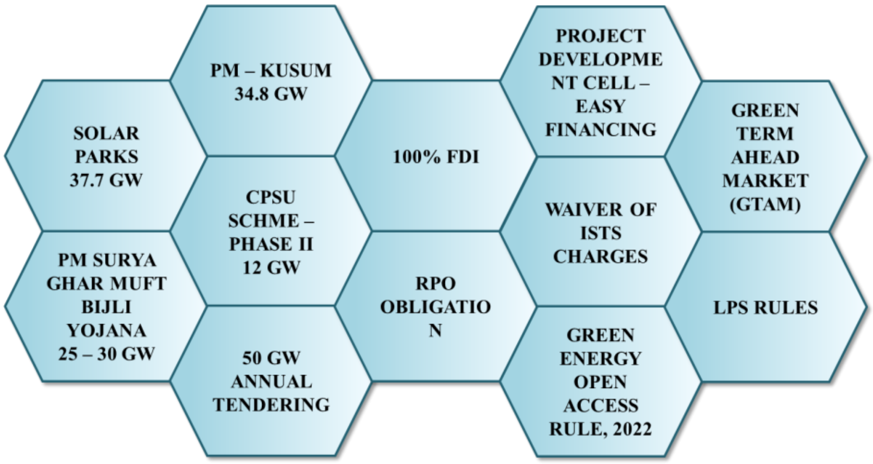
3.10.7. Policy initiatives to drive the Solar sector in India

In recent years, the Indian government has introduced a range of initiatives aimed at fostering the growth of the solar power sector. On the demand side, several schemes have been implemented to support the ambitious target of achieving 300 GW of installed solar capacity by CY2030. These measures include financial incentives for solar power adoption, such as subsidies for rooftop solar installations, as well as initiatives to encourage large-scale solar projects through competitive bidding and tariff-based incentives.

On the supply side, the government has enacted policies to attract investment in domestic solar manufacturing, with the goal of reducing reliance on imports, particularly from Chinese and Southeast Asian countries. These policies include production-linked incentives (PLI), which offer financial support to domestic manufacturers of solar components, as well as anti-dumping measures aimed at protecting local producers from unfair competition. Together, these efforts aim to strengthen India's solar manufacturing ecosystem while ensuring the country meets its renewable energy goals.

3.10.8. Demand side measures for the promotion of solar energy in the country

Figure 3.10.7: Demand side measures for the promotion of Solar energy in the country



Source: Frost & Sullivan Research & Analysis

A. Solar Parks – ~40 GW

This scheme underscores India's commitment to solar energy, aiming to establish 51 Solar Parks each of 500 MW and above by 2025-26, with a cumulative capacity of ~40 GW.

Figure 3.10.8: State-wise Solar Park sanctioned capacity and commissioned capacity, MW, As of 28 February 2025

Name of State/UT	Sanctioned Capacity (MW)	Project Commissioned (28.02.2025) (MW)	No of Parks
Gujarat	12,150	1,000	7
Rajasthan	10,276	3,241	10
Andhra Pradesh	4,200	3,187	5
Madhya Pradesh	4,330	2,313	8
Uttar Pradesh	3,840	430	9
Karnataka	2,500	2,000	2
Jharkhand	1,089	0	3
Maharashtra	1,105	0	4

Kerala	255	105	3
Chhattisgarh	100	100	1
Himachal Pradesh	53	0	1
Odisha	40	0	1
Mizoram	20	20	1
Total	39,958	12,396	55

These parks will serve as pivotal hubs for solar energy generation, stimulating investments and fostering an environment conducive to solar power development, thereby enhancing affordability and accessibility. Till the end of February 2025, 55 Solar parks with an aggregate capacity of approx. 40 GW have been sanctioned in 13 states in the Country, out of which solar projects of aggregate capacity 12.39 GW have been commissioned in various solar parks in the country.[78]

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

On 29th February 2024, the Government of India approved the PM Surya Ghar: Muft Bijli Yojana and it received administrative approval on 16th March 2024. The purpose of this scheme is to boost rooftop solar adoption and empower Indian households to generate their own electricity.

A National Programme Implementation Agency (NPIA) oversees execution at the central level, while State Implementation Agencies (SIAs), primarily DISCOMs or relevant power departments manage state-level rollout.

With an allocation of over INR 750 Bn, the scheme provides capital subsidies to install rooftop solar panels and offers up to 300 units of free electricity per month to about 10 Mn households and is to be implemented till FY 2026-27. As of August 5, 2025, approximately 1.67 million households have benefited from rooftop solar installations under the scheme, and a total of INR 92.8 Bn has been disbursed as Central Financial Assistance (CFA) to support these beneficiaries[9]

The goal of this scheme is to reduce household electricity costs, promote sustainable energy practices, and decrease reliance on traditional energy sources. The scheme requires the use of Domestic Content Requirement (DCR) solar modules. The government has proposed providing the below subsidies to various Indian households for the implementation of this programme:

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

This scheme is expected to generate 25–30 GW of rooftop solar installation opportunities over the next 2-3 years

C. PM-KUSUM Scheme – ~35 GW

The Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) aims to reduce diesel use in farming, enhance water and energy security, increase farmer income, and reduce pollution. Solar water pumps use solar energy to pump water, offering a clean, efficient alternative to diesel-powered systems. They reduce carbon footprints, require minimal maintenance

The PM Kusum Scheme targets to add ~35 GW of solar power by March 2026 with central financial support of INR 344 Bn.

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7 https://sansad.in/getFile/loksabhaquestions/annex/183/AU2647_YPLiLe.pdf?source=pqals
8 https://sansad.in/getFile/annex/267/AU3498_Sf47Hz.pdf?source=pqars
9 https://www.ptinews.com/editor-detail/Over-16-7-lakh-households-benefitted-under-solar-scheme--Rs-9-000-cr-disbursed--Parl-told/2815759

The three components of the scheme are:

- **Component A:** Setting up of 10,000 MW of decentralized ground/stilt mounted solar power plants on barren/fallow/pasture/marshy/cultivable land of farmers. Such plants can be installed by individual farmer, solar power developer, cooperatives, panchayats, and farmers producer organizations.
- **Component B:** Installation of 1.4 Mn stand-alone Solar Water Pumps in off-grid areas. As part of the scheme's expansion and refinement based on pilot phase learnings, the target for stand-alone solar agricultural pumps under PM-KUSUM was revised from 1.4 Mn to 1.75 Mn, with the updated guidelines issued around late 2023 to early 2024.[10,11]
- **Component C:** Solarization of 3.5 Mn grid connected agriculture pumps through (i) Individual Pump Solarization and (ii) Feeder Level Solarization. In 2023, the Department of Expenditure (DoE) revised the target under Component C of the Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM) scheme to 4.9 Mn grid-connected agriculture pumps, including feeder-level solarization.

Figure 3.10.9: Snapshot of Installed Pumps under various Compoinents as of 31.07.2025

<table>
<tr><th>Component</th><th>Target</th><th>Sanctioned</th><th>Installed</th></tr>
<tr><td>Component A: Ground/Stilt Mounted Solar Power Plants</td><td>10,000 MW</td><td>10,000 MW</td><td>640.99 MW</td></tr>
<tr><td>Component B: Standalone Solar Water Pumps</td><td>17,50,000 Solar Pumps</td><td>12,72,758 Solar Pumps</td><td>8,53,330 Solar Pumps</td></tr>
<tr><td>Component C: Solarization of Grid-Connected Agriculture Pumps through Individual Pump Solarization</td><td rowspan="2">49,00,000 Solar Pumps</td><td>60,828 Solar Pumps</td><td>8,966 Solar Pumps</td></tr>
<tr><td>Component C: Solarization of Grid-Connected Agriculture Pumps through Feeder Level Solarization</td><td>35,61,855 Solar Pumps</td><td>6,45,975 Solar Pumps</td></tr>
</table>

Source: PM Kusum Portal, PIB, Press Notes, Frost & Sullivan analysis

The scheme has been extended until March 2026, providing additional time to accelerate implementation and meet its ambitious targets.

D. CPSU Scheme – Phase II – 12 GW

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

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

[10] https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1989815#:~:text=Major%20steps%2C%20including%20new%20initiatives,provide%20subsidized%20loans%20to%20farmers
[11] https://www.india.gov.in/spotlight/pm-kusum-pradhan-mantri-kisan-urja-suraksha-evam-utthaan-mahabhiyan-scheme

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

E. Production Linked Incentive (PLI)

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

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

F. 50 GW Annual Tendering

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

G. 100% Foreign Direct Investment (FDI)

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

H. Project Development Cell

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

I. Waiver of ISTS charges

In March 2023, the Central Electricity Regulatory Commission (CERC) amended the CERC (Sharing of Inter-State Transmission Charges and Losses) Regulations, 2020. This amendment waives ISTS charges for renewable energy and pumped hydroelectric projects that begin commercial operations by June 30, 2025. The waiver also applies to any solar, wind, or other sources eligible for waiver of inter-state transmission charges, which are scheduled to be commissioned on or before June 30, 2025.

J. Green Energy Open Access Rules, 2022

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

Key Provisions of the rules are:

- **Minimum Consumption Threshold:** Only large consumers with a minimum contract demand or sanctioned load (typically 100 kW or more) can avail of Green Open Access.
- **Streamlined Process:** The rules aim to simplify the process for obtaining approvals and entering into agreements for direct purchase of renewable energy.
- **Green Certificates:** Consumers who purchase renewable energy through Green Open Access are eligible for green certificates, which can be used to meet their Renewable Purchase Obligation (RPO).
- Benefits for Solar Power are:
- **Increased Demand:** By creating a new market segment for large consumers, the policy can significantly increase demand for solar power.
- **Economic Advantages:** Large consumers might benefit from potentially lower prices through direct purchase and avoid some distribution charges.

K. Green Term Ahead Market (GTAM)

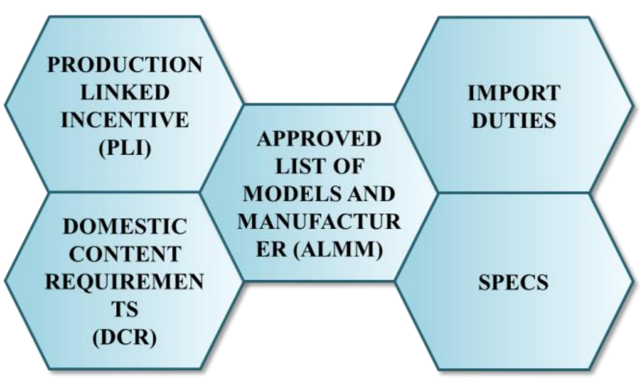
The Green Term Ahead Market (G-TAM) is a platform that allows bulk buyers of electricity to purchase renewable energy (RE) on a short-term basis. The G-TAM allows buyers such as corporates and discoms with a contracted load of 1 MW or more to purchase RE from sellers such as merchant RE projects or discoms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

L. LPS Rules (Late Payment Surcharge)

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

3.10.9. Supply side measures for the promotion of solar energy in the country

Figure 3.10.10: Supply side measures to strengthen domestic Solar manufacturing industry



Source: Frost & Sullivan Research & Analysis

A. The PLI Scheme

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

- **Tranche-I:** Under this tranche, Indian Renewable Energy Development Agency Limited (IREDA), the implementing agency on behalf of MNRE for the PLI Scheme, issued Letters of Award (LOA) in November and December 2021 to three successful bidders for setting up of 8,737 MW capacity of fully integrated Solar PV Module manufacturing units with an outlay of INR 45 Bn.
- **Tranche-II:** MNRE, on 30th September 2022, issued guidelines for implementation of Tranche-II with an outlay of INR 195 Bn. In this tranche, Solar Energy Corporation of India (SECI), the implementing agency on behalf of MNRE, issued Letters of Award (LOA) to 11 bidders in April 2023 for setting up 39,600 MW of fully / partially integrated solar PV module manufacturing units.

B. Domestic Content Requirement (DCR)

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

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

The policy applies to grid-connected solar power plants, rooftop solar installations on government-backed or subsidized projects, and off-grid solar solutions. In August 2022, the Ministry waived DCR requirements for projects awarded before June 20, 2023 which was further extended March, 2024. To further ensure adherence to DCR, the Indian government plans to set up a data repository to monitor compliance and curb imports.

C. Approved List of Models and Manufacturers (ALMM)

The ALMM program establishes a pre-approved list of reliable solar photovoltaic (PV) modules and cell manufacturers. This program ensures quality and efficiency of solar installations in India by requiring developers and investors to source their equipment from ALMM-listed vendors. By promoting high-quality domestic and imported products, ALMM fosters trust and encourages the adoption of reliable solar solutions throughout the country. The ALMM policy was introduced in April 2022 and after being under suspension for FY2024, the policy is again in effect from April 1, 2024. As on March 2025, the module manufacturing capacity in India is around 77 GW and ALMM list still does not mention any foreign manufacturer. The ALMM program, by ensuring that solar photovoltaic (PV) modules and cell manufacturers meet high-quality standards, indirectly benefits fixed tilt solar structural component manufacturers. Since the program requires developers and investors to source equipment from ALMM-listed vendors, it promotes the use of reliable and efficient solar products. This focus on quality encourages the deployment of solar installations, including fixed tilt structures, which are commonly used in such projects. Additionally, with the exclusion of foreign manufacturers from the current ALMM list, there is likely to be an increased demand for domestically produced modules and, consequently, for locally manufactured fixed tilt structural components that support these installations.

In June 2026, the Government of India introduced updated guidelines under ALMM-II, mandating the use of domestically manufactured solar cells in module production. This policy shift is expected to significantly boost demand for locally produced solar cells, strengthening the domestic solar manufacturing ecosystem and reducing reliance on imports.

On July 10, 2025, the Ministry of New & Renewable Energy (MNRE) issued a crucial clarification regarding the applicability of the Approved List of Models and Manufacturers (ALMM) to behind-the-meter solar PV projects, particularly those implemented by government bodies and public sector enterprises. While government solar projects have been under the ALMM framework since January 2019, and Net-Metering and Open Access projects were added in 2022, an earlier clarification issued in October 2022 had exempted behind-the-meter systems used solely for captive consumption by private consumers from ALMM compliance.

This exemption led to ambiguity about whether it also applied to government and public sector entities using similar behind-the-meter systems which is further clarified by MNRE on May 16, 2025, confirming that government and public sector projects are not exempt from ALMM requirements, even for behind-the-meter installations.

The July 2025 clarification further specifies that such projects must use ALMM-listed solar PV modules in all cases. However, solar PV cells from the ALMM list are only mandatory for projects commissioned on or after June 1, 2026. Projects commissioned before this date under RESCO or CAPEX models for self-consumption are exempt from the solar cell requirement.

This clarification reinforces the government's commitment to quality assurance and domestic manufacturing, while also providing transitional relief for projects already in the pipeline.

D. Import Duties

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

In the Union Budget 2025, the Government of India has also reduced the Basic Customs Duty (BCD) on imported solar cells from 25% to 20%, and on solar modules from 40% to 20%.

New Customs Duties introduced in Oct 2024: A 10% basic customs duty (BCD) on solar glass and a 5% BCD on tinned copper interconnects for solar cells and modules came into effect from October1, 2024.

3.10.10. Innovative tenders adopted by MNRE

The Ministry of New and Renewable Energy (MNRE) has introduced a range of forward-looking programs to accelerate the adoption of rooftop solar (RTS) and distributed renewable energy (DRE) technologies.

A. Start-Up Innovation Challenge for Solar and Distributed Energy:

This initiative is designed to accelerate the deployment of clean energy technologies by identifying and supporting high-impact innovations. The program is being carried out in collaboration with the National Institute of Solar Energy (NISE) and Startup India. This is an INR 23 Mn innovation challenge aimed at encouraging start-ups to develop cutting-edge solutions in rooftop solar and distributed renewable energy.

B. Proposal Call for Circular Economy in Renewable Energy:

The Ministry of New and Renewable Energy (MNRE) launched a call for proposals in June 2025, focused on circular practices within the renewable energy sector[12] to promote sustainability, particularly targeting solar PV and battery technologies. This initiative seeks innovative approaches for recycling, reusing, and managing waste, aligning with the broader goal of creating a resource-efficient and environmentally responsible energy ecosystem.

C. Launch of Innovative Project Component under PM Surya Ghar Scheme:

The Ministry of New and Renewable Energy (MNRE) has invited proposals in May 2025 for innovative solar projects under the "PM Surya Ghar: Muft Bijli Yojana," and is set to run through FY 2026–27. The scheme received

[12] https://www.saurenergy.com/solar-energy-news/mnre-seeks-innovative-ideas-for-boosting-circularity-in-re

administrative approval on 16th March 2024, with specific guidelines for the "Innovative Projects" component issued on 8th October 2024. This initiative aims to demonstrate novel solar technologies, applications, or integration methods that can accelerate industry growth and adoption across the country.[13]

3.10.11. Climate related initiatives taken by India

1. India NDC declarations and COP commitments:

India has been at the forefront in taking actions for combating climate change while meeting its development and growth aspirations. Building upon the Prime Minister's Panchamrit (five nectar elements) pledges at the 26th Conference of Parties (COP26) of the UNFCCC in Glasgow, including the target of net-zero emissions by CY2070, India updated its Nationally Determined Contributions (NDC) in August 2022 as follows:

a) Meet 50% of India's cumulative electric power installed capacity from non-fossil sources by CY2030.
b) Reduce the emission intensity of GDP by 45% below CY2005 levels by CY2030.
c) Put forward and further propagate a healthy and sustainable way of living based on the traditions and values of conservation and moderation, including through a mass movement for LiFE – Lifestyle for Environment as a key to combating climate change.

As India aspires to become carbon neutral by CY2070, low-carbon development of energy systems would be a critical contributor to this journey. To achieve this goal, India is aiming to rapidly expand its renewable energy capacity to 500 GW by CY2030 – Solar would account for 60% of this capacity or 300 GW and the same would be enabled through Policy and financial incentives including solar park development, accelerated depreciation on investment, waiver on transmission charges, and capital subsidy for residential solar roof-top, and agricultural solar pumps.

2. **CEA Generation Mix Plan till 2032:** The Central Electricity Authority (CEA) plan for India's electricity generation mix till 2032, with a strong emphasis on clean energy penetration

India aims to achieve 500 GW of renewable energy capacity by 2030, and over 600 GW by 2032.

The projected non-fossil fuel-based capacity by 2031-32 is 653 GW, which includes:

- Solar: 385 GW (including 60 GW rooftop)
- Wind: 165 GW
- Hydro: 62.8 GW
- Nuclear: 19.6 GW
- Biomass: 15.5 GW
- Small Hydro: 5.4 GW[14]

a) **Total Installed Capacity:** The total installed electricity generation capacity is expected to reach 997 GW by 2031-32.
b) **Grid Integration & Stability:** To manage the intermittent nature of renewable energy, CEA plans to implement:
    - 47 GW of Battery Energy Storage Systems (BESS)
    - 31 GW of Pumped Storage Plants
    - Use of STATCOMs (Static Synchronous Compensators) for voltage regulation and grid stability

a) **Transmission Infrastructure**

CEA plans 613 GW of transmission capacity to support renewable energy integration. This includes over 1,91,000 circuit kilometers of transmission lines and 1,270 GVA of transformation capacity. An investment of ₹9.15 lakh crore is projected in the transmission sector till 2032.

[13] https://mnre.gov.in/en/notice/call-for-proposal-for-innovative-projects-component-under-pm-surya-ghar-muft-bijli-yojana/
[14] https://www.thehindubusinessline.com/specials/clean-tech/cea-plans-613-gw-re-transmission-capacity/article68803265.ece

b) **Green Hydrogen & Industrial Hubs** Power delivery is planned for green hydrogen and ammonia hubs at coastal locations such as Mundra, Kandla, and Vizag.[15]

3.11. SOLAR STREET LIGHTING MARKET

3.11.1. Solar Street Lighting: Market Overview

India's solar street lighting sector has witnessed significant growth over the past decade, transitioning from basic installations in remote areas to sophisticated, technology-driven solutions integrated into urban infrastructure. This evolution is primarily attributed to a combination of supportive government initiatives, technological advancements, and a growing emphasis on sustainability.

Government Initiatives and Policies

The Indian government has been instrumental in promoting solar street lighting through various schemes and policies:

- **Atal Jyoti Yojana (AJAY):** Initiated in 2016, AJAY aimed to provide solar streetlights in areas with less than 50% grid connectivity. The program has seen multiple phases, each expanding its reach and impact across various states.
- **Off-Grid and Decentralized Solar PV Applications Programme:** This initiative focuses on providing solar solutions in off-grid areas, including solar street lighting systems, thereby enhancing energy access in remote regions.
- **Smart Cities Mission:** Under this initiative, urban areas are adopting solar street lighting as part of their infrastructure development, integrating features like remote monitoring and automated operations.
- **State-Level Schemes:** Various states have introduced their own programs to promote solar street lighting. For instance, Punjab's Mukhyamantri Street Light Yojana, Bihar's Mukhyamantri Gramin Solar Street Light Yojana, and Haryana's Manohar Jyoti Scheme have been instrumental in deploying solar streetlights in rural areas.

In addition to these initiatives, the MNRE's Off-Grid & Decentralised Solar PV Applications Programme (Phase-III) provides central financial assistance linked to MNRE benchmark costs — typically around 30% of benchmark cost for general category states, with up to 90% support for North-Eastern, hilly and island/UT regions as per scheme guidelines. For the Atal Jyoti Yojana (AJAY), earlier phases were implemented with MNRE bearing 75% of project cost while the balance was met through MPLADS/ local funds or ULB contributions. (MNRE; EESL/PIB).

Technological Advancements

Advancements in technology have played a pivotal role in the proliferation of solar street lighting systems:

- **Photovoltaic (PV) Technology:** The efficiency of solar panels has improved, leading to better energy conversion rates and reduced costs. This has made solar street lighting systems more viable and cost-effective.
- **LED Technology:** The adoption of LEDs in street lighting has resulted in significant energy savings due to their high efficiency and longer lifespan compared to traditional lighting solutions.
- **Battery Storage Solutions:** Improvements in battery technology have enhanced the reliability and autonomy of solar street lighting systems, ensuring consistent illumination even during periods of low sunlight.

These technological advances have not only reduced the cost of solar street lighting systems but have also improved their performance and reliability, making them a preferred choice for urban and rural lighting needs.

3.11.2. Evolution and Policy Landscape of Solar Street Lighting in India

India's street lighting infrastructure has undergone a significant transformation in recent years, driven by the dual imperatives of enhancing public safety and promoting environmental sustainability. Traditional grid-based street

[15] https://energy.economictimes.indiatimes.com/news/power/india-targets-500-gw-renewable-energy-by-2030-plans-9-15-lakh-crore-investment-in-transmission/114233479

lighting systems, characterised by high energy consumption and maintenance costs, have given way to more efficient and eco-friendly alternatives. Among these, solar-powered street lighting has emerged as a frontrunner, offering a sustainable solution that aligns with the nation's renewable energy goals.

A. Solar Policies in India

Off-Grid & Decentralized Solar PV Applications Programme (MNRE)

- This is one of the broad umbrellas under which solar street lighting is supported across India, especially in areas without reliable grid connection. It targets remote, rural, and special category regions.
- Under Phase-III of this programme, streetlights are eligible for Central Financial Assistance (CFA) of ~30% of benchmark cost (or tender cost whichever is lower) in general states; ~90% in Northeastern, hilly States/UTs and islands.
- As of July 2020, about 7.4 lakh solar streetlights had been installed under this off-grid / decentralised scheme across India.

Atal Jyoti Yojana (AJAY)

- Launched in September 2016 by MNRE, to deploy solar streetlights in areas with less than 50% grid connectivity. Phase I covered certain states first, Phase II expanded coverage to hilly/NE/island states and aspirational districts.
- AJAY Phase-I (2016–2018) had sanctions for ~1.45 lakh SSLs, of which ~ 1.35 lakh were installed by the deadline.
- Phase-II (December 2018 to ~31 March 2021) had a target of ~1.50 lakh SSLs; ~1.37 lakh actual installations, limited by MPLADS suspension during COVID-19, supply chain delays etc.
- Cost sharing: 75% of the cost borne by MNRE, the remaining by MPLADS/local contributions. SSL units under AJAY Phase II were typically 12W LED systems.

Figure 3.11.1: Key Data Table: Major Solar Street Lighting Policies

POLICY / SCHEME	KEY FIGURES
Off-Grid & Decentralized Solar PV Applications Programme – Phase III	• Launch date: ~ 7 August 2018; extended till 31 March 2021. • Target for solar streetlights under Phase-III: 300,000 units. • Central Financial Assistance (CFA): ~ 30% of benchmark cost in general states; ~ 90% in North-Eastern States, Hill States/UTs, Island UTs. • Outlay: INR 1,895 crore total, with INR 637 crore as CFA under Phase III for components (streetlights + others). • Actual installed solar streetlights under all off-grid / decentralised programmes (all phases, not just Phase-III): ~ 9,44,802 SSLs as of Dec 2022.
Atal Jyoti Yojana (AJAY) Phases I & II	• Start: September 2016 (Phase I); Phase II commenced December 2018. • Target under Phase II: ~ 1.50 lakh SSLs. • Actual installations: ~ 1.37 lakh SSLs under Phase II; total across phases ~ 2.72 lakh SSLs.

B. State-Level Solar Street Lighting and Decentralized Solar Initiatives

1. Maharashtra – Swayampurna Maharashtra Residential Rooftop (SMART) Solar Scheme

Launch Date: 2025

Objective: To provide additional subsidies for rooftop solar installations targeting domestic consumers with monthly electricity usage below 100 units, especially Below Poverty Line (BPL) and economically weaker sections.

Key Features:

- 35% subsidy for BPL consumers, 20% for economically weaker general consumers, and 30% each for Scheduled Caste (SC) and Scheduled Tribe (ST) communities.
- For a 1 kW system costing ₹50,000, BPL consumers will pay only INR 2,500.
- A total of five lakh consumers are expected to benefit, including 1.54 lakh BPL families and 3.45 lakh economically weaker users.
- The scheme has a budget allocation of INR 655 crore over two years (FY 2025–27).
- Implementation is managed by the Maharashtra State Electricity Distribution Company Limited (MSEDCL), focusing on underdeveloped areas like Melghat, Chandrapur, and Gadchiroli.

2. Kerala – Rooftop Solar Fee Waiver under PM Surya Ghar Muft Bijli Yojana

Launch Date: 2025

Objective: To promote rooftop solar adoption by waiving application and registration fees for consumers under the PM Surya Ghar Muft Bijli Yojana.

Key Features:

- The Kerala State Electricity Board (KSEB) has decided to waive all application and registration fees for rooftop solar units under the scheme.
- The central government has allocated ₹4,950 crore to support this initiative, with KSEB receiving ₹172 crore as part of the incentive package.

3. Haryana – LED-Based Solar Street Lighting Systems

Launch Date: 2024

Objective: To promote the installation of LED-based solar street lighting systems in the state.

Key Features:

- State subsidy of INR 4,000 per solar street lighting system and INR 20,000 per solar high mast lighting system.
- The total cost per unit for LED-based solar street lighting systems is INR 16,500, with a user share of INR 12,500.
- The total cost per unit for solar high mast lighting systems is INR 1,03,265, with a user share of INR 83,265.
- The scheme aims to install 9,000 LED-based solar street lighting systems and 600 solar high mast lighting systems.

4. Manohar Jyoti Scheme

The Manohar Jyoti Scheme was launched by the Government of Haryana to enhance rural electrification through solar-powered lighting systems. This initiative aims to provide sustainable and cost-effective lighting solutions to underserved areas, thereby improving the quality of life for rural communities.

Launch and Objectives

The scheme was officially launched in 2016 by the Haryana Renewable Energy Department (HAREDA). Its primary objectives include:

- **Promoting Renewable Energy**: Encouraging the use of solar energy to reduce dependence on conventional power sources.
- **Improving Rural Infrastructure**: Enhancing street lighting in rural areas to support safety and development.
- **Economic Empowerment**: Providing affordable lighting solutions to rural households, thereby reducing energy costs.

Target and Achievements

The scheme aims to install solar-powered lighting systems across various rural regions of Haryana. As of the latest reports, significant progress has been made in implementing the scheme, with numerous installations completed and more planned for the future

5. Bihar – Mukhyamantri Gramin Solar Street Light Scheme

Launch Date: September 2022

Objective: To install over one million solar streetlights in rural areas to improve public safety and infrastructure.

Key Features:

- The scheme aims to install ten solar lights in each of the 1.15 lakh wards of 8,053 gram panchayats across the state, totaling over one million solar streetlights.
- As of August 2024, approximately 203,223 solar streetlights had been installed, representing about 20% of the target.

6. Uttar Pradesh – Solar-Powered Street Lights in Ayodhya

Launch Date: January 2024

Objective: To set a world record by installing the longest line of solar-powered streetlights.

Key Features:

- Installation of 470 solar-powered streetlights over a stretch of 10.2 km connecting Guptar Ghat to Laxman Ghat.
- For the fiscal year 2024-25, plans included the installation of 150 smart solar streetlights, 1,100 solar streetlights, and 75 solar high masts in Ayodhya
- The project was executed under the Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA).

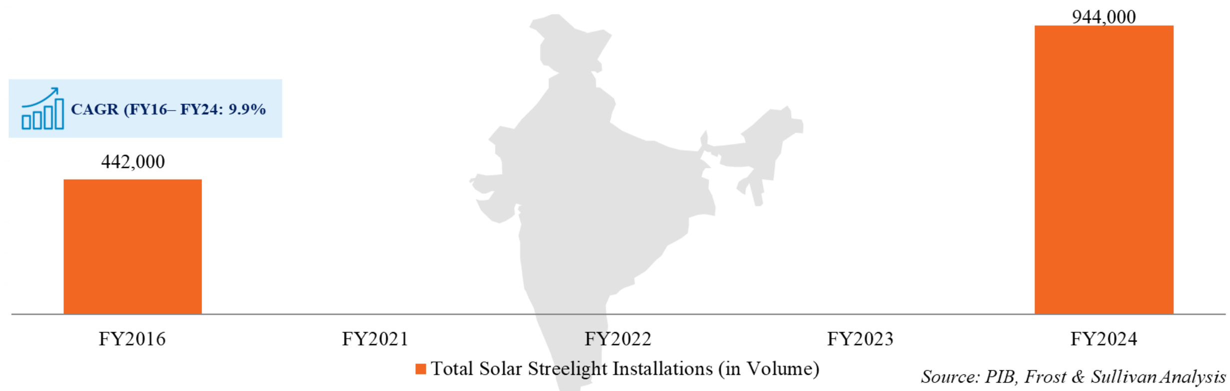
3.11.3. Solar Street Light Installations

(i) Current installed streetlights

Over the period from 2016 to 2024, India's solar street lighting sector has evolved significantly, transitioning from a primarily rural electrification initiative to a key component of sustainable urban and rural infrastructure. National schemes such as the Atal Jyoti Yojana and the Off-Grid and Decentralised Solar PV Applications Programme have been instrumental in promoting adoption in areas with limited grid connectivity, enhancing energy access, safety, and quality of life in remote regions. At the same time, urban development initiatives, particularly under the Smart Cities Mission, have integrated solar street lighting into modern city infrastructure, combining energy efficiency with smart features such as remote monitoring and automated controls.

Technological advancements in photovoltaic modules, LED lighting, and battery storage have further strengthened the reliability, performance, and cost-effectiveness of solar street lighting systems, enabling wider deployment and operational efficiency. The sector has also benefited from supportive policy frameworks, financial incentives, and streamlined implementation mechanisms, creating an environment conducive to both private and public sector participation. Collectively, these developments have positioned solar street lighting as a strategic solution that not only addresses energy and sustainability objectives but also complements India's broader goals of renewable energy adoption, climate resilience, and inclusive infrastructure development.

Figure 3.11.2: Solar streetlight installations in India, FY2016 and FY2024, in volume (cumulative)



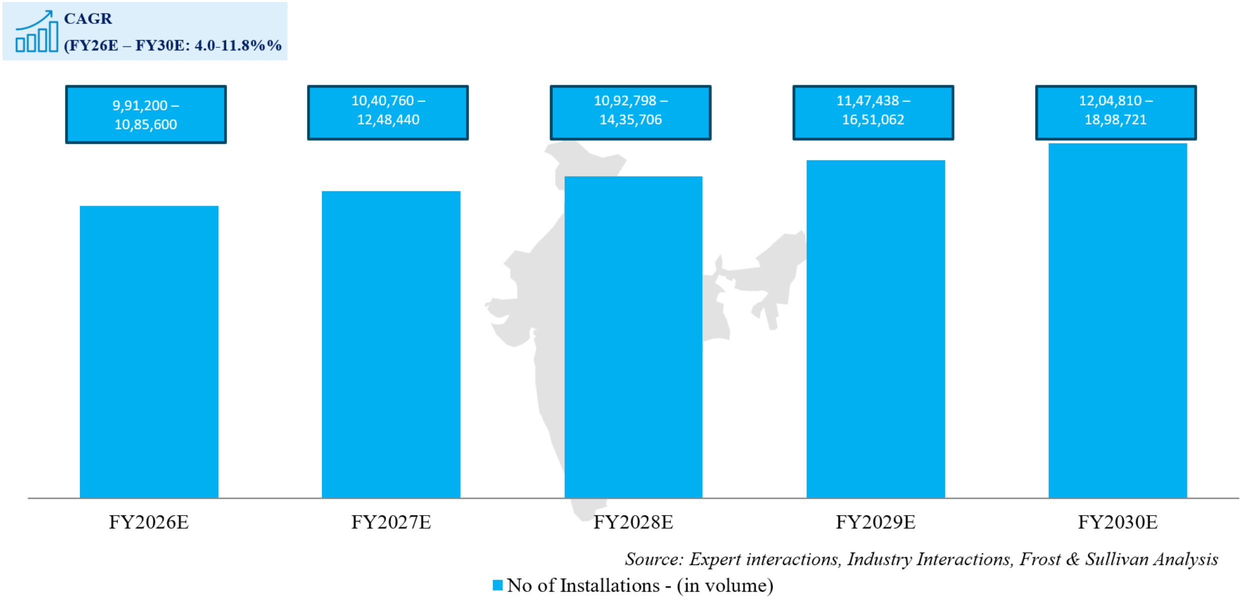
Source: PIB, Frost & Sullivan Analysis

In FY2016, India had cumulatively installed approximately 4.42 lakh solar street lights, largely concentrated in rural and off-grid areas under national initiatives like the Atal Jyoti Yojana and the Off-Grid and Decentralised Solar PV Applications Programme. These early installations focused on improving energy access, safety, and quality of life in regions with limited grid connectivity. By FY2024, the cumulative installations had grown significantly to around 9.44 lakh solar street lights, reflecting rapid adoption across both rural and urban areas. This growth was driven by continued national programs, state-level initiatives, integration into smart city infrastructure, and advancements in photovoltaic panels, LED lighting, and battery storage, which improved both performance and reliability. Over this period, solar street lighting evolved from small, localised projects to large-scale, coordinated deployments across multiple states, demonstrating the combined impact of policy support, technological progress, and strategic planning in India's renewable energy sector.

(ii) Market Outlook for Solar Streetlights

As of 2024, India had cumulatively installed approximately 9.44 lakh (944,000) solar street lights, primarily under national initiatives such as the Atal Jyoti Yojana (AJAY), the Off-Grid and Decentralized Solar PV Applications Programme, and various state-level schemes. These deployments have contributed significantly to improving energy access, public safety, and quality of life, particularly in rural and underserved regions.

Figure 3.11.3: Solar streetlight installations in India, Outlook, FY2026E to FY2030E, in volume (cumulative)



Source: Expert interactions, Industry Interactions, Frost & Sullivan Analysis

Looking ahead, the solar street lighting market is expected to continue expanding through FY2030, supported by ongoing government programs, state-level subsidy schemes, technological advancements in photovoltaic modules, LED lighting, and battery storage systems, as well as increasing integration with smart city and urban infrastructure projects.

Based on prevailing market conditions and expected policy support, India's cumulative installed base of solar street lights is projected to reach approximately 1.20–1.90 million units by FY2030, compared to 944,000 units in 2024. This represents an implied growth rate of approximately 4–12% annually over the forecast period, with actual deployment levels dependent on factors such as government funding allocations, project execution timelines, adoption across urban and rural applications, and continued improvements in technology and system economics.

These projections are demand-driven and focus on cumulative installed stock by fiscal year-end; they do not explicitly model confirmed program budgets, replacement cycles, or tender pipelines. However, they provide a clear framework for understanding potential growth under different policy, funding, and technological adoption conditions, offering a practical guide for planning and investment in India's solar street lighting sector.

(iii) Growth drivers, Restraints, and Challenges

1 Growth Drivers

1. **Government Initiatives and Policies**: The Indian government has been instrumental in promoting solar street lighting through various schemes. The Ministry of New and Renewable Energy (MNRE) has sanctioned over 1.74 lakh solar streetlights under its Off-Grid Solar PV Applications Programme Phase III, with significant installations reported in states like Uttar Pradesh and Bihar (Source: Press Information Bureau). Additionally, the Atal Jyoti Yojana (AJAY) has facilitated the installation of solar streetlights in rural areas, enhancing energy access.
2. **Financial Support and Subsidies**: Programs such as the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) and PM Surya Ghar Muft Bijli Yojana provide financial incentives, making solar street lighting more accessible to municipalities and local bodies (Source: Press Information Bureau).
3. **Energy Efficiency and Cost Savings**: Transitioning to solar-powered LED streetlights offers municipalities substantial savings on electricity bills, which can constitute up to 20% of municipal

budgets in smaller cities (Source: World Bank Blogs). These savings can be redirected to other urban development projects.

4. **Technological Advancements**: Advancements in solar panel efficiency, battery storage, and LED technology have improved the performance and reliability of solar street lighting systems, making them more viable for widespread adoption.

2 Challenges and Restraints

1. **High Initial Capital Costs:** Despite long-term savings, the upfront investment required for solar street lighting systems remains a significant barrier for many local governments, especially in economically weaker regions.
2. **Maintenance and Technical Expertise:** The need for specialised maintenance and technical expertise can be a constraint, particularly in rural areas where such resources are limited.
3. **Financing and Credit Access:** Limited access to financing and credit facilities hampers the ability of municipalities to invest in solar infrastructure
4. **Awareness and Capacity Building:** A lack of awareness about the benefits and operation of solar street lighting among local authorities and communities can impede adoption.
5. **Policy and Regulatory Barriers:** Inconsistent policies and regulatory frameworks across states can create uncertainties and delays in project implementation.

3.12. OVERVIEW OF THE WATER SECTOR IN INDIA

3.12.1. Water Scenario in India

Water is fundamental to sustainable development, serving not only as a cornerstone for human survival but also as a critical input for agriculture, industry, and energy production. In India, the challenge of managing water resources is intensifying due to rapid population growth, with the population estimated at approximately 1.46 Bn by 2025[16]. This demographic pressure is particularly acute in urban centres, where infrastructure often lags the pace of expansion. Currently, around 37% of India's population resides in urban areas, with the remainder spread across rural regions. Ensuring fair and efficient water distribution across these diverse geographies is a complex task. Urban water systems frequently draw from shared sources, creating competition with agricultural and industrial sectors. These dynamics highlight the need for integrated water management strategies.

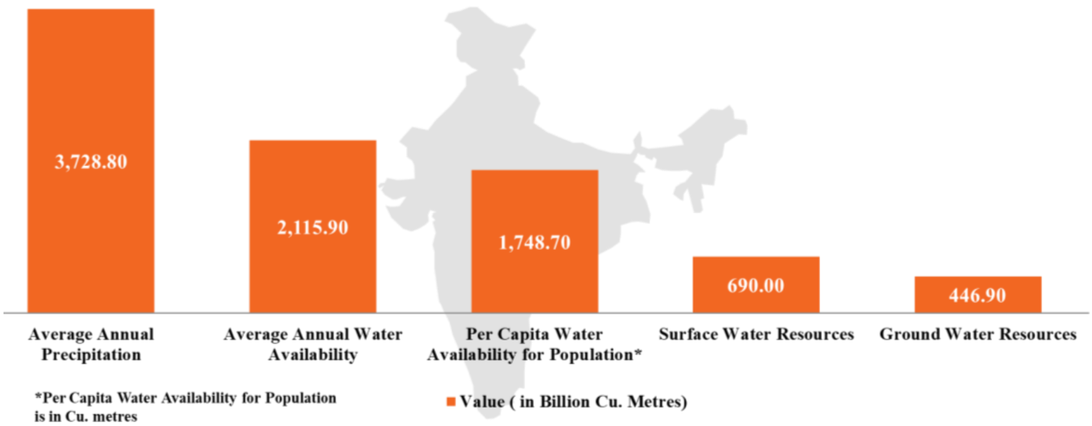
Despite receiving an estimated 3,728.80 billion cubic meters (BCM) of annual precipitation, India's usable water availability is significantly lower averaging around 2,115.90 BCM. The per capita water availability has declined to approximately 1,748.70 cubic meters, reflecting both population growth and uneven resource distribution.

The country's river basins show stark contrasts in water availability. The Brahmaputra (592.32 BCM), Ganga (581.75 BCM), and Godavari (129.17 BCM) basins are among the most water rich basins in India. However, the Ganga basin remains under stress due to its dense population. On the other hand, basins such as Sabarmati (9.87 BCM), Pennar (10.42 BCM), and Mahi (13.03 BCM) frequently experience water scarcity, driven by limited catchment areas and moderate rainfall. [17]

India's total renewable water resources comprise approximately 690 BCM from surface water and 446.90 BCM from groundwater. These statistics highlight an urgent need for strategic planning, conservation efforts, and robust infrastructure development to ensure long-term water security which poses significant opportunity for EPC developers to collaborate with government agencies in designing and executing advanced water infrastructure projects. From integrated water supply systems to smart conservation solutions, the sector is ripe for innovation, investment, and long-term impact.

[16] http://unfpa.org/sites/default/files/pub-pdf/EN_State%20of%20World%20Population%20report%202025.pdf
[17] https://cwc.gov.in/sites/default/files/reportwaterresourcesassessmentofindia2024_1.pdf

Figure 3.12.1: Water Availability Scenario in India, FY2025



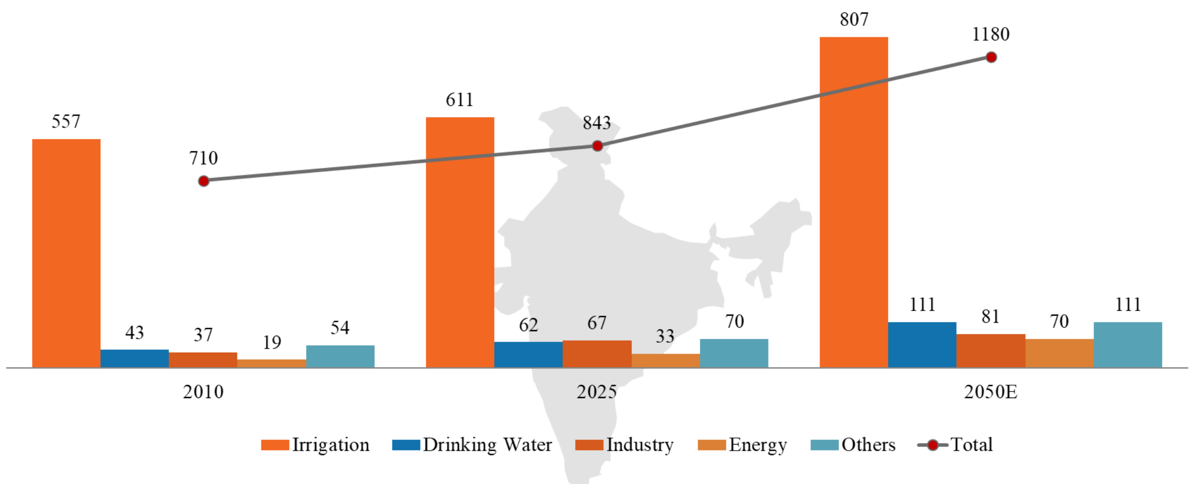
Source MoSPI Report on EnviStats India 2025, Frost & Sullivan Analysis

3.13. Water Demand Forecast in India

The water demand projections, expressed as per capita water availability in cubic meters, reveal a clear and structured increase across all sectors. These projections are based on the assessment done by National Commission for Integrated Water Resources Development (NCIWRD)

- Irrigation is expected to remain the largest consumer with an increase of 54 BCM between 2010 and 2025, and a further increase of 196 BCM by 2050 is expected highlighting continuing pressure from agriculture and water-intensive cropping patterns.
- Drinking water demand is expected to triple from 2010 to 2050, rising by 19 BCM by 2025 and by 68 BCM by 2050, driven by demographic growth and the expansion of piped water supply under national programmes. Government briefs also emphasise the increasing requirements of urban populations.
- Industrial and energy sectors show robust proportional growth. Industrial demand rises by 30 BCM by 2025, with further gains toward 2050, while energy-related demand more than triples by mid-century, reflecting increased power generation and industrialisation highlighted in official projections.
- Demand in ‘other uses’—including ecological flows, livestock, and municipal requirements—increases by 16 BCM by 2025 and is expected to increase to 57 BCM by 2050, aligning with government emphasis on environmental needs and diversified consumption patterns.

Figure 3.13: Water Demand Forecast in India, in Billion Cu.meters, 2010-2050E



Source: NCIWRD, MoSPI Report on Envistats India 2025, Frost & Sullivan Analysis

Overall, total water demand rises from 710 BCM in 2010 to 843 BCM in 2025 (an increase of 133 BCM) and is further expected to reach 1180 BCM by 2050, representing a total increase of 470 BCM over four decades. These projections approach India's utilizable resource ceiling, underscoring the urgency of integrated water management and improved irrigation efficiency.

3.14. Regulatory and Policy Frameworks Driving Investment in the Water Sector in India

3.14.1. Swachh Bharat Mission (Grameen) – SBM(G)

Swachh Bharat Mission (Grameen) is the Government of India's flagship rural sanitation programme, aimed at achieving and sustaining universal sanitation coverage and improving solid and liquid waste management in rural areas. While the first phase of SBM(G) focused on eliminating open defecation through household toilet construction, the programme has since evolved into SBM(G) Phase II, which emphasises ODF Plus outcomes, including greywater management, solid waste processing, and village-level sanitation infrastructure.

Under SBM(G) Phase II, significant funding is directed towards creation of soak pits, drainage channels, community composting units, waste collection systems, and faecal sludge management solutions. These interventions have direct linkages with rural water quality, groundwater protection, and surface water pollution control, thereby aligning closely with drinking water and sanitation outcomes reflected in the budget allocation.

From an investment and implementation perspective, SBM(G) generates sustained demand for decentralised wastewater solutions, civil construction, waste management equipment, and operation and maintenance services at the Gram Panchayat level. The programme's shift from one-time asset creation to lifecycle-based sanitation management underpins continued budgetary support and explains a portion of the sharp increase in the Drinking Water and Sanitation allocation in FY2026.

3.14.2. Jal Jeevan Mission (Har Ghar Jal)

Launched in August 2019, the Jal Jeevan Mission (JJM) is the Government of India's flagship rural drinking-water programme aimed at providing functional tap-water connections to every rural household. At launch, only approximately 32 Mn (16.7%) rural households had piped water access. As of July 2025, this has increased to over 156.7 Mn households, covering approximately 80.9% of rural households.

This rapid expansion has been supported by the development of approximately 0.64 Mn village-level water supply schemes, with a total sanctioned cost of approximately INR 8.29 trillion and cumulative expenditure of approximately INR 3.91 trillion. The programme includes both single-village schemes and large multi-village schemes, particularly in water-stressed regions where bulk water transfer, treatment plants, and long-distance pipeline networks are required.

From a market perspective, JJM represents one of the largest ongoing water infrastructure pipelines in India, with a strong execution focus extending beyond initial connection targets toward system sustainability, source augmentation, and service reliability. The extension of the scheme to 2028 further reinforces visibility of this pipeline.

Translation into EPC and execution opportunity

JJM is highly execution-intensive and translates directly into a large and distributed EPC opportunity across multiple components:

- **Pipeline infrastructure:** Extensive laying of transmission and distribution pipelines across rural and semi-urban geographies
- **Water treatment and storage:** Construction of treatment plants, overhead reservoirs, and ground-level storage systems
- **Pumping systems:** Installation of pump houses, electro-mechanical equipment, and energy-efficient systems
- **Multi-village schemes:** Development of bulk water supply systems involving long-distance conveyance, which are typically higher-value EPC packages
- **Digital integration:** Deployment of monitoring systems including SCADA, IoT-based sensors, and water quality tracking

Execution is largely carried out through EPC contracts, with significant subcontracting across civil works, pipeline laying, mechanical installation, and local distribution networks. Given the geographic dispersion and scale of implementation, regional contractors play a critical role in on-ground delivery.

The nature of JJM projects, particularly in pipeline laying, distribution network development, and associated civil and mechanical works, aligns closely with PTL's execution capabilities and on-ground presence. The programme's focus on multi-village schemes and last-mile connectivity creates sustained demand for subcontracting partners across multiple states, positioning PTL within a structurally strong and policy-backed execution pipeline.

3.14.3. PM Gati Shakti (National Master Plan)

Unveiled in October 2021, the PM Gati Shakti National Master Plan is a cross-ministerial digital platform for integrated infrastructure planning. It brings together over 200 GIS layers and project databases from 57 Central ministries and 36 States, covering sectors from highways and railways to bulk water supply and sewage. A dedicated Network Planning Group has already evaluated 293 major projects (totalling INR 13.59 trillion) under this scheme, ensuring multimodal connectivity (roads, ports, waterways, etc.) and targeting last-mile integration.

PM Gati Shakti is conceived as a long-term, continuous planning framework with no fixed end date, aligned with the government's vision of achieving 'Viksit Bharat 2047'. Rather than being a one-time programme, it is intended to serve as the permanent digital backbone for infrastructure planning, coordination, and sequencing across sectors and geographies.

Notably, the government is now mapping all Jal Jeevan Mission pipelines and rural water assets on the Gati Shakti platform, so that drinking-water and irrigation systems are planned in concert with road and rail networks. By eliminating silos, for example, enabling a railway project to "see" pending irrigation or water-supply schemes in the same corridor, Gati Shakti reduces delays, land-use conflicts, and duplication in infrastructure development.

Since its launch in 2021, the platform has progressed from a planning concept to an operational decision-making tool. Central and State agencies increasingly rely on Gati Shakti for project appraisal, inter-ministerial coordination, and sequencing of large infrastructure investments, particularly for linear assets such as pipelines, canals, highways, and transmission corridors. The growing use of geospatial overlays has helped improve project readiness and reduce approval timelines for major infrastructure proposals.

PM Gati Shakti does not have a standalone budget allocation, as it functions primarily as a planning and coordination layer. Capital expenditure for projects planned through the platform continues to be routed through respective sectoral schemes and ministries, such as Jal Jeevan Mission, PMKSY, urban infrastructure programmes, and projects under the National Infrastructure Pipeline, while budgetary support for Gati Shakti itself is limited to platform development, data integration, and institutional coordination.

For investors, the PM Gati Shakti framework lowers project risk through centralized reviews, improved visibility of future infrastructure corridors, and better alignment of approvals. It also creates opportunities in geospatial and analytics services, as companies providing GIS platforms, digital planning tools, IoT-based asset mapping, and data-integration solutions participate in this whole-of-government push to modernize water, irrigation, and allied infrastructure systems.

3.14.4. National Infrastructure Pipeline (NIP)

The National Infrastructure Pipeline, launched in 2019, is an INR 111+ trillion (~USD 1.4 trillion) roadmaps of infrastructure projects across FY2020–25. It spans economic and social sectors, from power, roads and metros to urban sanitation and rural development, with projects selected centrally and by states. By 2025, the NIP covered roughly 7,400 projects worth over INR 115 trillion, with financing split ~39% Central, 40% State and 21% private sector. Importantly for water and irrigation, NIP explicitly includes goals such as universal household piped water supply and expanded irrigation and micro-irrigation coverage. Urban infrastructure projects under NIP incorporate integrated water supply networks, while rural and agricultural projects channel funds into dam modernisation, canal rehabilitation and watershed development. The government supports financing with new institutions, including a Development Finance Institution (DFI), and through asset monetisation of brownfield water assets via InvITs (Infrastructure Investment Trusts).

Since its launch, the NIP has moved from a planning framework to an execution-focused pipeline, with a large number of projects under implementation and monitored through the India Investment Grid. While the original roadmap covered FY2020–25, the NIP is expected to continue beyond 2025 in an updated and rolling form, increasingly integrated with PM Gati Shakti for spatial planning and aligned with long-term development objectives such as Viksit Bharat @2047.

For investors, NIP signals a sustained pipeline of bankable water infrastructure projects, structured to allow PPPs, InvITs and long-term debt participation.

3.14.5. River Interlinking Programme

The River Interlinking Programme aims to address regional imbalances in water availability by transferring surplus water from water-abundant basins to deficit regions through a network of reservoirs, canals, and associated infrastructure. The programme includes priority links such as the Ken–Betwa interlinking project, which has moved into the implementation phase after extensive appraisal and inter-state agreements.

Expenditure under this programme is capital-intensive and long-gestation in nature, covering dam construction, canal networks, pumping stations, and associated power and control systems. While the number of active links is limited, each project involves large-scale civil works and multi-year funding commitments, contributing materially to the Water Resources allocation.

For infrastructure developers and equipment suppliers, river interlinking projects create opportunities across EPC contracting, tunnelling, pumping systems, electro-mechanical equipment, and long-term maintenance. Continued budgetary provisioning reflects the government's intent to progressively advance strategic inter-basin water transfer projects to enhance irrigation security and regional water resilience.

3.14.6. Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)

PMKSY ("Har Khet Ko Paani") is India's umbrella irrigation scheme, launched in 2015–16 to expand farm irrigation and water-use efficiency. It integrates legacy programs: the *Accelerated Irrigation Benefits Programme* (AIBP) for large dams and irrigation projects, and *Har Khet Ko Paani* (minor irrigation, command-area dev., tank renovation, groundwater). In December 2021, the government approved continuation of PMKSY through 2025–26. Central releases under AIBP (~ INR 190.8 Bn to date) have completed 66 major projects, creating ~2.9 Mn hectares of new or restored irrigation potential. Concurrently, around 3,462 minor-irrigation schemes (ponds, lift-pumps, etc.) and watershed projects have been executed, adding millions of acres under cultivation. The Watershed Development Component (now INR 124.32 Bn central spend) has taken up 9,434 projects covering 9.2 Mn hectares of rainfed land. Separately, the *Per Drop More Crop* program (drip/sprinkler irrigation) has covered nearly 9.68 Mn hectares of farmland. Notably, PMKSY has modernised delivery: over 55,000 km of underground pipelines have been laid (avoiding ~76,600 ha of land acquisition) and SCADA pump-controls installed to improve efficiency. This scale of activity – from canals, pumps and pipelines to solar pumps and moisture sensors – translates into strong demand for irrigation equipment and services. Investors (and manufacturers) are finding opportunities in pump and sprinkler supply, rural pipeline and valve construction, water-saving tech, and even PPP-based O&M contracts in completed irrigation projects, all buoyed by ongoing PMKSY funding and subsidies.

3.14.7. National Ganga Plan (Namami Gange)

The National Ganga Plan (NGP), implemented under the Namami Gange programme, is India's largest river rejuvenation initiative, focused on pollution abatement and ecological restoration of the Ganga and its tributaries. The programme combines Externally Aided Projects (EAP) and budget-supported components, with a strong emphasis on urban wastewater infrastructure. Key interventions include construction and upgradation of sewerage treatment plants (STPs), interception and diversion of drains, riverfront development, and long-term operation and maintenance of assets.

A defining feature of NGP is the adoption of Public-Private Partnership (PPP) models, particularly Hybrid Annuity and Design-Build-Operate-Transfer (DBOT) formats, which ensure sustained performance and financial viability of wastewater assets over 15–20 years. High-value contracts under the EAP component (supported by multilateral agencies) have driven large-scale deployment of modern treatment technologies, real-time monitoring, and performance-linked payments.

For investors and infrastructure players, NGP represents a stable pipeline of urban water and wastewater projects, spanning EPC execution, PPP investments, O&M services, and technology supply (biological treatment, sludge management, sensors, and automation). Continued budgetary support in FY2026 underscores the government's commitment to long-term river health and urban sanitation outcomes

3.14.8. Atal Bhujal Yojana (Atal Jal)

Atal Bhujal Yojana is a national programme aimed at improving groundwater governance through community participation, data-driven planning, and performance-linked incentives. Implemented in water-stressed blocks across multiple states, the scheme promotes sustainable extraction, aquifer-based planning, and behavioural change in water use.

The programme links financial assistance to measurable improvements in groundwater management outcomes, supported by technical interventions such as aquifer mapping, monitoring wells, and local water-use plans. Atal Jal complements irrigation and drinking water schemes by addressing groundwater sustainability at the source.

For solution providers and consultants, Atal Bhujal Yojana drives demand for hydrogeological services, groundwater monitoring equipment, data platforms, and capacity-building programmes. As groundwater becomes central to both rural water supply and agriculture resilience, Atal Jal strengthens the institutional foundation for sustainable water use.

3.14.9. Other Major Irrigation Projects

In addition to PMKSY-supported schemes, the Water Resources budget provides for other major and special irrigation projects, including nationally important and inter-state projects implemented directly by central authorities. These projects typically involve construction and completion of large dams, barrages, canal systems, and command-area infrastructure aimed at expanding irrigation coverage, stabilising existing ayacut, and ensuring reliable water supply to agriculture-dependent regions.

Such projects are characterised by high capital intensity, complex execution, and extended timelines, often requiring phased funding over multiple years. Budgetary support in FY2026 reflects continued emphasis on completing legacy projects, modernising irrigation delivery systems, and maximising utilisation of created storage and conveyance assets.

From an investor and industry standpoint, these projects sustain demand for large-scale civil construction, hydro-mechanical equipment, canal lining, pumping stations, and automation systems. The focus on completion and optimisation, rather than only new starts, indicates a policy shift towards improving returns on existing irrigation infrastructure and strengthening agricultural water security.

Figure 3.14: Overview of Government Policies Driving Investment in Water and Irrigation Infrastructure

POLICY	LAUNCH YEAR	PROGRESS/KEY DATA (AS OF SEP 2025)
Jal Jeevan Mission (JJM)	2019	~80.9% rural HHs with tap water (156.7 Mn of 193.6 Mn); ≈0.64 Mn rural schemes approved (INR 8.3 Trillion); INR 3.9 Trillion spent.
PM Gati Shakti (PMGS NMP)	2021	Integrates 57+ ministries and ~1700 GIS layers. 293 projects (~INR 13.6 Trillion) evaluated. JJM pipelines are being mapped on the platform.
National Infrastructure Pipeline	2019	~7,400 projects identified, total ~INR 115 Trillion investment. 100% piped water & expanded irrigation targets. Dedicated DFI (INR 200 Bn) formed.
PM Krishi Sinchayee Yojana (PMKSY)	2015–16	Central releases: ~INR 19.08 Bn (AIBP; 66 major projects, 29.22 L ha); ~INR 57.06 Bn (minor irrigation; 4.96 L ha); INR 124.32 Bn (watersheds; 9,434 projects, 92.02 L ha); 96.8 L ha under micro-irrigation. 55,290 km of pipelines laid.

3.15. Linkage Between Economic Growth and Water Resources

India's sustained economic growth is intrinsically dependent on the availability, efficient management, and long-term sustainability of its water resources. As the economy expands and urbanisation deepens, water demand across domestic, industrial, and agricultural segments continues to accelerate, placing pressure on supply systems and natural ecosystems. Economic growth not only drives higher consumption but also raises expectations around reliability, quality, and equitable access, making water availability a critical enabler of productivity and competitiveness.

While water does not directly generate GDP, it underpins a substantial share of economic output. Based on sectoral water-use patterns and their contribution to the economy, it is estimated that over 50% of India's economic activity is water-dependent. Agriculture, accounting for roughly 15–18% of GDP, remains the single largest user of freshwater, consuming an estimated 70–80% of total withdrawals. Industrial sectors such as food processing, textiles, power generation, steel, and chemicals together contribute approximately 25–30% of GDP and are increasingly water-intensive as manufacturing scales up. Urban and municipal services, construction, and allied activities, while accounting for a smaller share of direct withdrawals, support economic segments that collectively contribute over 30% of GDP. These figures are indicative estimates, intended to illustrate relative dependence rather than precise attribution.

As these sectors expand simultaneously, competition for water resources is intensifying across rural, industrial, and urban geographies. Water stress, if unaddressed, can directly constrain growth by disrupting agricultural productivity, interrupting industrial operations, and undermining urban service delivery. Conversely, reliable and efficiently managed water systems support higher farm yields, stable manufacturing output, and improved urban living standards, reinforcing the foundations of inclusive economic development.

As economic activity grows, the government's fiscal capacity, defined as its ability to generate revenues to fund public goods and services, also expands, enabling higher investment in water-related infrastructure. Both central and state governments are therefore increasingly prioritising spending on water supply, wastewater treatment, irrigation modernisation, and urban water management, not merely as welfare interventions but as productivity-enhancing investments. In parallel, industries are adopting water-efficient technologies, recycling systems, and zero liquid discharge processes to mitigate operational risks and meet regulatory requirements.

Ultimately, the sustainability of India's growth trajectory will depend on how effectively economic expansion is balanced with water resource stewardship. Efficient, inclusive, and technology-driven water management is not only a response to scarcity but a prerequisite for long-term economic resilience, competitiveness, and sustainable growth.

3.16. Current Landscape of the Water Market in India

The water infrastructure market in India can be viewed across three major segments: Water Infrastructure, Smart Water Solutions, and Operations & Maintenance (O&M). Together, these segments define both the current structure of the market and its ongoing transition toward technology-enabled and service-oriented delivery models.

From a market perspective, India's water sector represents a large and policy-driven investment opportunity, supported by flagship programmes such as Jal Jeevan Mission, AMRUT 2.0, PMKSY, and urban wastewater initiatives. Across these programmes, a multi-year project pipeline spanning urban, rural, and irrigation infrastructure is driving sustained EPC activity, with cumulative investments estimated in the range of several trillion rupees over the medium term.

Water Infrastructure: The Water Infrastructure segment encompasses traditional physical assets that support water supply, treatment, and distribution networks, including reservoirs, pipelines, and treatment plants. This segment forms the foundation of both urban and rural water systems and accounts for the majority of capital expenditure in the sector.

From an execution standpoint, this segment represents the core EPC opportunity, covering large-scale pipeline networks, water treatment plants, pumping systems, storage infrastructure, and irrigation assets. Government-led programmes such as Jal Jeevan Mission and AMRUT 2.0 are translating into a high-volume pipeline of EPC contracts, particularly in pipeline laying, distribution network expansion, and bulk water transfer systems.

Smart Water Solutions: The Smart Water Solutions segment represents the growing integration of digital technologies such as sensors, meters, analytics platforms, and automated control systems into water management networks. These solutions enable data-driven decision-making, improve system efficiency, and support utilities and industrial users in optimising resource use.

While relatively smaller in value compared to core infrastructure, this segment is witnessing high growth and increasing integration within EPC projects, particularly through SCADA systems, smart metering, leak detection, and remote monitoring solutions. As government programmes increasingly mandate reduction of non-revenue water and improved service delivery, digital components are becoming embedded within infrastructure tenders.

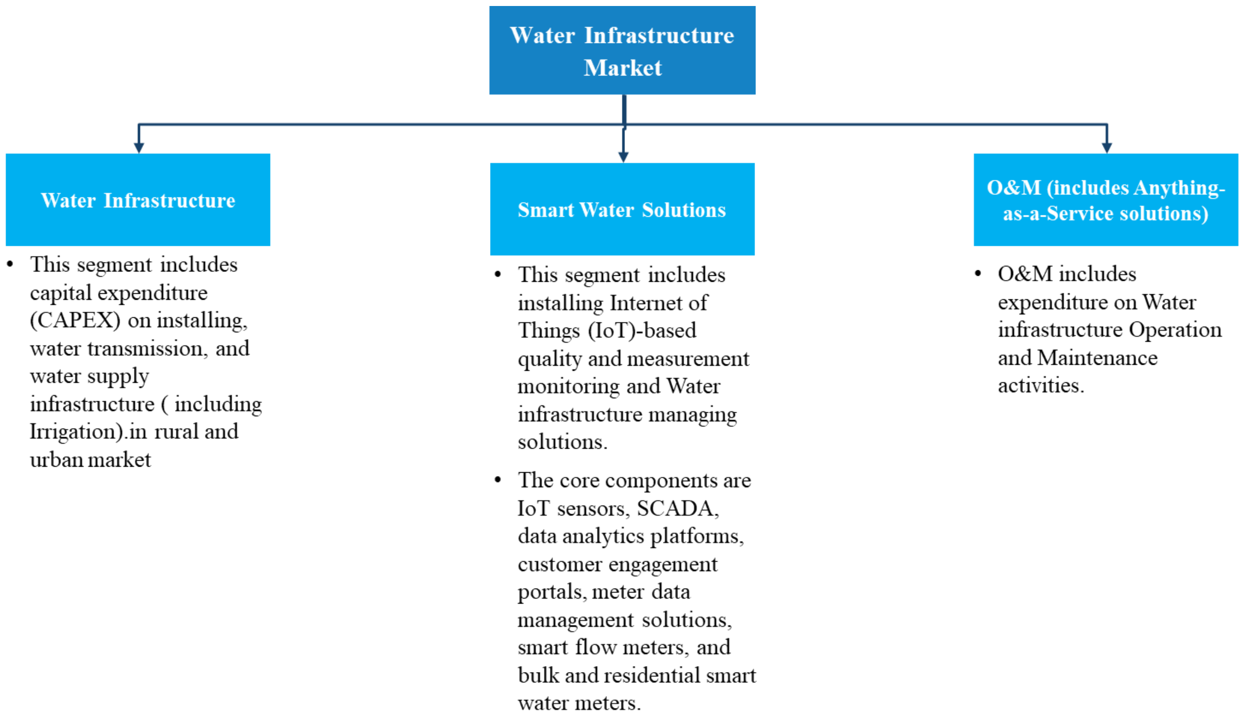
Operations & Maintenance (O&M): The Operations & Maintenance (O&M) segment includes services focused on asset performance, preventive maintenance, and lifecycle management of water infrastructure assets. Increasingly, O&M is transitioning toward outcome-based or subscription-driven delivery models, broadly referred to as Anything-as-a-Service (XaaS), where infrastructure performance, monitoring, analytics, and maintenance are delivered as a bundled service for a recurring fee.

This shift is being supported by long-term contracts under programmes such as Namami Gange and urban water supply schemes, where EPC players are increasingly participating beyond construction into multi-year O&M and performance-based contracts. This expands the revenue pool from one-time execution to recurring service-based engagement.

Linkage to EPC opportunity: Across all three segments, the water market continues to be execution-led, with EPC forming the primary monetisation layer. Large-scale government programmes are translating policy intent into tendering activity, project awards, and subcontracting demand across pipeline construction, treatment infrastructure, metering, and system integration.

The combination of high capital expenditure in core infrastructure, increasing digital integration, and expanding O&M scope is creating a diversified and sustained opportunity for EPC contractors and subcontractors across the water value chain.

Figure 3.16: Overview of Water Infrastructure Market Landscape in India



Source: Frost & Sullivan Analysis

3.17. Major Upcoming Water Pipeline Projects in India

Recent tender announcements across multiple states highlight India's continued investment momentum in strengthening its water supply and distribution infrastructure. A mix of urban and rural projects is being implemented through municipal corporations, water supply boards, and railway departments, covering activities such as the laying and replacement of large-diameter pipelines, operation and maintenance (O&M) of regional water supply schemes, and rehabilitation of existing distribution systems.

These projects reflect the government's focus on expanding potable water coverage, improving system efficiency, and modernizing legacy infrastructure under national initiatives like the Jal Jeevan Mission (JJM) and AMRUT 2.0 (Atal

Mission for Rejuvenation and Urban Transformation), which focuses on universal urban water supply coverage, reduction of non-revenue water, sewerage expansion, and reuse of treated wastewater across cities. The table provides a snapshot of key upcoming tenders issued across various regions, illustrating the scale and geographic spread of ongoing water infrastructure development in India.

Figure 3.17: Information About Major Upcoming Tenders

Tender Detail	Deadline	Location	Tender Issuing Authority	Estimated Cost (in INR)
O&M of civil & electromechanical assets such as all bulk transmission and distribution pipelines etc. for the umrala water supply scheme, including supply of 12.53 mld potable water to all the 62 villages 2 towns	10-11-2025	Bhavnagar, Gujarat, India	Gujarat Water Supply And Sewerage Board	5,63,87,266
Supply and laying of 1600 mm diameter MS pipeline from Veeline estate pvt. ltd to Jinjira bazar junction of Taratala road and BBT road	12-11-2025	Kolkata, West Bengal, India	Kolkata Municipal Corporation	4,22,03,341
O&M of civil & electromechanical assets such as all bulk transmission and distribution pipelines, etc. for the Malpara regional water supply scheme, including supply of 2.70 mld potable water to all the 15 villages	10-11-2025	Bhavnagar, Gujarat, India	Gujarat Water Supply And Sewerage Board	3,37,70,100
Laying of 1600 mm diameter MS pipeline	12-11-2025	Kolkata, West Bengal, India	Kolkata Municipal Corporation	3,02,66,750
Repairs to pipeline connections and toilets	07-11-2025	Guntakal, Andhra Pradesh, India	South Central Railway	1,99,89,182
Replacement of old pipeline and provision of individual water tank of Satna railway colony	04-11-2025	Jabalpur, Madhya Pradesh, India	West Central Railway	1,86,31,747
Day to day O&M of water distribution system and rising main pipeline (upvc/hdpe) for tubewell with connecting line, stand post, FHTC	04-11-2025	Bankura, West Bengal, India	Public Health Engineering Department	68,55,248
Repairs to pipeline for over head tank and its surrounding area at Belagavi (bgm) railway station	07-11-2025	Hubli, Karnataka, India	South Western Railway	52,12,051
Replacement of damaged drainage pipeline in colony quarters at STPS (phase-ii)	07-11-2025	Jamnagar, Gujarat, India	Gujarat State Electricity Corporation Limited	24,73,469
Construction of pipelines for drinking water supply at Abadanga	07-11-2025	Birbhum, West Bengal, India	Zilla Parishad	2,33,235

Source: Tender 247, Frost & Sullivan Analysis

3.18. Overall Market for Water Sector in India

The Indian Water Sector that includes Water Infrastructure Market (which includes both water supply and irrigation segments), Smart Water Infrastructure and Operation and Maintenance was valued at INR 571.3 Bn in FY2021, combining contributions from core infrastructure, smart systems, and operations & maintenance.

From FY2021 to FY2025, the market has expanded sharply from INR 571.3 Bn in FY2021 to around INR 988.9 Bn in FY2025, recording a compound annual growth rate (CAGR) of about 14.7%. This early acceleration was primarily policy- and investment-driven, reflecting heavy capital expenditure by the central and state governments under flagship schemes such as Jal Jeevan Mission, AMRUT 2.0, and various irrigation modernization and rural pipeline projects.

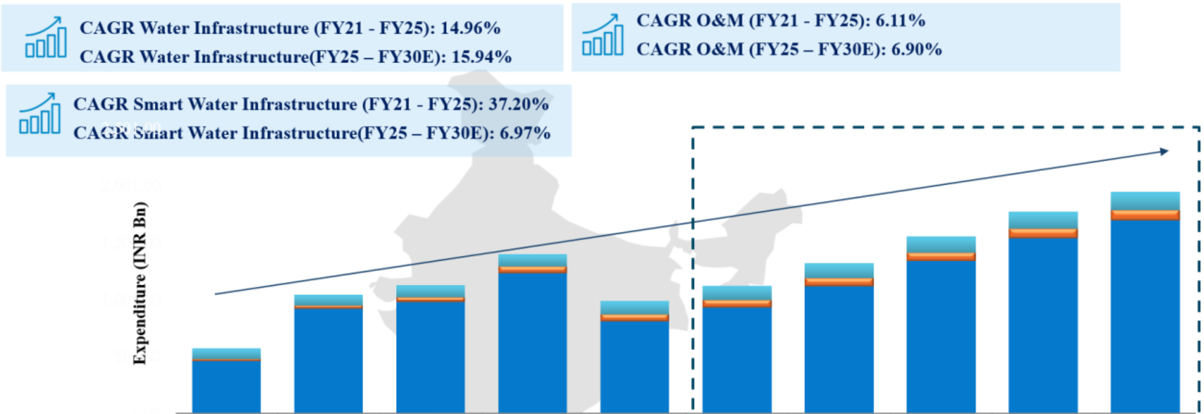
This growth essentially represents the EPC (Engineering, Procurement and Construction) opportunity within India's water sector. The market continues to be driven by capital-intensive execution projects, with EPC players engaged across the full spectrum from design and engineering to turnkey construction of water supply networks, treatment facilities, and irrigation infrastructure.

The ongoing scale-up in both rural and urban water programs has resulted in a steady pipeline of EPC contracts. Over time, the scope of EPC work has also broadened to include integration of digital monitoring, automation, and control systems within traditional civil and mechanical works, increasing both the technical complexity and value of projects.

However, the FY2025 number, at around INR 989 Bn, shows a temporary moderation compared to FY2024. This softening is largely due to project completion cycles, slower fund disbursals in certain state-level projects, and a rebalancing of central funding after the major rollout phase of Jal Jeevan Mission. So, while the underlying demand remains strong, FY2025 marks a pause in execution intensity, not a structural slowdown.

From FY2026 onwards, the market is expected to regain momentum and transition into a steady, technology-integrated growth phase. Between FY2025 and FY2030, the water infrastructure market is projected to grow at a CAGR of around 14.5%, reaching approximately INR 1,948 Bn by FY2030E.

Figure 3.18: Water Infrastructure: Expenditure Forecast by Segments, India, FY2021– FY2030E



	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026E	FY 2027E	FY 2028E	FY 2029E	FY 2030E
O&M	88.2	93.3	98.9	105.0	111.9	119.2	127.2	136.0	145.7	156.1
Smart Water Infrastructure	18.6	27.9	41.9	62.8	66.0	69.3	72.7	76.4	84.0	92.4
Water Infrastructure	464.4	923.1	984.6	1,234.2	811.2	932.8	1,119.4	1,343.3	1,544.8	1,699.3

Source: Expert Interactions, Frost & Sullivan Analysis

3.19. EPC Opportunity Universe and Subcontracting Dynamics

Between Between FY2026E and FY2030E, India's municipal water and irrigation infrastructure sector is expected to attract a sizable investment reflecting continued government focus on strengthening urban and rural water systems through programmes such as Jal Jeevan Mission, AMRUT 2.0, and state-led water supply and wastewater projects.

AMRUT 2.0 supports this investment momentum through initiatives including universal urban water supply coverage, reduction of non-revenue water, expansion of sewerage networks, and reuse of treated wastewater, alongside service-level benchmarking and asset sustainability measures. These interventions complement Jal Jeevan Mission's rural focus and reinforce end-to-end water infrastructure development across urban and peri-urban areas.

EPC market structure and execution layers

The water infrastructure market is primarily executed through EPC contracts, which can be broadly segmented into:

- **Principal EPC contractors:** Responsible for end-to-end project delivery including design, procurement, project management, and client interface
- **Subcontractors and execution partners:** Responsible for on-ground implementation across civil, mechanical, electrical, and pipeline works

Principal EPC players typically retain project management, engineering design, procurement coordination, and client-facing responsibilities, while a substantial portion of physical execution is outsourced.

Subcontracting dynamics and share

A significant share of EPC execution in the water sector is delivered through subcontracting, particularly due to the geographically dispersed and labour-intensive nature of projects.

Subcontracting typically accounts for 25% to 35% of total EPC value, broadly aligned with other linear infrastructure sectors such as transmission and distribution. This includes:

- Pipeline laying and distribution network construction
- Civil works for treatment plants and pumping stations
- Mechanical and electro-mechanical installation

- Electrical systems and automation integration
- Field-level activities including trenching, jointing, and restoration

Execution model and margin structure

The division of roles between EPC contractors and subcontractors also reflects differences in margin profile and risk allocation:

- **Principal EPC contractors:**
    - Lower execution intensity
    - Higher responsibility for design, coordination, and risk management
    - Margins driven by project structuring and cost control
- **Subcontractors:**
    - Execution-focused roles with high labour and site intensity
    - Typically operate on thinner margins but higher volume turnover
    - Limited exposure to client-side risks but dependent on EPC payment cycles

Drivers of subcontracting

The growing reliance on subcontracting is driven by:

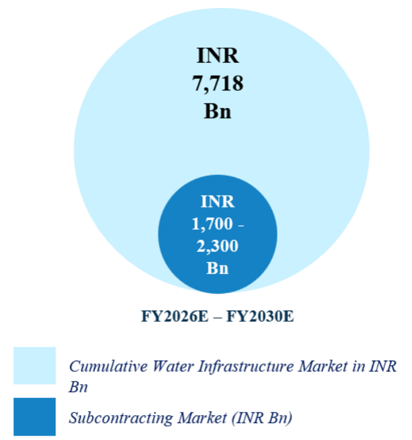
- Geographic dispersion of projects across rural and urban locations
- Need for local execution capabilities and labour mobilisation
- Parallel execution of multiple work packages
- Increasing integration of specialised technologies such as automation, SCADA, and energy-efficient systems

EPC contractors leverage regional partners to improve execution efficiency, manage timelines, and optimise cost structures, while also collaborating with technology providers for system integration and compliance.

Figure 3.19.1: Sub-contracting opportunity, India, FY2026E – FY2030E

SCENARIO	SUBCONTRACTING SHARE OF TOTAL MARKET	CUMULATIVE SUBCONTRACTING OPPORTUNITY (FY2026E–FY2030E)
Low	~22.0%	~INR 1,700 Bn
Base	~25.0%	~INR 1,900 Bn
High	~30.0%	~INR 2,300 Bn

Figure 3.19.2: Engineering, procurement and construction and Subcontracting Opportunities within India's Water & Irrigation Infrastructure Market, FY2026E – FY2030E



3.20. Water Use Issues and Challenges in India

(a) Groundwater Depletion

Over-extraction of groundwater for agriculture, industry, and domestic use has led to significant depletion of aquifers. In many regions, especially in states like Punjab, Haryana, and Rajasthan, groundwater levels are declining at alarming rates, threatening the sustainability of water resources.

(b) Pollution of Water Sources

Industrial effluents, untreated sewage, and agricultural runoff have severely polluted many of India's rivers and lakes. The Ganga and Yamuna rivers, for instance, are among the most polluted in the world, with high levels of contaminants making the water unsafe for consumption and aquatic life.

(c) Infrastructure Deficiencies

A significant portion of the population lacks access to reliable water supply systems. In urban areas like Noida, residents have been forced to rely on private tankers due to inadequate municipal water supply infrastructure.

(d) Climate Change and Extreme Weather Events

Climate change has exacerbated water-related challenges in India. Erratic monsoon patterns, prolonged droughts, and intense flooding events have disrupted water availability and quality. For instance, the 2025 floods in Punjab affected over 1,400 villages, displacing millions and damaging agricultural land.

Role of the Public Sector in Strengthening Water Infrastructure

Addressing India's water use challenges requires coordinated, long-term intervention where public sector companies and government agencies play a central role. Large-scale public investment is critical to revive and modernise water infrastructure, ranging from groundwater recharge systems and urban water supply networks to wastewater treatment and reuse facilities. Equally important is sustained funding for R&D in water-saving and water-efficient technologies such as micro-irrigation, smart metering, leak detection systems, advanced treatment for industrial effluents, and nature-based solutions for flood and drought resilience. Through policy support, public–private partnerships, and targeted financing, government agencies can enable wider adoption of these technologies, strengthen regulatory enforcement, and build institutional capacity at the state and local levels. Together, these actions can help transition India from reactive water management to a more resilient, efficient, and sustainable water ecosystem.

Smart Metering as a Strategic Enabler in Water Infrastructure Reform

Within the broader public investment and reform framework, smart water metering represents a critical implementation tool to improve efficiency, transparency, and financial sustainability in urban water systems. Although India does not currently have a standalone national subsidy or quantified rollout mandate exclusively for smart water meters, existing reform-linked programs create a structural policy environment that encourages their adoption.

Under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT 2.0), which has an indicative outlay of approximately INR 2,99,000 crore for FY2021–22 to FY2025–26 (including central share of INR 76,760 crore), participating cities are required to prepare City Water Balance Plans and undertake measures to reduce non-revenue water as part of reform-linked commitments. Since reduction of non-revenue water requires accurate measurement of supply and consumption at granular levels, digital metering becomes a practical necessity for cities seeking to meet these reform conditions. In addition, AMRUT 2.0 targets the provision of 2.68 crore new tap connections across statutory towns (Ministry of Housing and Urban Affairs), expanding the formal urban consumer base and increasing the relevance of systematic consumption monitoring.

From an operational perspective, smart metering enables real-time monitoring of water usage, remote data transmission, and automated billing. This significantly improves the accuracy of consumption measurement compared to conventional mechanical meters. Enhanced measurement capability allows utilities to identify leakages, unauthorised connections, and abnormal consumption patterns at zone or ward levels, thereby supporting measurable reduction in distribution losses.

Financially, smart metering strengthens the revenue framework of urban local bodies by reducing estimation-based billing, minimising manual errors, and improving collection efficiency. Improved billing transparency enhances cost recovery ratios and supports the credit profile of municipalities, which is increasingly relevant in the context of municipal bond issuances and performance-linked financing. Reliable consumption data also supports volumetric tariff structures, enabling more rational pricing mechanisms and encouraging responsible water use.

From a governance and planning standpoint, continuous consumption data allows utilities to develop evidence-based demand forecasts, optimise network pressures, and integrate monitoring systems with SCADA platforms. This facilitates a shift from reactive maintenance toward predictive asset management. Additionally, digital dashboards enhance accountability and regulatory oversight by providing auditable consumption and revenue data.

In summary, while smart water metering is not currently driven by a dedicated central incentive scheme, it directly supports reform-linked objectives under national urban water programs by enabling measurable reduction in non-revenue water, improving financial sustainability of utilities, and strengthening data-driven water governance.

3.21. Growth Drivers in India's Water Sector

(a) Short Term (1–2 Years)

- Continued public investment under government-led programs such as Jal Jeevan Mission and AMRUT 2.0 will remain the primary growth catalyst.
- Focus areas include expansion of drinking water access, pipeline network augmentation, and strengthening of water treatment capacity.
- State-level budget allocations and mission-mode implementation will sustain project momentum, particularly in rural and semi-urban regions.
- Initial adoption of metering and monitoring technologies will begin to enhance visibility into consumption and loss patterns.

(b) Medium Term (3–4 Years)

- The market will gradually shift focus from infrastructure creation to operational efficiency and system reliability.

- Digitalization will play an increasing role through the deployment of sensors, Supervisory Control and Data Acquisition (SCADA) systems, and data-driven leak detection and pressure management tools.
- PPP models and performance-linked contracts are expected to expand private participation in operation and maintenance (O&M).
- Utilities will begin integrating asset management and predictive maintenance practices to extend asset life and improve service quality.

(c) Long Term (5–6 Years)

- The sector is expected to move toward fully integrated, technology-enabled water management systems covering the complete asset lifecycle.
- Anything-as-a-Service (XaaS) models are likely to gain traction, allowing utilities to access digital and O&M capabilities through subscription-based arrangements.
- Circular economy initiatives such as wastewater recycling, sludge management, and resource recovery will become part of mainstream planning.
- Increasing policy alignment around sustainability, data integration, and water reuse will shape the long-term structure of the market.

Overall Outlook

- Near-term growth will continue to be driven by public investment and mission-driven infrastructure rollout.
- Over time, efficiency enhancement, private participation, and digital transformation will emerge as the defining characteristics of India’s water infrastructure landscape.

3.22. Growth Trends in India's Water Sector

(a) Rising public investment and regulatory push

- Government programmes such as Jal Jeevan Mission (rural piped water supply) and AMRUT 2.0 (urban water & sanitation) are backed by higher budget allocations and mission-mode implementation.
- Increasing emphasis on policy frameworks for wastewater treatment, reuse and industrial compliance is driving demand for infrastructure and services.

(b) Urbanisation, industrialisation & rising demand

- Rapid urban growth and industrial expansion are raising the demand for reliable water supply, treatment, distribution, and reuse systems.
- Agriculture remains a water-intensive sector; irrigation modernisation and groundwater management are also growth drivers for water-equipment and infrastructure segments

(c) Technology adoption and smart water solutions

- Use of digital tools such as GIS mapping, IoT sensors, SCADA systems and AI analytics is increasing in water networks, treatment plants and distribution systems.
- The market for water-management systems (including smart metering, leak detection and asset monitoring) is growing at a double-digit rate.

(d) Desalination and alternative supply augmentation

- In coastal and water-stressed regions, desalination is gaining traction as a supplementary source of water supply.
- Rainwater harvesting, groundwater recharge and decentralised treatment systems are being adopted to augment supply and mitigate stress in water-scarce zones.

(e) Focus on operational efficiency and lifecycle services

- Beyond new asset creation, there is a growing focus on improving asset performance, reducing non-revenue water, optimising operations & maintenance (O&M) and extending asset life.
- Private participation, performance-based contracts and service-oriented models are being introduced in many urban utilities

4. SYSTEM INTEGRATION (SI) IN EDUTECH, SMART CLASSROOMS, AND DIGITAL EDUCATION FOR GOVERNMENT SCHOOLS IN INDIA

4.1. Introduction

4.1.1. Importance of Digital Education in Government Schools

Digital education in government schools has become a critical enabler for bridging the learning gap between urban and rural students. With India's vast student population, many from underprivileged socio-economic backgrounds, providing access to technology enabled learning ensures inclusivity and equal opportunity. Smart classrooms and digital tools enhance teaching effectiveness, improve student engagement, and support the delivery of standardized, quality content across geographies. EduTech also provides platforms for students in rural, semi-urban, and unprivileged areas to learn new concepts and techniques, driving socio-economic growth. In line with the National Education Policy (NEP) 2020, it fosters 21st-century skills, such as critical thinking, collaboration, and digital literacy, to support India's knowledge-driven economy.

Key adoption trends in government schools include:

- Computer availability rose from 38.5% in FY2020 to 57.2% in FY2024; 64.7% nationwide as of FY2025.
- Internet connectivity doubled to 53.9% from FY2020–FY2024.
- Smart classrooms and digital tools: Grew from 14.4% in FY2022 to 21.2% in FY2024.

4.1.2. Role of System Integration in Smart Classroom / EduTech

System integration (SI) brings together hardware, software, content, and services. It creates seamless solutions for government school ecosystems. Individual components like interactive panels and projectors work best when integrated. SI makes systems easy for teachers and students to use. It unlocks the full potential of smart classrooms. This boosts teaching effectiveness and student engagement. As of FY2025, around 24.4% of Indian schools have functional smart classrooms, with government schools at 21.2%, indicating that adoption is still in early stages but accelerating year over year.[18]. In 2025, Delhi alone sanctioned INR 900 crore for nearly 19,000 smart classrooms, equipped with interactive panels, projectors, LMS, and digital content libraries.[19].Odisha's 5T initiative (FY2024-25) added smart setups in schools via iDream Education. Under this initiative, 6,872 high schools were fully transformed by March 2023[20]. Odisha's 5T initiative, like similar governance models in other states, promotes teamwork for departmental coordination, transparency for open and ethical processes, technology for digital efficiency, timely service delivery, and transformation for citizen-centric reforms[21]. On the second day of the fourth phase of Odisha's 5T School Transformation Programme, high schools in six districts (Malkangiri, Balasore, Gajapati, Dhenkanal, Keonjhar, and Cuttack) were upgraded. These include 35 schools in Malkangiri, 76 in Balasore, 28 in Gajapati, 63 in Dhenkanal, 45 in Keonjhar, and 80 in Cuttack. Notably, 6,883 schools statewide were already transformed across the first three phases. The fourth phase targets 1,794 more schools, bringing the total to 8,677 upon completion. This initiative enhances infrastructure with smart classrooms and digital tools[22]. The Centre approved ₹106 crore for Punjab's digital school initiatives under Samagra Shiksha, prioritizing quality education, skill development, and girls' education while resolving prior funding delays. This funding supports computer labs and smart classrooms in government schools for FY2025-26, after earlier withholding a similar proposal and urging stronger focus on quality interventions.[23] Tamil Nadu plans a significant digital overhaul of government schools by 2026-27, targeting 6,672

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[18] *https://educationforallinindia.com/concept-of-smart-classrooms-in-india-its-present-status/*

[19] *https://www.idreameducation.org/blog/smart-classrooms-in-delhi/*

[20] *https://www.drishtiias.com/daily-updates/daily-news-analysis/the-5t-initiative-of-odisha*

[21] *https://www.ensureias.com/blog/current-affairs/5t-initiative-of-odisha*

[22] *https://ommcomnews.com/odisha-news/5t-school-transformation-programme-cm-inaugurates-327-transformed-high-schools/*

[23] *https://www.hindustantimes.com/cities/chandigarh-news/samagra-shiksha-scheme-centre-sanctions-106-cr-for-computer-labs-smart-classrooms-for-state-schools-101764871610665.html*

smart classrooms across 5,322 schools (₹127.57 crore) and 2,236 hi-tech labs in 2,232 schools (₹159.06 crore). This effort seeks to equip nearly 90% of state government schools with advanced digital learning infrastructure.[24]

4.1.2.1. Definition and Scope of System Integration in EduTech

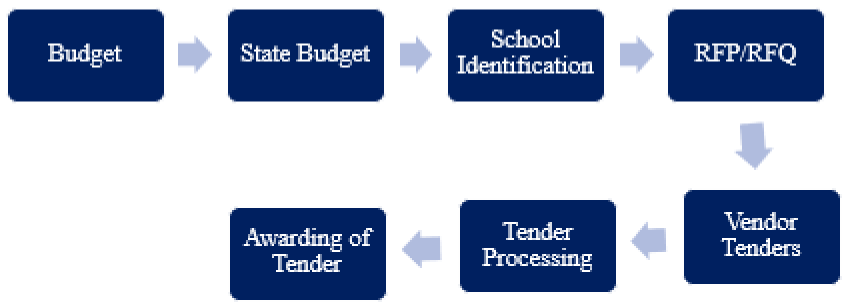
In the EduTech and smart classroom domain, System Integration (SI) refers to the end-to-end process of designing, deploying, and managing interconnected digital learning solutions. This includes:

- Hardware: Integration of interactive boards, digital displays, projectors, tablets, servers, connectivity devices, and other infrastructure that form the physical backbone of smart classrooms.
- Software: Seamless connection of content delivery platforms, Learning Management Systems (LMS), assessment tools, video conferencing apps, and student information systems. Standards like Learning Tools Interoperability (LTI) enable different software modules to communicate and share data effectively.
- Services: Comprehensive teacher training, ongoing technical support, system maintenance, and regular upgrades to ensure long-term functionality and usability.
- Content: Curriculum-aligned digital lessons, adaptive learning modules capable of catering to individual learning speeds, and multilingual language support tools to enable inclusive access.

The scope of SI extends beyond installation to lifecycle management, ensuring that solutions remain effective, scalable, and sustainable in diverse government school environments.

4.1.2.2. Stakeholders in Smart class Room Value Chain

Figure 4.1 Value Chain for Smart Class Rooms



Source: Frost and Sullivan Analysis

Budget Allocation

The Smart Classroom implementation process begins with financial allocation at the central level. Funds are typically sanctioned under national education initiatives such as Samagra Shiksha, which support digital learning infrastructure in government schools. The allocated budget covers procurement of interactive panels or smart boards, projectors, computing devices, digital content licenses, teacher training, installation, and annual maintenance contracts. This step establishes the financial foundation for large-scale deployment.

State Budget Distribution

After central approval, funds are distributed to state education departments. Each state determines the number of schools to be covered, defines technical specifications, and sets implementation timelines. States may supplement central funds with additional allocations to expand coverage or enhance infrastructure standards. This stage ensures that the program is aligned with regional priorities and administrative structures.

[24] *https://timesofindia.indiatimes.com/city/chennai/6672-more-smart-classrooms-to-be-set-up-in-govt-schools-across-state/articleshow/125116626.cms*

School Identification

At the district and block levels, eligible schools are identified based on predefined criteria. These criteria often include infrastructure readiness such as availability of electricity, internet connectivity, classroom space, student enrollment size, and priority for rural or underserved areas. A finalized list of selected schools is prepared before moving to the procurement phase.

Issuance of RFP/RFQ

Once schools are identified, the state releases a Request for Proposal (RFP) or Request for Quotation (RFQ). An RFP is issued when the project requires a comprehensive solution including hardware, software, training, and maintenance services. An RFQ is typically used when only equipment procurement is involved with clearly defined specifications. The tender document outlines technical requirements, quality standards, service expectations, and compliance conditions.

Vendor Tender Submission

Interested technology providers and EdTech companies submit their bids in response to the tender. These submissions generally include detailed technical proposals, financial quotations, prior project experience, certifications, and implementation plans. Vendors must demonstrate their capability to deliver equipment, provide digital content, conduct teacher training, and ensure long-term support.

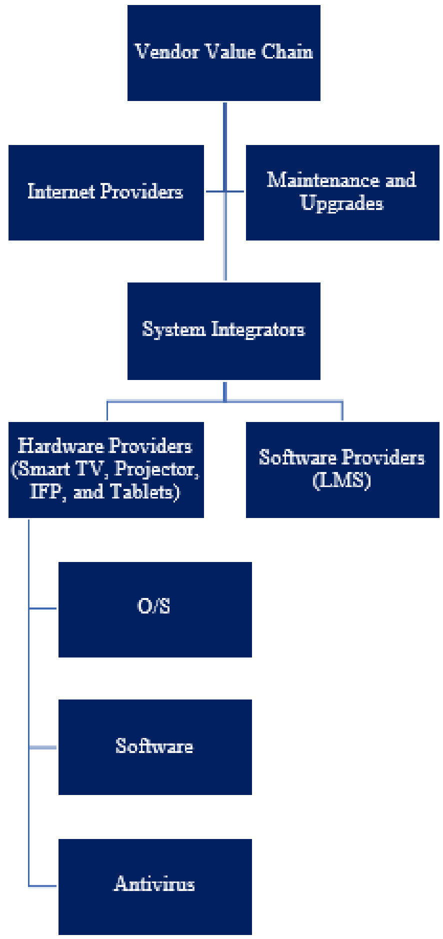
Tender Processing and Evaluation

A designated evaluation committee reviews all submitted bids. The assessment typically includes technical qualification checks, financial comparison, compliance verification, and review of past performance. Depending on the procurement model, selection may be based on the lowest financial bid or a quality-and-cost-based evaluation method. This stage ensures transparency and competitiveness in vendor selection.

Awarding of Tender and Implementation

After evaluation, the contract is awarded to the selected vendor or consortium. The implementation phase begins with supply and installation of smart classroom equipment in identified schools. This is followed by teacher training sessions, deployment of digital content, system integration, and activation of maintenance support. Upon completion, the smart classrooms become operational, enhancing digital learning delivery across the selected schools.

Figure 4.2 Vendor Value Chain in Smart Class room



Source: Frost and Sullivan Analysis

Vendor Value Chain in Smart Classroom Implementation

The vendor value chain in a Smart Classroom project represents the ecosystem of stakeholders involved in delivering, integrating, and sustaining digital learning infrastructure. It illustrates how multiple service and technology providers work together to ensure seamless classroom digitization, from connectivity and system integration to long-term maintenance and upgrades.

Internet Providers

Internet service providers form the backbone of a Smart Classroom environment. They supply reliable broadband or fiber connectivity required for accessing cloud-based educational platforms, streaming digital content, conducting live classes, and enabling remote monitoring. Stable internet connectivity ensures uninterrupted teaching and learning experiences, especially where digital content and online assessments are integrated into the curriculum

Maintenance and Upgrades

Maintenance and upgrade service providers ensure the long-term functionality of smart classroom systems. Their responsibilities include preventive maintenance, troubleshooting hardware issues, updating software versions, replacing faulty components, and ensuring cybersecurity compliance. Regular upgrades are essential to keep the system aligned with evolving educational technologies and digital standards.

System Integrators

System integrators act as the central coordinating entity in the value chain. They combine hardware, software, networking, and security components into a unified and functional solution. Their role includes project planning, procurement coordination, installation, configuration, testing, and training. System integrators ensure that all components work seamlessly together and comply with government tender specifications.

Hardware Providers

Hardware providers supply the physical infrastructure required for smart classrooms. This includes interactive flat panels or smart boards, projectors, computers, tablets, servers, speakers, cameras, and networking devices. Quality and durability are critical factors, as the equipment must withstand continuous classroom usage and varying environmental conditions.

Operating Systems (O/S)

Operating system providers supply the foundational software that enables hardware devices to function effectively. The operating system manages system resources, supports application execution, and ensures compatibility between devices and educational software platforms.

Core Software

Core software providers deliver educational applications, content management systems, learning management systems, and subject-specific digital content. These platforms enable interactive teaching, assessments, progress tracking, and multimedia-based learning experiences.

Antivirus and Security Solutions

Cybersecurity providers supply antivirus and endpoint protection solutions to safeguard classroom devices from malware, unauthorized access, and data breaches. Security solutions are critical in protecting student data, maintaining system integrity, and ensuring compliance with data protection standards.

Software Providers

Software providers focus specifically on delivering educational technology solutions, including digital curriculum content, analytics tools, teacher training modules, and cloud-based platforms. They play a crucial role in enhancing the pedagogical value of smart classrooms by transforming hardware infrastructure into an effective digital learning environment.

Figure 4.3 Types of Smart Classrooms

	Projector	Smart TV	Laptop	Pre loaded Digital Content	Digital White Boards	Interactive Flat Panels (IFPs)	AI Enabled Tools	Real time Collaborat ion Software
Basic Smart Classrooms	✓	✓	✓	✓				
Intermediate Smart Classrooms	✓	✓	✓	✓	✓			
Advanced Smart Class Rooms	✓	✓	✓	✓	✓	✓	✓	✓

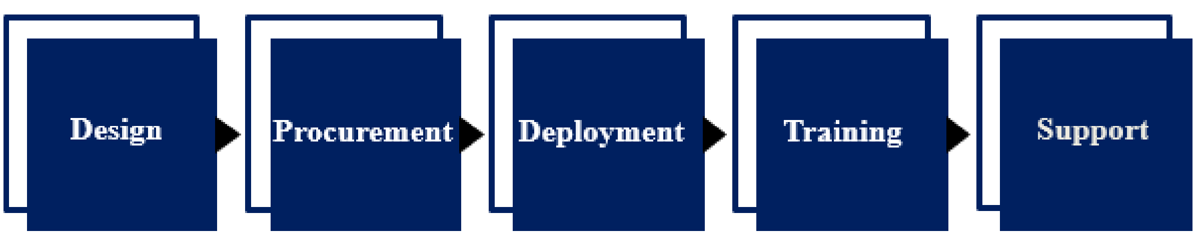
Source: Frost and Sullivan Analysis

Smart classrooms in India can be categorized into basic, intermediate, and advanced levels based on the extent of technology implemented. Basic smart classrooms, which are predominantly present across government schools and many public institutions, typically include projectors, smart TVs, laptops, and pre-loaded digital content to support digital teaching. Intermediate smart classrooms, commonly found in some private schools, incorporate digital whiteboards or interactive panels that enhance classroom engagement and multimedia learning. Advanced smart classrooms integrate interactive flat panels, AI-enabled tools, and real-time collaboration software, enabling hybrid learning models, improved interactivity, and technology-driven instructional delivery across digitally mature educational institutions.

4.1.2.3. System Integration Workflow:

The System Integration (SI) workflow for EduTech in government schools involves multiple phases to ensure effective deployment and sustainability:

Figure 4.4 System Integration Workflow



Source: Frost and Sullivan Analysis

Design: The design phase serves as the foundation of the integration process, demanding a thorough understanding of local conditions across India’s varied educational landscape. Schools differ significantly in classroom sizes, infrastructure, bandwidth availability, and linguistic and curricular needs. Designing EduTech systems that reflect these realities ensures contextual alignment and usability. Solutions must be tailored, not standardized, as a one-size-fits-all model fails to account for regional diversity. For instance, rural schools with low connectivity require offline-compatible tools, while urban schools may need systems supporting real-time interactivity. Rural schools often require offline-compatible tools due to low connectivity (only 18.5% have internet vs. 47.3% urban. Urban schools support real-time interactivity through high-bandwidth systems like live LMS collaboration and interactive flat panels. Moreover, regional language support and alignment with state-specific curricula are vital for inclusivity.

Procurement: Procurement in the public education sector is complex, particularly due to the absence of unified national procurement legislation. Different states and departments follow varying norms, often leading to inconsistencies and inefficiencies in contract awards. Transparent, well-governed procurement frameworks are essential to minimize risks of opaque practices and ensure equitable access. The process should emphasize a balanced evaluation of cost, quality, and contextual suitability rather than lowest-price selection alone.

Deployment: Once solutions are procured, the deployment phase focuses on setting up the infrastructure and integrating it with existing systems. This phase presents logistical and technical challenges, especially across geographically dispersed and resource-constrained government schools. Key considerations include reliable power supply, internet connectivity, and compatibility of new systems with existing infrastructure. Many schools still face intermittent electricity and low bandwidth, necessitating hybrid or offline-first approaches to maintain functionality. The deployment process should also ensure standardization in setup, proper network integration, and verification of system performance. Coordinated planning between vendors, education departments, and local authorities is crucial for smooth rollouts and timely issue resolution. As organizations modernize their digital capabilities, Pragyawan's integration services reduce fragmentation, enhance data flow, and build resilient infrastructures.

Figure 4.5 Challenges of Deploying System Integration

Challenge	Description
Unreliable Power Supply	Intermittent electricity due to grid instability or frequent outages
Poor Internet Connectivity	Low bandwidth, lack of fiber access, or unreliable mobile data in remote areas
Geographical Dispersion	Schools spread across vast regions with poor road access
Integration with Existing Infrastructure	Incompatible legacy hardware and varying school setups
Resource Constraints	Limited staff training, maintenance budgets, and technical expertise
Coordination Gaps	Misalignment between vendors, departments, and local authorities

Source: Frost and Sullivan Analysis

Training: Technology adoption in education is meaningful only when teachers are confident and skilled in using new tools. Hence, training forms the heart of the SI workflow. It should extend beyond one-time technical orientations to include ongoing capacity building focused on pedagogical integration. Teachers must be trained to embed digital tools into lesson planning, student engagement, and assessment processes. Continuous refresher programs, peer learning networks, and mentoring systems can help sustain engagement. Effective training builds user confidence, reshapes classroom practices, and ensures that technology enhances rather than disrupts learning. DIKSHA platform has trained over 4.7 million teachers via NISHTHA and CPD courses, with total enrollments exceeding 15 crore including stakeholders.[25] Teacher training programmes are already in place under CBSE, with teachers required to attend capacity-building programmes at regular intervals to continuously enhance their skills and competencies.

Support: Sustaining EduTech systems over time requires robust, multi-tiered support mechanisms. Centralized support ensures policy updates, software upgrades, and content refreshes, while regional support teams handle on-ground issues like hardware maintenance and troubleshooting. Quick and reliable support prevents downtime and equipment obsolescence, keeping teachers and students motivated to use technology consistently. Periodic performance audits and user feedback loops further strengthen the support ecosystem. System Integrators main responsibility is also to provide Operation & Maintenance activities for long duration (say 3 to 5 years), which helps government to ensure proper functioning of EduTech solution in respective schools

[25] *https://www.pib.gov.in/Pressreleaseshare.aspx?PRID=1844723&reg=3&lang=2*

This holistic, participatory, and context-driven SI workflow addresses the multifaceted challenges of EduTech deployment in India's government schools, ensuring infrastructure investments translate into meaningful and sustained improvements in educational quality

4.1.2.4. Public Procurement Models (CAPEX, BOOT, PPP / CSR)

Public procurement models for EduTech in government schools shape how technology integration and resource allocation occur, each presenting unique operational dynamics and outcomes.

- Under the CAPEX model, the government directly purchases all required EduTech assets such as hardware, software, and digital content. Once procured, ownership transfers to the schools, granting them long-term control and flexibility in customizing and upgrading the systems based on evolving pedagogical needs. This model ensures institutional ownership and accountability, making it suitable for schools with established administrative and technical capacities. However, the CAPEX model requires significant upfront capital investment and entails continuous budgetary allocation for maintenance, upgrades, and teacher training. Without robust maintenance frameworks, assets risk becoming obsolete. Despite these challenges, CAPEX remains a preferred approach in regions where the government seeks full control over infrastructure and data, emphasizing autonomy, quality assurance, maintaining curriculum in line with government guidelines and approach as per existing education policy and alignment with public education goals. The Union Budget 2025-26 allocates ₹41,250 crore to the Samagra Shiksha scheme under the Ministry of Education (central government), supporting school Edutech initiatives nationwide. This includes broadband connectivity for government secondary schools, 50,000 Atal Tinkering Labs (hardware supply), and digital infrastructure via direct government tenders to EdTech vendors.[26]
- The BOOT model represents a more collaborative, risk-sharing approach between the public and private sectors. In this structure, private vendors are responsible for financing, installing, and operating EduTech systems for a pre-determined contract period, after which ownership is transferred to the government. This arrangement significantly reduces the initial financial burden on public authorities and allows them to leverage private expertise in technology deployment and management. However, the success of BOOT arrangements hinges on well-defined contractual frameworks with clear performance metrics, service-level agreements, and transfer timelines. Poorly designed contracts can lead to dependency on vendors, cost escalations, or operational inefficiencies. When executed effectively, the BOOT model promotes accountability, innovation, and operational excellence while ensuring eventual government ownership of assets. Assam (Educomp): 100 high schools received computer labs under BOOT Phase-IV; vendor built, operated for years, then transferred, covering 60,000 students.[27]
- The PPP model integrates public sector oversight with private sector innovation and operational efficiency. Here, both the government and private stakeholders share responsibilities in financing, implementing, and maintaining EduTech initiatives. PPPs are particularly effective for large-scale projects such as digital classrooms, content platforms, or data-driven education management systems. They balance public interest with commercial viability, encouraging private firms to innovate while adhering to social and educational objectives. However, success depends on transparent governance frameworks, equitable risk sharing, and outcome-based monitoring. When well-structured, PPPs can deliver scalable, sustainable, and high-impact EduTech ecosystems that bridge resource gaps and enhance learning outcomes across diverse regions. Atal Innovation Mission (AIM): The government has set up Atal Tinkering Labs (ATLs) in schools across India with support from private organizations to provide hands-on experience in robotics, AI, and engineering. The Atal Innovation Mission (AIM) has established 10,000 Atal Tinkering Labs (ATLs) with significant funding, led by Maharashtra (1,033 labs). The Union Budget 2025-26 aims to add 50,000 more ATLs, prioritizing rural areas and aspirational districts to broaden innovation access.[28]
- Corporate Social Responsibility initiatives add another dimension to EduTech procurement by allowing private corporations to contribute directly to educational development. Through CSR programs, companies

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[26] *https://www.gwmeindia.com/%E2%82%B91-28-lakh-crore-education-budget-government-tenders-for-edtech-and-infrastructure/*

[27] *https://digitallearning.eletsonline.com/2008/03/implementation-of-ict-in-schools-under-boot/*

[28] *https://www.tice.news/tice-trending/india-crosses-10000-atal-tinkering-labs-govt-plans-50000-more-9681971*

fund and implement smart classroom projects, teacher training, or digital infrastructure as part of their social responsibility mandates. These projects often bring cutting-edge solutions and rapid innovation to underserved areas. However, CSR-driven initiatives can face limitations in scale, geographic continuity, and sustainability when not integrated into larger governmental strategies. To maximize impact, CSR efforts should align with national or state digital education frameworks, ensuring long-term usability and coherence with curriculum goals.

Figure 4.6 Public Procurement Models

Model	Description	Pros	Cons
CAPEX	Government buys assets outright through capital expenditure (e.g., direct purchase of hardware).	Full ownership, no recurring payments, customizable to needs	High upfront costs strain budgets, full risk borne by government, ongoing maintenance burden
BOOT	Build-Own-Operate-Transfer: A private entity builds and operates the infrastructure and transfers it after a defined term.	Low initial outlay, private-sector efficiency and expertise, technology upgrades included	Long-term dependency, potential high transfer costs, risk of profit-driven quality compromises
PPP	Public-Private Partnership involving shared investment, risks, and revenues (e.g., design-build-finance-operate).	Risk sharing, private-sector innovation, scalable funding	Complex contracts, alignment challenges, profit motives may inflate costs
CSR	Corporate Social Responsibility: Companies fund or deploy solutions as part of non-profit obligations.	No direct cost to government, faster rollout, access to corporate technology expertise	Limited scale and sustainability, donor-driven priorities, lack of long-term guarantees

Source: Frost and Sullivan Analysis

Indian states select among these models based on budgetary constraints, administrative capacity, and strategic priorities. For instance, Karnataka's expansive AI learning rollout utilized government procurement (CAPEX), while other states incorporate PPPs and CSR to pilot and scale EduTech solutions, reflecting a hybrid and adaptive ecosystem driving India's EduTech revolution. In rural Karnataka (e.g., Yadgir via iDream Education partnership), PPP elements emerge through Samagra Shikshana Karnataka collaborations: private firms supply/install Smart TVs, Kannada content, and training, with government funding and monitoring usage for scalability. CSR supplements via corporate donations (e.g., Confluent India's 10 smart boards across districts), blending with state CAPEX for broader reach without ownership transfer.[29][30]

This diversification supports effective resource utilization, accountability, and long-term sustainability within India's evolving digital education landscape.

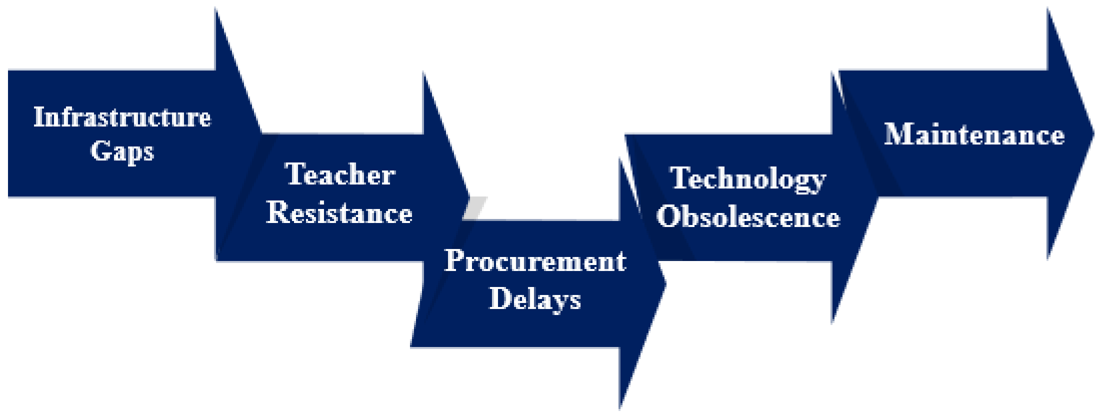
4.1.2.5. Risks in Execution and Mitigation

System integration in government schools faces several risks that undermine EdTech sustainability and effectiveness. Infrastructure gaps like power outages and poor connectivity disrupt access. Teacher resistance from inadequate training causes underutilization. Content irrelevance fails to engage diverse students. Mitigation includes reliable backups, ongoing training, and localized materials.

[29] *https://www.idreameducation.org/blog/learning-in-rural-karnataka/*

[30] *https://www.aim.gov.in/pdf/AIM-CSR-Guidebook.pdf*

Figure 4.7 Risks in Execution and Mitigation



Source: Frost and Sullivan Analysis

System integration in government schools faces several risks impacting sustainability and effectiveness of EduTech initiatives. Key challenges include:

Infrastructure Gaps:

One of the most persistent challenges in system integration is the uneven distribution of infrastructure across regions. Many rural and remote schools continue to face unreliable electricity supply, poor internet connectivity, and inadequate physical infrastructure. A recent parliamentary panel found that more than 40% of government schools across India lack access to electricity and playground facilities. Deploying solar-powered systems can ensure energy reliability in electricity-deficient regions, while offline or locally cached digital content allows learning continuity even without internet access. Furthermore, implementing a phased technology rollout starting with basic digital infrastructure before advancing to sophisticated systems can help schools gradually build readiness without overwhelming resources. Long-term infrastructure planning, backed by state-level audits and public-private collaboration, is essential to create equitable digital environments across all schools.

Teacher Resistance or Low Adoption:

Teachers are central to EduTech adoption, and their resistance or hesitation poses a significant risk to system effectiveness. Many educators lack prior exposure to digital tools, leading to apprehension, low confidence, or reluctance to integrate technology into daily pedagogy. Regular, hands-on workshops tailored to local needs, peer mentoring systems where experienced teachers guide others, and professional learning communities can foster collaboration and build confidence. Moreover, introducing incentive mechanisms such as digital teaching certifications, recognition programs, or performance-linked benefits can motivate teachers to embrace technology consistently. Empowering teachers as change agents rather than passive users ensures deeper pedagogical integration and long-term behavioural change.

Procurement Delays and Cost Overrun

Procurement inefficiencies remain a major barrier to timely and cost-effective system integration. Complex bureaucratic procedures, unclear technical specifications, and inconsistent vendor performance often result in project delays, inflated costs, and diminished trust among stakeholders. Employing professional project management practices such as milestone-based monitoring and transparent reporting can streamline processes. Additionally, linking vendor payments to verified performance outcomes ensures accountability and incentivizes timely completion. Establishing centralized procurement frameworks or digital procurement platforms can further reduce delays, encourage competition, and promote transparency across departments. Big private schools set efficiency benchmarks through agile vendor management and real-time analytics. Government initiatives can adopt similar practices standardized RFPs, milestone-based payments, and GeM portal integration to ensure vendor accountability and optimal resource use.

Technology Obsolescence:

The rapid evolution of digital technologies presents another critical risk: obsolescence. Devices, software platforms, and digital tools become outdated quickly, often before schools can fully utilize their potential. Such obsolescence not only leads to financial losses but also disrupts continuity in teaching and learning. To address this, EduTech systems should be designed for modularity and upgradability. Schools should invest in hardware that supports incremental upgrades rather than full replacement cycles. Cloud-based solutions offer another layer of adaptability, allowing regular content updates and system enhancements without physical changes to equipment. Open-source software and interoperable platforms can further reduce dependency on specific vendors, extending system life and flexibility. EdTech systems should prioritize modularity, upgradability, and cloud-based solutions like Google Workspace for Education, widely adopted in Nordic countries where digital classrooms use scalable cloud platforms for seamless updates without hardware overhauls. Open-source software further enhances vendor independence and longevity.

Maintenance and Support Challenges:

Sustaining EduTech systems beyond initial deployment is perhaps the most underestimated challenge. Maintenance and technical support, particularly in remote regions, face logistical hurdles due to limited local expertise and resource constraints. Delays in troubleshooting can lead to prolonged downtime, discouraging both teachers and students from using digital tools. To strengthen support mechanisms, schools can partner with regional service providers for on-site assistance and establish centralized help desks for quick resolutions. Remote monitoring systems can track device performance and network health, enabling proactive maintenance before major issues arise. Regular audits, refresher sessions for technical staff, and accessible service-level agreements with vendors further enhance reliability.

Addressing these risks through proactive strategies enables system integration to deliver sustainable digital education solutions that can transform learning in India's government schools, bridging digital divides and equipping students and teachers for the future.

4.2. Policy and Funding Landscape

4.2.1. National Education Policy 2020 (NEP)

The NEP 2020 is the overarching policy framework that re-imagines school and higher education in India; it places strong emphasis on equity, foundational literacy & numeracy, multidisciplinary learning, teacher capacity building and critically for EduTech and Smart Classrooms digital infrastructure, blended learning and the creation of high-quality open digital content. NEP explicitly recommends that every school and higher-education institution create digital repositories of learning resources, that teachers be trained in technology-enabled pedagogy, and that state/central governments incentivize investments in ICT infrastructure (connectivity, devices, e-content and training) to reduce digital divides. For procurement and implementation this creates a demand signal: centrally-endorsed standards and platforms (e.g., national repositories, teacher training modules) that state systems and vendors must align with, and funding windows that prioritize scalable, interoperable digital solutions.

Implications for SI/EduTech projects

- Tender/RFPs increasingly require alignment with NEP learning outcomes, language-inclusive content, local adaptation and teacher upskilling plans.
- Projects that demonstrate measurable learning outcomes (foundational skills) and data privacy compliance are favored for funding and scale-up.

- NEP's focus on multimodal delivery (in-person + online + on-air) supports hybrid architectures (classroom AV + local server/CMS + cloud services).

Structural Reforms in School Education under NEP 2020

The 5+3+3+4 Curriculum Framework

NEP 2020 replaces the traditional 10+2 structure with a new 5+3+3+4 curricular and pedagogical framework covering ages 3–18. This structure is designed to align education with children's cognitive development stages:

- Foundational Stage (5 years): Three years of pre-primary education plus Grades 1–2, with a focus on play-based and activity-based learning.
- Preparatory Stage (3 years): Grades 3–5, emphasizing experiential learning, reading, writing, speaking, and basic numeracy.
- Middle Stage (3 years): Grades 6–8, introducing subject-based learning, coding, vocational exposure, and experiential pedagogy.
- Secondary Stage (4 years): Grades 9–12, offering greater subject flexibility, multidisciplinary choices, and depth of learning.

This restructuring has direct implications for digital content design, assessment tools, and classroom technologies, as solutions must be age-appropriate, interactive, and aligned with developmental outcomes rather than uniform, one-size-fits-all models.

Foundational Literacy and Numeracy (FLN)

Foundational Literacy and Numeracy is identified as the highest priority of NEP 2020. The policy recognizes that without basic reading, writing, and numeracy skills in early grades, long-term educational outcomes are severely compromised. Technology-enabled adaptive learning platforms, diagnostic assessments, and teacher-support tools are therefore encouraged to track and improve FLN outcomes at scale.

For EduTech providers, this creates opportunities for early-grade digital learning solutions, local-language content, and assessment analytics that align with national FLN benchmarks

Language, Equity, and Holistic Development

Multilingualism and Mother Tongue Instruction

NEP 2020 strongly advocates teaching in the mother tongue or local language at least until Grade 5, and preferably until Grade 8. Multilingualism is viewed as a cognitive asset rather than a barrier. This policy direction places significant emphasis on the availability of digital content, interfaces, and teacher resources in regional and local languages.

EduTech and Smart Classroom solutions must therefore support multilingual content delivery, language switching, and local contextualization. Platforms that can easily adapt content to different linguistic and cultural contexts are better positioned for large-scale adoption under NEP-aligned programs.

Holistic and Multidisciplinary Learning

The policy moves away from narrow academic silos and rote memorization, instead promoting holistic development that integrates arts, sports, vocational skills, and life skills. Vocational education is introduced from Grade 6 onwards, including internships and hands-on exposure.

Digital tools such as virtual labs, simulations, multimedia content, and project-based learning platforms can play a critical role in supporting this multidisciplinary approach, especially in schools with limited physical infrastructure.

Assessment Reforms and Pedagogical Shift

NEP 2020 emphasizes formative, competency-based assessment over high-stakes summative examinations. Continuous assessment, qualitative feedback, and adaptive evaluation methods are encouraged to support learning rather than merely ranking students.

This shift creates demand for:

- Digital assessment platforms
- Learning Management Systems (LMS) with analytics
- Dashboards for teachers and administrators
- Tools that track learning progress over time

For SI and EduTech projects, alignment with competency-based learning outcomes and data-driven evaluation mechanisms is increasingly becoming a requirement in government tenders and RFPs.

Role of Technology and Digital Infrastructure

Digital Platforms and Content Ecosystem

NEP 2020 explicitly promotes the use of technology platforms such as DIKSHA for teacher training and digital content dissemination. The policy recommends the creation of high-quality open digital educational resources (OERs) and digital repositories at school and institutional levels.

Schools and higher-education institutions are encouraged to:

- Develop digital repositories of learning materials
- Use technology-enabled pedagogy
- Adopt blended and hybrid learning models

This creates a structured policy backing for Smart Classroom deployments, cloud-based content management systems, and interoperable digital platforms.

Bridging the Digital Divide

Recognizing disparities in access to devices and connectivity, NEP 2020 supports multimodal delivery of education through in-person, online, and on-air channels (TV, radio, digital). This approach acknowledges ground realities while still pushing for long-term digital inclusion.

For technology projects, this supports hybrid architectures that combine classroom audiovisual systems, local servers or offline content repositories, and cloud-based services to ensure continuity of learning even in low-connectivity environments.

Teacher Capacity Building and Professional Development

Teachers are positioned at the center of NEP 2020 implementation. The policy mandates continuous professional development, digital literacy, and training in technology-enabled pedagogy. A four-year integrated B.Ed. program is introduced as the minimum qualification for teachers by 2030.

Digital platforms for teacher training, certification, and peer learning are therefore critical enablers. EduTech solutions that integrate teacher upskilling modules, classroom support tools, and easy-to-use interfaces are more likely to align with NEP priorities and gain institutional acceptance.

Higher Education Reforms and Technology Enablement

NEP 2020 aims to increase the Gross Enrolment Ratio (GER) in higher education to 50% by 2035. This will be achieved through the creation of large multidisciplinary universities, flexible entry-exit options, academic credit banks, and greater use of online and blended learning.

Technology will be central to managing this expansion, particularly in areas such as:

- Digital academic credit systems
- Online and hybrid degree programs
- Virtual laboratories and research collaboration tools

This opens opportunities for large-scale digital infrastructure projects, enterprise-level LMS deployments, and data-driven governance solutions.

4.2.2. Digital India Initiatives Relevant to Education

Digital India delivers the national digital stack connectivity, identity (Aadhaar), payment rails, digital public infrastructure (APIs/IDS), and capacity programs which enables delivery of education services at scale. Relevant strands include multi-modal content delivery (DTH + web + mobile), national e-governance infrastructure which schools can plug into for reporting and grants, and digital skilling initiatives that complement school curriculum. The Digital India architecture reduces the integration cost for vendors who can reuse national services (identity, payment, authentication, cloud endpoints) rather than building proprietary backends.

4.2.3. Key Government Schemes:

4.2.3.1. Samagra Shiksha Abhiyan

Samagra Shiksha Abhiyan (integrating SSA, RMSA and teacher education) is the primary centrally-sponsored programme for school education financing, covering infrastructure, quality improvement, teacher training, and digital initiatives for pre-primary through class 12. It provides states co-funding (central + state) for approved activities; digital/ICT investments (smart classrooms, computer labs, connectivity grants, e-content development, teacher training) are eligible components under the scheme's programmatic matrix. Funding allocations are routed to State Education Departments through the usual central scheme mechanisms, and implementation often requires state procurement (tenders) or shortlisted empanelment of vendors. The scheme has been extended for five years, from FY2022 to FY2026. It encompasses 1.16 million schools, more than 156 million students, and 5.7 million teachers in government and aided schools, covering education from pre-primary to senior secondary levels[31].

Procurement & contracting note

- Vendors typically engage via state tenders or through centrally-sponsored pilot projects; demonstrating compliance with Samagra's eligibility & safeguards (equity, special needs, teacher training plan) strengthens

[31] https://dsel.education.gov.in/en/scheme/samagra-shiksha

bids. Haryana's PAL (Personalized Adaptive Learning) tablet program under Samagra funded adaptive learning for 500,000+ students (Grades 10-12), demonstrating equity compliance and teacher training safeguards to secure bids and scale-up.[32][33]

- States sometimes create dedicated budget lines (SAMAGRA digital pools) or partner with SPVs for rapid rollouts.

4.2.3.2. PM e-Vidya

PM e-VIDYA is the Ministry of Education's umbrella for multi-mode digital education launched in 2020. It features 750 Virtual Labs focusing on Science and Mathematics for classes 6 to 12 and 75 Skilling e-labs that create simulated learning environments to foster critical thinking and creativity[34]. It brings together DIKSHA, SWAYAM, Swayam Prabha (DTH) channels, and other platforms to enable "on-air + online + offline" access for nearly all school students. For implementers, PM e-VIDYA sets the expectation of interoperable content (DIKSHA compatibility), broadcast-ready e-content and teacher training that enables teachers to blend digital resources into everyday instruction. Central grants under PM e-VIDYA augmented other schemes during COVID and created continuing funding corridors for large scale content creation and teacher capacity programs. PM e-VIDYA launched on May 17, 2020, as part of the Atmanirbhar Bharat Abhiyaan by the Ministry of Education to unify digital, online, and on-air education platforms.DIKSHA under PM e-VIDYA hosts over 3.17 lakh e-contents, 6,600 energized textbooks in 36 languages, and 6,125+ crore learning minutes with 2.2+ crore daily page hits. It includes 4,000+ radio programs broadcast on 398 stations, 2,900+ live iRadio programs, and special content like 4,200+ Indian Sign Language videos and a dedicated DTH channel for hearing-impaired students. NDEAR-linked DIKSHA reports 5 billion+ learning sessions and 12 billion+ QR codes scanned. In FY 2020-21, Rs 14.75 crore was spent on PM e-VIDYA implementation.[35]

Implementation guidance

- Design content in small modular lessons (micro-learning) so it can be repurposed across DIKSHA, DTH playlists and mobile apps.
- Provide teacher facilitation guides and low-bandwidth/offline versions as required under PM e-VIDYA's multimodal approach.

4.2.3.3. ICT@Schools

ICT@Schools (earlier IT@School) is a long-running scheme to provide computers, educational software, connectivity, teacher training and content development support to secondary and higher secondary government schools. The scheme finances equipment, Internet connectivity and capacity building for a large number of government/aided schools and encourages state-level adapted models (e.g., state SPVs). Procurement is traditionally through state education departments; equipment and training norms (unit costs, lifecycle, replacement) are defined in scheme guidelines. This scheme is a centrally sponsored scheme under the Ministry of Education targeting secondary and higher secondary government and aided schools nationwide. Launched in 2004-05 as part of the 10th Five-Year Plan, it evolved from earlier state initiatives like Kerala's IT@School project started in 2001.The scheme provided ICT infrastructure to over 4071 schools in Kerala alone during 2007-2012 via the central program, with nationwide coverage extending computers, broadband, and labs to lakhs of schools. It trained 1.5 lakh+ teachers (Std 1-12) in ICT skills, launched educational channels like VICTERS (India's first full educational DTH), and enabled tools like SchoolWiki for collaborative content across 15,000 schools. KITE-like models have benefited 43 lakh students and 1.7 lakh teachers through hi-tech classrooms, robotics, and AI training in participating states.

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[32] *https://www.linkedin.com/posts/samagra-transforming-governance_e-adhigam-pedagogy-lessons-from-haryana-activity-6952123142416789504-Kp3-*

[33] *https://www.business-standard.com/article/current-affairs/haryana-buys-500-000-tablets-for-classes-10-12-govt-school-students-122080801621_1.html*

[34] *https://www.pib.gov.in/PressReleasePage.aspx?PRID=2081633#:~:text=PM%20e%2DVidya:%20A%20Comprehensive,%2C%20courses%2C%20and%20interactive%20content.*

[35] *https://www.business-standard.com/article/education/over-rs-14-75-crore-spent-on-pm-evidya-initiative-in-fy-2020-21-govt-121071901145_1.html*

4.2.3.4. DIKSHA Platform

DIKSHA (Digital Infrastructure for Knowledge Sharing) is the national learning platform and repository for teacher and student content: it hosts lesson plans, textbooks, assessment items, teacher CPD modules and QR-tagged classroom resources. DIKSHA is the standard interoperability target for central/state content initiatives (content packaged as SCORM/JSON/IMS). For SI and EduTech vendors, DIKSHA acts as both a distribution channel and compliance target content integrated or certified for DIKSHA gains rapid uptake by state systems. The DIKSHA platform is built with a federated architecture, allowing 35 states and union territories to have their own dedicated tenants on the platform. DIKSHA offers over 2,700 e-contents focused on Foundation Literacy and Numeracy (FLN), spanning various formats such as assessment sheets, gamified contents and assessments, infographics, videos, worksheets, activity sheets, and readings. These resources have collectively been accessed or used more than 500,000 times by users nationwide. The platform continuously updates and customizes content to align with the curricula of different states and UTs, empowering learners and educators with diverse, interactive digital educational tools.[36] States appoint SCERT (State Council of Educational Research and Training) as nodal agency with a steering committee led by education secretaries for rollout, focusing on teacher training (e.g., NISHTHA via DIKSHA), content integration into textbooks, and school-level adoption through apps and offline modes. Content procurement uses Expressions of Interest (EOI) and tenders by NCERT for agencies creating digital resources across DIKSHA, TV, and radio under PM e-VIDYA, prioritizing quality, transparency, and value-for-money without hardware focus. Vendors certify content per metadata standards (multilingual, facilitation notes, remediation paths) for seamless state uptake; cloud infrastructure leverages partners like Oracle OCI.[37] More than 15 million teachers have utilized DIKSHA resources. The platform offers over 100,000 e-learning modules in 36 languages. Since its launch, it has logged more than 10 billion learning sessions.[38]

Technical expectations

- Use DIKSHA content metadata standards, provide multilingual support, and include teacher facilitation notes and remediation pathways to increase adoption by states.

4.2.3.5. BharatNet Connectivity Projects

BharatNet is the national broadband backbone project that delivers fiber connectivity to gram panchayats and underpins e-education services in rural India. BharatNet phases (I & II) progressively extended OFC to hundreds of thousands of rural nodes; public-private partnerships and last-mile models (Wi-Fi, radio, satellite) are used to reach schools and community access points. For EduTech deployments, BharatNet reduces recurring internet costs for schools where a local access provider or state network terminates the link but implementers still need to manage last-mile in-school Wi-Fi, power backup and LAN distribution.

- As of March 19, 2025, a total of 2,18,347 Gram Panchayats (GPs) across India have been made service ready under the BharatNet project.
- By March 25, 2025, the Optical Fiber Cable (OFC) network has expanded to 42.13 lakh route kilometers.
- Additionally, 6,92,676 kilometers of OFC have been laid as of January 13, 2025.
- The project has also commissioned 12,21,014 Fibre-To-The-Home (FTTH) connections and installed 1,04,574 Wi-Fi hotspots to enhance digital connectivity in rural areas, thereby bridging the digital divide and supporting inclusive digital growth.[39]

4.2.3.6. National Program on Artificial Intelligence

National AI policy work (NITI Aayog and allied documents) envisions public sector AI pilots across health, agriculture and education and recommends establishment of a National Program on AI to coordinate R&D, skilling

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[36] *https://www.pib.gov.in/PressReleasePage.aspx?PRID=2036640*

[37] *https://cio.economictimes.indiatimes.com/news/cloud-computing/oracle-cloud-empowers-diksha-to-serve-millions-of-students-in-india/102358195*

[38] *https://careervarta.com/diksha-revolution-transforming-indias-teachers-into-digital-leaders/*

[39] *https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2123137*

and pilot deployments. In education this translates into curriculum guidance for AI literacy, teacher training in AI tools, AI-enabled assessment pilots, and pilots that use AI for remediation and learning analytics. For implementers, alignment to national AI principles (responsible AI, data governance, explainability) is increasingly required in tender specifications or evaluation criteria. Under the IndiaAI Mission, the Ministry of Electronics and Information Technology (MeitY) has introduced 'YUVA AI for ALL', a pioneering free course that brings the essentials of Artificial Intelligence (AI) to all Indians, particularly young people. This concise 4.5-hour self-paced program equips students, professionals, and eager learners with foundational AI knowledge and demonstrates its real-world impact. Delivered through simple, hands-on content with relatable Indian examples, it makes complex concepts engaging and accessible. Hosted for free on platforms like FutureSkills Prime, iGOT Karmayogi, and other major ed-tech sites, the course awards completers an official Government of India certificate.[40]

4.2.4. State-Level Flagship Programs

State governments run complementary flagship programs that often move faster than central schemes and create significant demand for SI services. These programs vary in design (direct procurement by education department, SPV execution, PPP models) and commonly fund smart classrooms, lab upgrades, state content and teacher CPD.

4.2.4.1. Kerala (KITE), Odisha (5T), Tamil Nadu (Smart Board Scheme)

Kerala - KITE (Kerala Infrastructure and Technology for Education): a state SPV that evolved from ICT@School to manage large scale ICT deployment, content, training and state-level platforming useful model for PPP or SPV partnership. KITE has successfully completed the distribution of 29,000 robotic kits to high schools across the state[41].

Odisha - 5T initiative: a governance reform package (Transparency, Technology, Teamwork, Time, Transformation) that explicitly prioritizes school transformation, digital classrooms and measurable learning outcome dashboards has catalyzed rapid school upgrades. It has transformed over 7000 schools[42].

Tamil Nadu - Smart Board / Smart Classroom schemes (and recent pilots like TN SPARK for AI/robotics): large procurement drives for interactive boards, teacher training and lab equipment; these state programs often specify large volume rollouts and rapid deployment timelines, creating opportunities for device suppliers, content partners and SI firms. For example Tamilnadu's tenders targets 6,672 additional smart classrooms (INR 127.57 crore) in 5,322 schools and 2,236 hi-tech labs (INR 159.06 crore) in 2,232 schools, targeting 90% tech coverage by 2026-27; includes interactive panels, PCs, UPS, cameras, and 5-year maintenance.[43]

Figure 4.8 Statewise Initiatives for Smart Class rooms

State	Initiative	Key Features
Kerala	KITE (evolved from ICT@School)	ICT deployment, digital content, teacher training, state education platforms; PPP/SPV implementation model
Odisha	5T(Transparency,Technology,Teamwork,Time, Transformation)	Digital classrooms, learning dashboards, comprehensive school infrastructure upgrades
Tamil Nadu	Smart Board / Smart Classroom; TN SPARK	Interactive smart boards, teacher training, AI and robotics labs; large-scale centralized procurement

Source: Frost and Sullivan Analysis

[40] *https://www.pib.gov.in/PressReleasePage.aspx?PRID=2191334&reg=3&lang=2*

[41] *https://www.thehindu.com/news/national/kerala/kite-completes-distribution-of-29000-robotic-kits-in-states-high-schools/article69179975.ece*

[42] *https://timesofindia.indiatimes.com/education/news/odisha-ranks-5th-surpassing-kerala-in-school-education-ranking-secures-prachesta-3-grade/articleshow/122238798.cms*

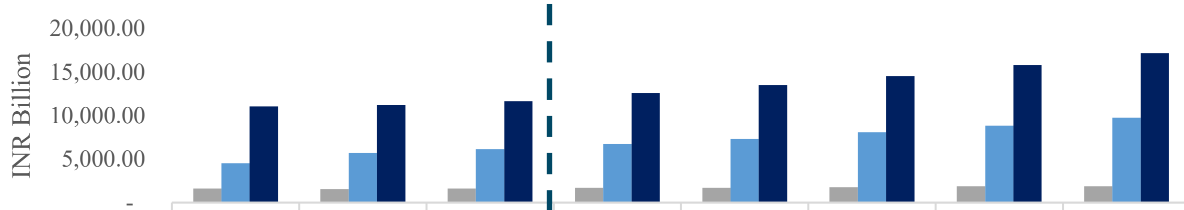
[43] *https://timesofindia.indiatimes.com/city/chennai/6672-more-smart-classrooms-to-be-set-up-in-govt-schools-across-state/articleshow/125116626.cms*

4.3. Market Overview and Opportunity for Smart classrooms in India

4.3.1. Total Technology Spend in India and split by hardware / software and services (incl. system integration)

India's technology spending is projected to grow steadily through 2030, led by rapid software and services expansion, alongside moderate hardware growth, driven by digital transformation.

Figure 4.9 Total Technology Spend in India, CY2023-CY2030F, INR Billion



	CY2023	CY2024	CY2025	CY2026E	CY2027F	CY2028F	CY2029F	CY2030F
Hardware	1,615.00	1,530.00	1,615.00	1,700.00	1,700.00	1,785.00	1,870.00	1,870.00
Software	4,505.00	5,695.00	6,120.00	6,715.00	7,310.00	8,075.00	8,840.00	9,775.00
Services	11,050.00	11,220.00	11,645.00	12,580.00	13,515.00	14,535.00	15,810.00	17,170.00

Source: Frost and Sullivan Analysis

Note: Step 1: Available data from inhouse and secondary research

Step 2: Calculated the historical growth performance of software, services and hardware

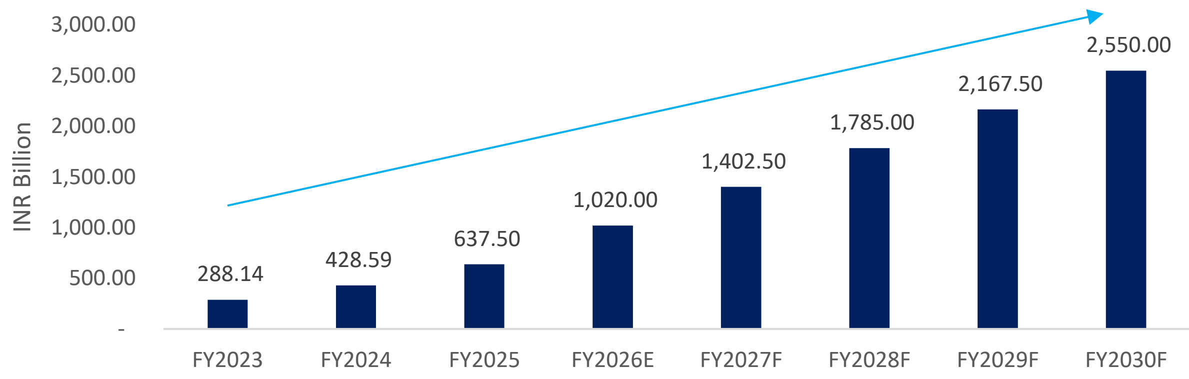
Step 3: Projected the annual future market sizing across the segments based on historical growth.

India's total technology spending is projected to rise significantly between CY2025E and CY2030F, driven by strong growth across hardware, software, and services. Hardware spending is expected to grow from INR 1,615.00 Bn in CY2025E to INR 1,870.00 Bn by CY2030F, reflecting a CAGR of 2.98%. Software will see the fastest growth, expanding from INR 6,120.00 Bn to INR 9,775.00 Bn at a CAGR of 9.82%. Meanwhile, services spending will increase from INR 11,645 Bn to INR 17,170 Bn, growing at a steady 8.08% CAGR, highlighting India's expanding digital transformation and IT infrastructure investments.

4.3.2. Total Technology Spend in India in Education Sector and split by hardware / software and services (incl. system integration)

India's education technology spending is projected to grow rapidly through FY2030F, driven by strong adoption of digital learning platforms, smart classrooms, and EdTech solutions, supported by government initiatives, expanding online infrastructure, and increasing integration of AI-enabled and analytics-based learning technologies across the education ecosystem.

Figure 4.10 Total Technology Spend in India in Education Sector, FY2023-FY2030F, INR Billion



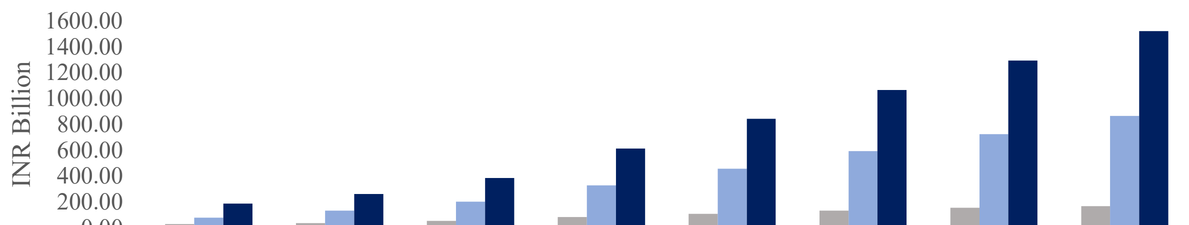
Source: Frost and Sullivan Analysis

Note: Step 1: Available data from inhouse and secondary research
Step 2: Calculated the historical growth performance
Step 3: Projected the annual future market sizing across the segments based on historical growth.

India's technology spending in the education sector is projected to rise sharply from INR 637.50 Bn in FY2025 to INR 2,550.00 Bn by FY2030F, reflecting a robust CAGR of 31.95%. This rapid growth highlights the accelerating adoption of digital learning platforms, smart classrooms, and educational technology solutions across the country. Increasing investments in online learning infrastructure, government initiatives to promote digital education, and the growing integration of AI and analytics in learning processes are key contributors. The surge underscores India's commitment to transforming its education ecosystem through technology-driven innovation and accessibility.

India's education technology spending is set to grow strongly through FY2030, led by services and software expansion, with rising hardware investments supporting nationwide digital learning and smart classroom adoption.

Figure 4.11 Total Technology Spend in India in Education Sector, Split by Hardware, Software and Services FY2023-FY2030F, INR Billion



	FY2023	FY2024	FY2025	FY2026E	FY2027F	FY2028F	FY2029F	FY2030F
Hardware	27.10	35.55	53.13	82.59	105.85	130.61	152.84	165.49
Software	75.60	132.33	201.32	326.23	455.15	590.85	722.50	865.04
Services	185.44	260.71	383.06	611.17	841.50	1063.54	1292.16	1519.47

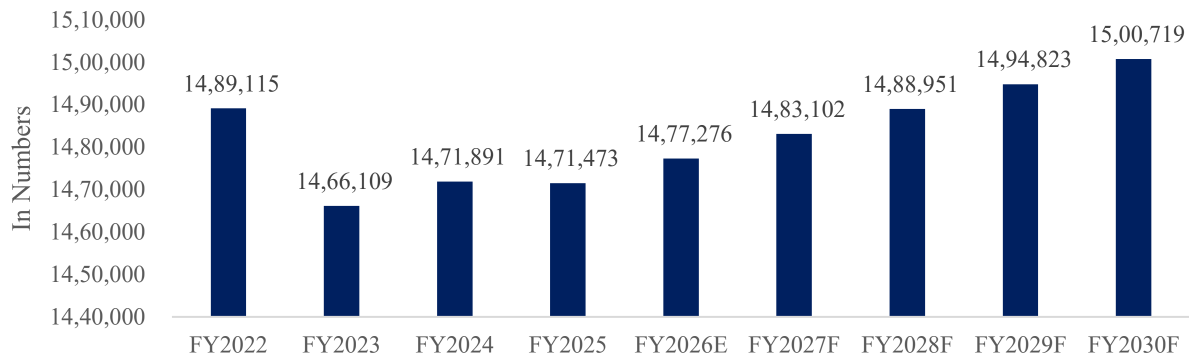
Source: Frost and Sullivan Analysis

India's education sector technology spending is projected to grow sharply between FY2023 and FY2030, driven by accelerated digital adoption across schools and higher education institutions. Hardware spending rises steadily from INR 27.10 billion to INR 165.49 billion, reflecting large-scale deployments of smart classrooms, devices, and infrastructure. Software expenditure shows faster growth, increasing from INR 75.60 billion to INR 865.04 billion, supported by learning platforms, digital content, and assessment solutions. Services remain the largest component, expanding from INR 185.44 billion to INR 1,519.47 billion, driven by system integration, cloud services, maintenance, training, and managed services.

4.3.3. Total System Integration Market in India in Education Sector (split for public sector schools)

Smart classroom adoption across Indian schools accelerates through FY2025, led by government-aided and private institutions, reflecting strong policy support, rising digital demand, and sustained education technology investments.

Figure 4.12 Number of Schools, FY2022-FY2025, Units

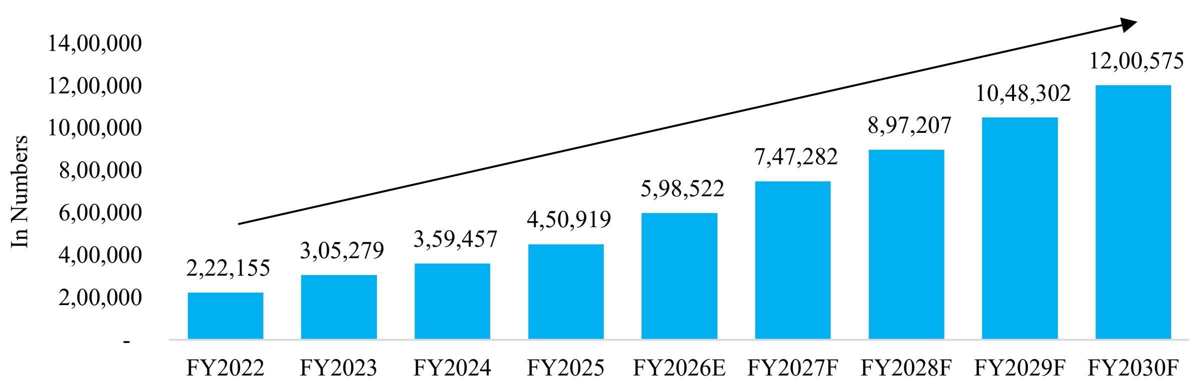


Source: Frost and Sullivan Analysis | Note: The above market includes Primary, Upper Primary, Secondary, and Higher Secondary Schools across India

The number of schools in India was 1,489,115 in FY2022, declining to 1,466,109 in FY2023, before increasing to 1,471,891 in FY2024 and remaining almost stable at 1,471,473 in FY2025. From FY2026 onwards, the total number of schools is projected to rise steadily, reaching 1,477,276 in FY2026E, 1,483,102 in FY2027F, 1,488,951 in FY2028F, 1,494,823 in FY2029F, and 1,500,719 by FY2030F.

Figure 4.13 Total Number of schools, Smart class rooms equipped, FY2022-FY2030F, In Units

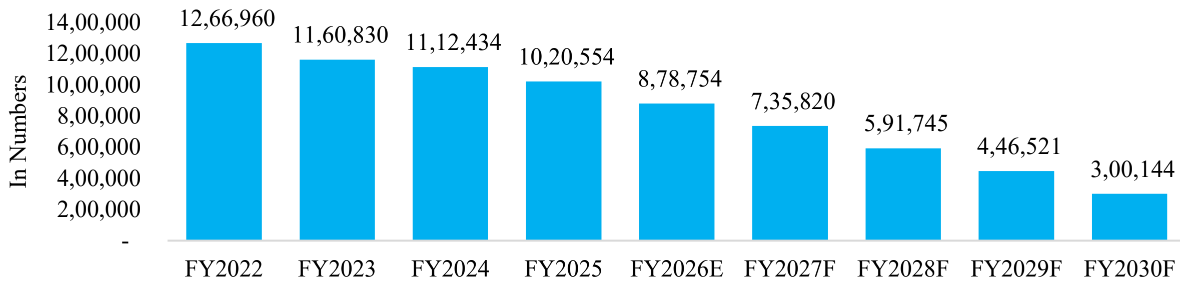
India's smart-classroom–enabled schools are projected to grow rapidly through FY2030, reflecting strong digital education adoption, government initiatives, and large-scale investments in classroom technology infrastructure.



Source: Frost and Sullivan Analysis | Note: The above market includes Primary, Upper Primary, Secondary, and Higher Secondary Schools across India

The number of schools in India equipped with functional smart-classrooms has increased significantly over recent years. In FY2022, around 222,155 schools across the country had functional smart-classrooms. This number is projected to nearly double to approximately 450,919 schools by FY2025, and further surge to an estimated 1,200,575 schools by FY2030F. This reflects more than a fivefold increase over FY2022, underscoring the country's accelerating shift toward digital learning environments.

Figure 4.14 Total Number of schools, not equipped with Smart Class, FY2022-FY2030F, In Units



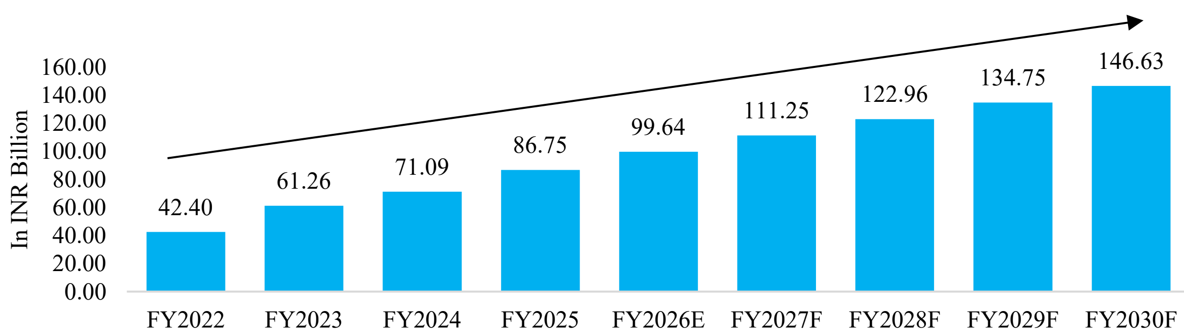
Source: Frost and Sullivan Analysis | Note: The above market includes Primary, Upper Primary, Secondary, and Higher Secondary Schools across India

The number of schools in India not equipped with smart classroom infrastructure has been steadily declining, reflecting accelerated digital adoption in school education. In FY2022, about 1,266,960 schools lacked smart classrooms, which reduced to 1,160,830 in FY2023 and 1,112,434 in FY2024. The figure further declined to 1,020,554 schools in FY2025. This downward trend is projected to continue, with unequipped schools decreasing to 878,754 in FY2026, 735,820 in FY2027, 591,745 in FY2028, 446,521 in FY2029, and 300,144 by FY2030. The sharp reduction underscores sustained government initiatives, policy alignment with NEP 2020, and large-scale smart classroom deployment programs across states.

Smart classroom adoption across Indian schools is projected to surge through FY2030, led by government institutions, with rapid growth in aided and private schools driven by digital education initiatives.

TAM

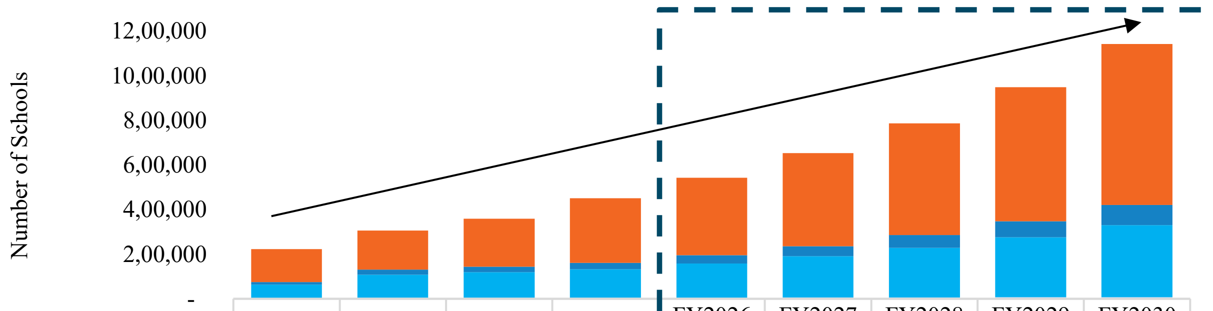
Figure 4.15 TAM, India Smart Classroom, FY2022-FY2030F, INR Billion



Source: Frost and Sullivan Analysis

The total addressable market (TAM) for smart classrooms in India shows strong and sustained growth over the period FY2022–FY2030F. The market size stood at INR 42.40 billion in FY2022 and expanded to INR 61.26 billion in FY2023 and INR 71.09 billion in FY2024. Growth accelerated further to INR 86.75 billion in FY2025. The TAM is projected to rise sharply to INR 99.64 billion in FY2026E, INR 111.25 billion in FY2027F, INR 122.96 billion in FY2028F, INR 134.75 billion in FY2029F, and reach INR 146.63 billion by FY2030F, driven by large-scale smart classroom deployments and policy-led digital education initiatives.

Figure 4.16 Total number of schools adopted smart classrooms, Across management type, FY2022-FY2030F, In Units



	FY2022	FY2023	FY2024	FY2025	FY2026 E	FY2027 F	FY2028 F	FY2029 F	FY2030 F
Government	1,47,670	1,75,041	2,15,432	2,89,815	3,47,828	4,17,453	5,01,015	6,01,304	7,21,668
Government Aided	10,531	22,739	24,870	28,974	36,355	45,615	57,235	71,815	90,109
Private Unaided	60,536	1,03,107	1,14,463	1,27,391	1,53,446	1,84,829	2,22,631	2,68,165	3,23,012
Others	3,418	4,392	4,692	4,739	5,206	5,719	6,283	6,902	7,582

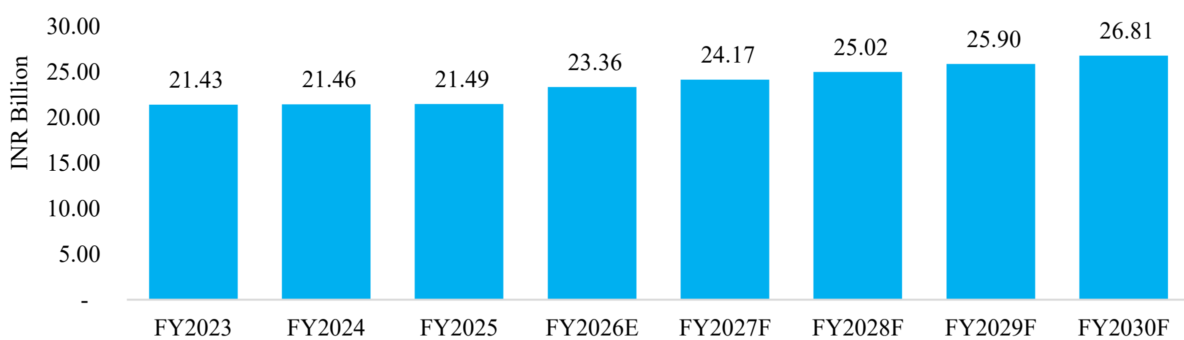
Source: Frost and Sullivan Analysis

The adoption of smart-classrooms across all management types in India has shown remarkable growth and is projected to accelerate further in the coming years.

- The total number of schools equipped with functional smart-classrooms is expected to rise from 222,155 in FY2022 to 450,919 by FY2025, and further to 1,162,890 by FY2030F, marking an overall increase of nearly 424%.
- Among these, government schools dominate with the largest share, growing from 147,670 in FY2022 to 721,668 by FY2030F, a surge of about 389% driven by large-scale public digital initiatives.
- Government-aided schools are projected to record the highest relative growth of approximately 756%, increasing from 10,531 to 90,109 schools, supported by targeted schemes under national education programs.
- Private unaided schools are also set to expand substantially by around 434%, from 60,536 to 323,012, reflecting the rising adoption of technology-based learning in urban and semi-urban regions. Meanwhile, the 'Others' category is expected to grow by nearly 122%, from 3,418 to 7,582 schools.

India's public-sector education system integration market is projected to grow steadily through FY2030, driven by government investments in smart classrooms, digital infrastructure, and ICT-enabled school modernization.

Figure 4.17 Total System Integration Market in India in Education Sector for public sector schools, FY2023-FY2030F, INR Billion



Source: Frost and Sullivan Analysis | The above Market Sizing is only for government run schools

Note: Step 1: The total budget for smart class rooms were calculated based on the budgets published by Department of School education and literacy.

Step 2: Calculated the historical budget for smart class implementation

Step 3: Projected the annual future market sizing for smart class rooms based on historical growth.

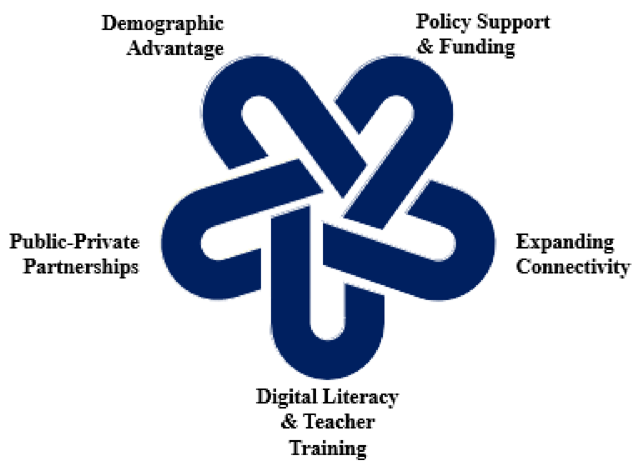
The total system integration market in India's education sector for public sector schools is expected to increase moderately from INR 21.49 Bn in FY2025 to INR 26.81 Bn by FY2030F, registering a CAGR of 4.53%. This growth reflects steady investments by government bodies in modernizing school infrastructure, implementing digital learning solutions, and integrating IT systems to enhance administrative efficiency. While the pace of expansion is gradual compared to private sector initiatives, continued emphasis on digital classrooms, centralized data management, and ICT-driven education programs is expected to sustain market momentum through 2030.

4.3.4. Key market enablers, challenges and technology trends and innovation in the education / EduTech and smart classrooms sector

The education and EduTech ecosystem in India, particularly the smart classroom segment, is influenced by a combination of policy support, funding flows, infrastructure readiness, and user adoption dynamics. Several enablers are accelerating adoption, while persistent challenges constrain scalability. Alongside, a wave of emerging technology trends and innovations is reshaping the future trajectory of this sector.

Market Enablers

Figure 4.18 Market Enablers



Source: Frost and Sullivan Analysis

Policy Support & Funding: India's policy ecosystem provides a robust foundation for EduTech expansion in schools. The National Education Policy (NEP) 2020 has been a key catalyst, emphasizing technology integration to improve access, equity, and quality in education. Complementary initiatives such as Digital India, Samagra Shiksha Abhiyan, and PM e-Vidya further strengthen this momentum by funding digital infrastructure, smart classrooms, and teacher training programs. The creation of national digital platforms like DIKSHA (Digital Infrastructure for Knowledge Sharing) has enabled states to host and disseminate curriculum-aligned content. Collectively, these policies establish an enabling environment that encourages experimentation, public-private partnerships, and long-term sustainability of digital learning.

Expanding Connectivity: Connectivity has historically been a bottleneck for digital learning, particularly in rural India. However, nationwide efforts under BharatNet and various state-led broadband initiatives are gradually bridging the last-mile connectivity gap. By extending high-speed internet to gram panchayats and schools in remote areas, these programs are enabling access to cloud-based learning platforms and virtual classrooms. The expansion of 4G and emerging 5G networks further supports real-time interactivity and multimedia-rich learning experiences, allowing even small schools to participate in digital ecosystems.

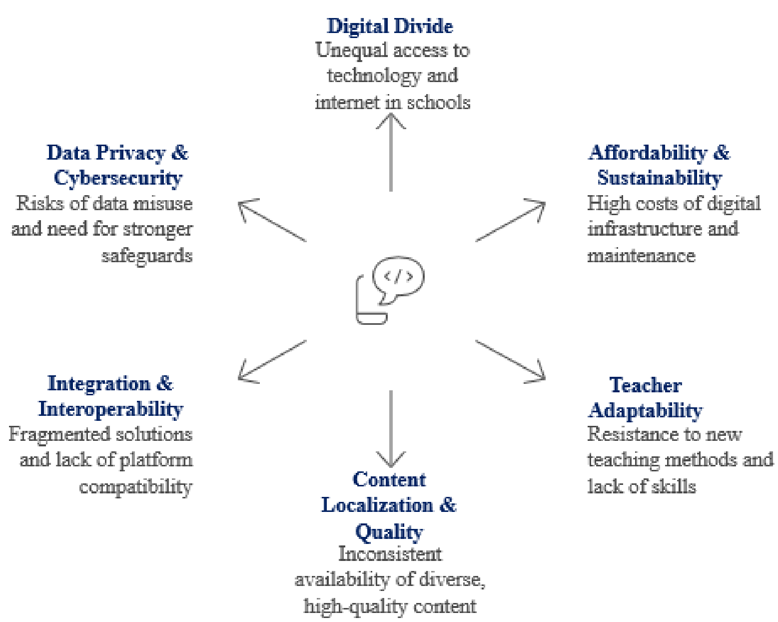
Growing Digital Literacy & Teacher Training Programs: Teacher readiness is improving through structured capacity-building programs across states. Initiatives under Samagra Shiksha and National Initiative for School Heads' and Teachers' Holistic Advancement (NISHTHA) focus on digital literacy, ICT-enabled pedagogy, and blended learning practices. These training efforts are helping teachers integrate digital tools into classroom instruction, design interactive lessons, and use analytics for student assessments. Continuous professional development through online platforms and peer networks ensures that teacher competency evolves alongside technological advancements.

Public-Private Partnerships (PPPs): Collaborations between government agencies and private EduTech players have become instrumental in scaling technology adoption. PPPs enable states to leverage private sector innovation, technical expertise, and flexible financing models while maintaining public oversight. These partnerships often cover system integration, content development, and end-to-end management of digital classrooms. For instance, partnerships with content providers and startups have accelerated digital resource deployment across states such as Karnataka, Maharashtra, and Gujarat. PPPs also foster knowledge transfer and bring global best practices into the public education ecosystem.

Demographic Advantage: India's demographic profile is one of its strongest enablers. With over 250 million school-going children, the country represents one of the world's largest education markets. Rising aspirations for quality education among middle- and lower-income families are driving demand for digital and smart classroom solutions. The growing penetration of affordable smartphones and tablets is also increasing student familiarity with technology, making digital learning more natural and engaging. This demographic momentum ensures a steady and expanding user base for EduTech innovations in the years ahead.

Market Challenges

Figure 4.19 Market Challenges



Source: Frost and Sullivan Analysis

Digital Divide: Despite substantial progress, the digital divide remains a pressing challenge. Unequal access to devices, reliable electricity, and stable internet continues to create disparities between urban and rural learners. Many government schools still lack the basic infrastructure needed to operate smart classrooms effectively. Students from marginalized communities risk falling behind due to these infrastructural and socio-economic barriers. Addressing this requires focused interventions such as device-sharing models, offline-first applications, and solar-powered systems that make digital learning accessible in low-resource settings.

Affordability & Sustainability: Implementing and maintaining smart classrooms involve significant costs. Beyond the initial capital investment for hardware, recurring expenses such as maintenance, software licensing, and content updates can strain public school budgets. Without dedicated funding mechanisms or long-term procurement frameworks, many projects risk becoming unsustainable. Developing cost-sharing models through PPPs, adopting open-source content, and prioritizing energy-efficient hardware can help optimize costs and ensure financial sustainability.

Teacher Adaptability: Technology adoption in classrooms ultimately depends on teachers. Resistance to change, fear of technology, and lack of confidence in digital pedagogy can hinder effective use of EduTech. While many training programs exist, they often focus on tool familiarity rather than pedagogical transformation. To enhance adaptability, training must be contextual, continuous, and aligned with local teaching realities. Empowering teachers through recognition programs, digital certification, and peer learning networks can foster a positive attitude toward technology integration.

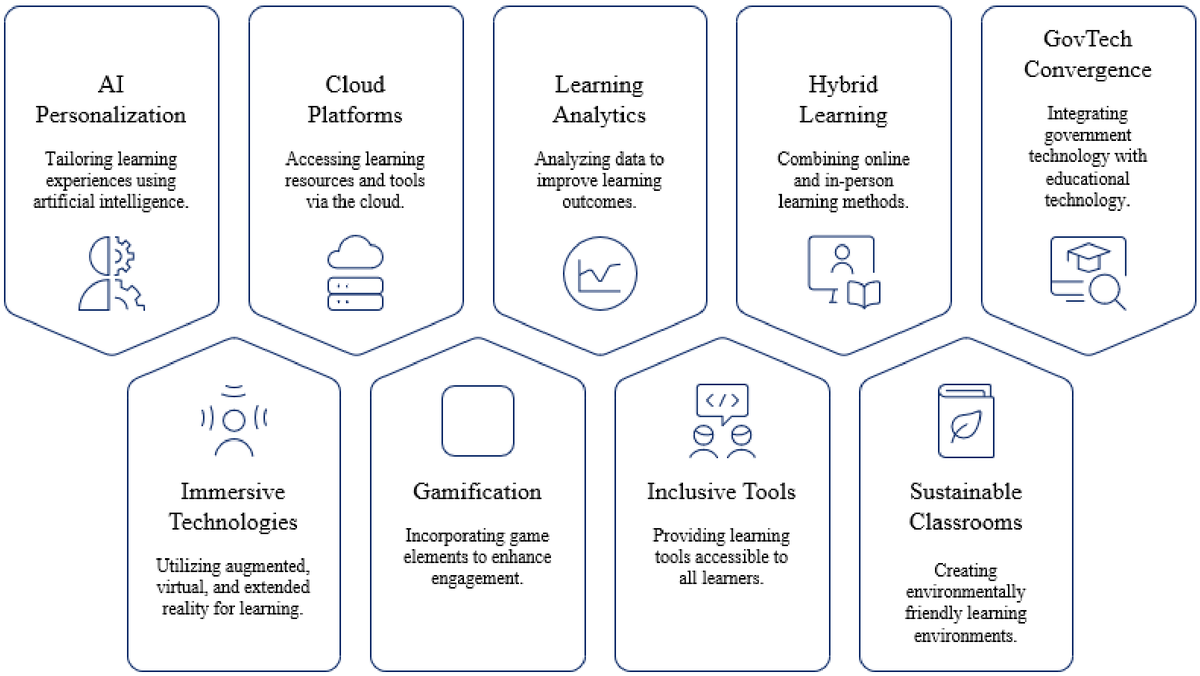
Content Localization & Quality: A major bottleneck in the Indian EduTech landscape is the uneven availability of high-quality, curriculum-aligned content in regional languages. Despite large digital repositories, much of the material remains urban-centric or linguistically limited, reducing its relevance for diverse learners. Localized, culturally sensitive, and interactive content tailored to regional curricula can bridge this gap. Investment in multilingual digital content creation using AI-powered translation and voice technologies—will enhance inclusivity and learner engagement.

Integration & Interoperability Issues: The EduTech market is often fragmented, with multiple vendors offering proprietary solutions that do not seamlessly integrate. Lack of adherence to open standards and poor interoperability between Learning Management Systems (LMS), digital boards, and assessment tools complicates system-wide implementation. This fragmentation leads to data silos and inefficiencies. Encouraging open APIs, standardized data formats, and national interoperability guidelines can enable smoother integration across platforms.

Data Privacy & Cybersecurity Concerns: As schools increasingly rely on digital platforms for learning management and student data, cybersecurity and privacy risks are growing. Without strong regulatory safeguards, sensitive student information can be exposed to misuse. Establishing stringent data protection frameworks, adopting encryption protocols, and training teachers and administrators on cybersecurity best practices are crucial to maintaining trust in digital education systems.

Technology Trends & Innovation

Figure 4.20 Technology Trends and Innovation



Source: Frost and Sullivan Analysis

AI-Driven Personalization: Artificial Intelligence (AI) has become a cornerstone of next-generation EduTech systems, offering the promise of personalized and adaptive learning. Traditional classroom models often rely on standardized instruction, which fails to account for the diverse learning pace and style of each student. AI-driven personalization addresses this limitation by analyzing data on student behavior, performance, and preferences to tailor learning experiences in real time.

Adaptive learning platforms and intelligent tutoring systems (ITS) are increasingly being piloted in Indian schools to provide customized learning paths, automated feedback, and remedial recommendations. These systems can dynamically adjust lesson difficulty, suggest targeted exercises, and identify areas where students need extra support. Teachers benefit as well AI analytics help them track class-wide learning patterns, pinpoint struggling learners, and design differentiated instruction strategies. When scaled effectively, AI personalization has the potential to democratize access to quality education by ensuring that each student, regardless of background, receives instruction suited to their abilities and learning style. Haryana's e-Adhigam project exemplifies this, deploying personalized adaptive learning (PAL) apps pre-installed on devices for over 500,000 students across government schools, dynamically adjusting content based on performance data to address learning gaps. Delhi's Project Abhishikt uses AI to identify gifted students and tailor advanced curricula, while iPrep PAL operates in states like Rajasthan and Andhra Pradesh, offering offline-capable diagnostics, videos, and mastery-based paths for Classes 3-12.[44]

Immersive Technologies (AR/VR/XR): Immersive technologies such as Augmented Reality (AR), Virtual Reality (VR), and Extended Reality (XR) are transforming passive learning into interactive, experiential engagement. In subjects like science, geography, and vocational education, these tools enable students to visualize complex concepts through lifelike simulations. For example, students can explore virtual chemistry labs, dissect 3D human anatomy models, or experience historical events as if they were present.

In India, AR and VR-based learning tools are being introduced in smart classrooms and teacher training programs to enhance comprehension and retention. These technologies also support skill-based education, particularly in

[44] https://www.idreameducation.org/blog/adaptive-education-technology-trends/

vocational and technical fields, where hands-on experience is critical but physical labs are often unavailable. As hardware costs decline and cloud-based XR content becomes more accessible, immersive learning will increasingly become a core component of mainstream education, bridging the gap between theory and practice.

Cloud-Based and Mobile-First Platforms: Cloud computing is a critical enabler of scalability, accessibility, and flexibility in EduTech deployment. With India's vast geographical and demographic diversity, centralized, cloud-hosted learning platforms allow uniform access to content, assessments, and analytics from anywhere. These platforms ensure seamless integration with Learning Management Systems (LMS), providing a backbone for content management, student tracking, and collaboration tools.

Mobile-first approaches complement this trend, acknowledging the reality that mobile devices remain the most widely used gateway to the internet for students and teachers, especially in rural areas. Mobile learning apps optimized for low bandwidth and offline access make digital education inclusive, even in areas with unstable connectivity. Platforms like DIKSHA and SWAYAM leverage cloud architecture to deliver digital textbooks, interactive lessons, and teacher training content to millions. This convergence of cloud and mobile ecosystems ensures continuity of learning, cost efficiency, and equitable access across India's education landscape.

Gamification & Interactive Content: Gamification is reshaping classroom engagement by introducing elements of play, competition, and reward into learning environments. Game-based learning modules, quizzes, and simulations stimulate curiosity and make lessons more participatory. For younger students, gamification turns routine tasks like math exercises or vocabulary drills into exciting challenges, reinforcing learning through repetition and reward mechanisms.

Interactive content, when integrated with smart boards and tablets, encourages active participation and enhances retention. Teachers can use gamified dashboards to track student progress and reward achievements, fostering motivation and collaboration. Indian EduTech startups are increasingly using gamification to address diverse learner groups—ranging from early education to professional skill development making learning not only effective but also enjoyable.

AI & Learning Analytics: The role of AI extends beyond personalization into large-scale learning analytics, where data becomes a powerful tool for decision-making. AI-driven dashboards and predictive analytics help administrators, educators, and policymakers monitor student performance, evaluate teacher effectiveness, and assess institutional efficiency.

Learning analytics systems aggregate data from assessments, attendance records, and digital interactions to provide insights into learning outcomes. Predictive algorithms can flag at-risk students, enabling timely interventions and support. At the policy level, these insights inform curriculum reforms and funding decisions by revealing systemic gaps and success patterns.

In India, initiatives such as NDEAR (National Digital Education Architecture) are integrating analytics with government databases like UDISE+ to create data-driven governance models. By enabling evidence-based decision-making, AI and learning analytics are transforming education from reactive management to proactive improvement.

Multi-Language & Inclusive Learning Tools: India's linguistic and socio-economic diversity demands inclusive digital learning ecosystems. Advances in Natural Language Processing (NLP), machine translation, and text-to-speech technologies are helping bridge linguistic and accessibility barriers.

AI-driven translation engines can now convert educational content into multiple Indian languages, ensuring that learners from different regions can access material in their mother tongue. Text-to-speech and speech recognition technologies assist visually impaired or differently abled learners, while adaptive interfaces support those with cognitive or motor challenges. AICTE's Anuvadini platform supports text-to-speech and translation across 22 Indian and foreign languages, enabling seamless multilingual educational content delivery for 80% of non-English native speakers.[45]

Inclusive design is becoming central to EduTech innovation, aligning with NEP 2020's vision of equitable education. Platforms that offer multilingual, accessible content are not only expanding reach but also improving comprehension and learner engagement across diverse student populations.

Hybrid & Blended Learning Models: The COVID-19 pandemic fundamentally altered the education paradigm, leading to a sustained shift toward hybrid and blended learning models. These models combine traditional classroom instruction with digital learning tools, allowing flexibility and continuity even during disruptions.

In India, this has translated into rising demand for smart boards, interactive displays, digital repositories, and collaborative platforms that complement physical teaching. Hybrid models promote self-paced learning, enabling students to review recorded lessons or access supplementary material online. Teachers can integrate online quizzes, videos, and interactive assignments into lesson plans, enhancing engagement and personalization.

Blended learning is also improving school resilience by reducing dependence on physical infrastructure. It supports differentiated instruction and encourages student autonomy, making education more adaptable and learner-centric.

Green & Sustainable Classrooms: Sustainability is emerging as an important pillar of digital education. As India scales up EduTech deployment, ensuring environmental responsibility has become a key consideration. Green classrooms integrate energy-efficient hardware, solar-powered setups, and responsible e-waste management practices to minimize ecological impact.

Solar-powered digital boards and charging stations are particularly relevant for rural schools with inconsistent electricity supply. Furthermore, modular device design and lifecycle management reduce electronic waste by enabling repair and component reuse. Institutions are also exploring eco-friendly procurement policies that prioritize longevity and recyclability of devices. Sustainable technology practices not only reduce costs but also align with India's broader climate and development goals, making green EduTech models both economically and environmentally viable.

EduTech–GovTech Convergence: A defining feature of India's evolving EduTech ecosystem is its increasing integration with government digital infrastructure what can be termed EduTech–GovTech convergence. Platforms like DIKSHA, UDISE+, and BharatNet serve as foundational layers that link educational content, data, and connectivity across the nation.

This convergence eliminates redundancy by consolidating digital resources under common frameworks and open standards. For instance, integrating LMS platforms with DIKSHA enables content sharing across states, while UDISE+ provides granular data to inform policy decisions. NDEAR serves as a unifying architecture, facilitating interoperability among EduTech tools, databases, and administrative systems.

Such integration ensures that technology deployments are not fragmented or vendor-dependent, but instead form part of a cohesive national digital education ecosystem. The result is greater efficiency, scalability, and transparency key prerequisites for sustainable digital transformation in the public education sector.

[45] https://netf.aicte-india.org/major-initiatives.html

5. MARKET OUTLOOK AND OPPORTUNITY FOR SKILL DEVELOPMENT IN INDIA

5.1. Introduction

India's skill development ecosystem features flagship national programs focused on workforce upskilling, apprenticeships, and artisan enablement, creating significant market opportunities for toolkit suppliers through large-scale procurement under schemes like PM Vishwakarma. These initiatives target grassroots workers, with standardized toolkits (e.g., modern carpentry/sewing kits) driving demand via government tenders and partnerships.

Key Flagship Programs

- Pradhan Mantri Kaushal Vikas Yojana 4.0 (PMKVY 4.0): Delivers short-term training, Recognition of Prior Learning (RPL), and special projects via Skill India Digital Hub; updated 2025 guidelines emphasize job-linked outcomes with 1.5 crore trainees targeted by 2026.
- Skill India Digital Hub (SIDH): Live portal/app for course discovery, e-KYC, enrollment, and job matching; 2 crore+ registrations as of 2026, integrating NSQF courses.
- Apprenticeships: NAPS (MSDE) reformed stipends (May 2025); NATS 2.0 (Education Ministry) supports 50 lakh apprentices with DBT payouts via AICTE portal.
- ITI Modernization: STRIVE upgraded 424 ITIs (concluded 2024); PM-SETU (Sep 2025) creates SPVs with industry for 1,000 ITIs; new DGT affiliation norms boost equipment standards.
- Jan Shikshan Sansthan (JSS): 289 units train 10 lakh+ disadvantaged learners annually in non-formal skills.
- PM Vishwakarma: Launched in September 2023, the PM Vishwakarma Scheme has evolved into a holistic program aimed at strengthening traditional artisans and craftspersons in rural areas by integrating them into the formal economic ecosystem. The initiative delivers comprehensive assistance, including issuance of a PM Vishwakarma Identity Card and Certificate, skill upgradation training with a daily stipend of ₹500, a complimentary toolkit valued at ₹15,000, access to collateral-free credit facilities, and incentives to promote digital transactions. Beyond financial aid and capacity building, the scheme prioritizes market access through platforms such as PM Vishwakarma Haat, enabling artisans to display, brand, and sell their products to wider national and global markets. Captured in the vision statement "Virasat se Vikas," the program seeks to transform traditional heritage into sustainable economic growth. As of 22 January 2026, the scheme has attracted 2.72 crore applications for selection and has successfully registered around 30,000 artisans.[46]
- NSDC Partnerships: Future Skills PRIME hubs (2025 launch) for AI/green jobs; global academies via CSR.
- IndiaSkills/WorldSkills: Prepares 1,000+ competitors yearly, with WorldSkills Asia 2025 success

5.1.1. Role of Skill Development in India's Economic & Social Agenda

For government schools, skill development via EduTech plays three complementary roles:

- **Foundational & 21st-century skills:** EduTech platforms in government schools are instrumental in fostering both foundational and 21st-century competencies among students. Adaptive digital tools, such as AI-powered learning modules, are widely deployed to address literacy and numeracy gaps while simultaneously building digital literacy and problem-solving abilities. Platforms like DIKSHA provide access to interactive videos, QR-coded textbooks, and culturally relevant content in over 35 languages, directly serving more than 120 million learners[47]. These resources go beyond rote learning, enabling

[46] https://www.pib.gov.in/FeaturesDeatils.aspx?id=157068&NoteId=157068&ModuleId=2&reg=3&lang=2

[47] *https://www.roombr.com/blog/digital-classroom-govt-initiatives-india*

students to engage with material through simulations, quizzes, and contextual challenges. This not only improves overall learning outcomes but ensures that students are equipped with digital skills essential for future employability, narrowing the gap between academic achievement and workforce readiness.

- **Teacher capacity building at scale:** EduTech also serves as a catalyst for large-scale teacher professional development a critical factor in the effectiveness of school education. Through platforms like DIKSHA and PM e-VIDYA, teachers gain access to continuous professional development (CPD) resources, micro-courses, and digital coaching modules. Over 2.5 million teachers have taken advantage of these national tools for CPD, participating in blended instruction, digital lesson planning, and assessment support. Real-time dashboards and integrated feedback mechanisms on these platforms allow for ongoing evaluation and adaptation of teaching practices, raising classroom standards consistently across diverse geographies. This scalable approach addresses the chronic shortage of in-person training and fosters a culture of lifelong learning among educators, which is key to sustaining improvements in student outcomes.
- **Local livelihoods & community resilience:** Government schools increasingly act as hubs for local economic development by anchoring after-school vocational modules, micro-entrepreneurship labs, and digital literacy workshops for students, parents, and broader community members. By delivering skilling programs such as coding clubs, basic business skills, and digital fluency badges at the school level, these initiatives promote social mobility and help bridge the rural-urban skills divide. National EduTech platforms and schemes like Samagra Shiksha and NIPUN Bharat enable cost-effective rollout of these services, often leveraging shared digital infrastructure or low-cost devices. The result is a sustainable model where schools double as community skilling centers, empowering local populations and instilling resilience in the face of economic shifts.

5.1.2. The Rural-Urban Skilling Divide: Addressing India's Informal Workforce

India’s unemployment rate stands at 7.8%, with rural unemployment marginally higher than urban unemployment at 7.9%. In developing economies, such vulnerability in the labour market is largely driven by low levels of education and limited skill development among workers, which restrict their employability and resilience to economic shocks.[48]

The rural-urban skilling divide remains one of the most persistent barriers to inclusive economic growth in India. Most of India’s workforce is employed in the informal economy, where jobs are characterized by low productivity, income insecurity, and limited access to formal training. This divide is not merely geographical; it reflects deep structural inequalities in access to education, infrastructure, technology, and employment networks.

In rural areas, skilling challenges stem from inadequate training institutions, poor digital connectivity, and curricula that are misaligned with local livelihoods. Most rural workers acquire skills informally through family-based occupations such as agriculture, construction, handicrafts, or small-scale services. While these skills are valuable, they often remain uncertified, restricting mobility and wage growth. Women and youth are particularly affected, as social norms and migration constraints further limit exposure to diversified skill opportunities.

Urban centers, by contrast, offer greater access to vocational institutes, industrial clusters, and digital platforms. However, informal urban workers—such as migrants, street vendors, and gig workers—face their own barriers, including high living costs, unstable employment, and limited recognition of prior learning. The result is a fragmented skilling ecosystem where mobility between rural and urban labor markets remains inefficient.

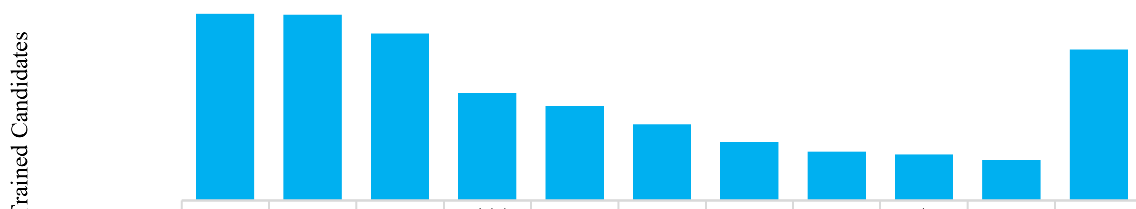
Bridging this divide requires a context-specific and inclusive approach. Skilling programs must integrate local demand mapping, modular training, and recognition of prior learning to formalize existing capabilities. Digital skilling initiatives should be paired with investments in rural connectivity and last-mile training delivery. Industry partnerships, apprenticeships, and cluster-based training can align skills with real employment opportunities. Equally important is social protection such as portable benefits and wage-linked incentives to encourage informal workers to participate in training.

[48] *https://www.sdmimd.ac.in/iec2022/papers/236.pdf*

Addressing the rural-urban skilling divide is essential not only for improving livelihoods but also for enhancing productivity, supporting manufacturing and services growth, and realizing India's demographic dividend in an equitable and sustainable manner.

5.1.3. Impact of skill development program in India

Figure 5.1 Total Number of Skill Trained Candidates (as of 31.05.2026)



	Mason (Rajmistri)	Carpenter (Suthar/ Badhai)	Tailor (Darzi)	Cobbler (Charmakar)/ Shoesmith/Footwear artisan	Garland maker (Malakaar)	Basket/ Mat/Broom Maker/ Coir Weaver	Washerman (Dhobi)	Potter (Kumhaar)	Sculptor (Moortikar, stone carver), Stone breaker	Hammer and Tool Kit Maker	Others
Skilled Candidates	4,17,800	4,15,589	3,73,284	2,40,147	2,11,758	1,70,218	1,31,048	1,09,089	1,02,725	90,205	3,37,046

Source: Ministry Of Micro, Small & Medium Enterprises | Note: Others include Fishing Net Maker, Barber (Naai), Goldsmith (Sonar), Doll & Toy Maker (Traditional), Armourer, Boat Maker, Locksmith and Metal smith/Metal Caster

The total Skilled trained workers through various government initiatives include 4,17,800 masons, 4,15,589 carpenters, 3,73,284 tailors, 2,40,147 cobblers, and others in crafts like garland making, basket weaving, pottery, and sculpting. The government, through initiatives like the Ministry of Skill Development & Entrepreneurship (MSDE), is actively working to upskill these traditional artisans as well as modern workforce segments to enhance employability and bridge skill gaps. This effort aligns with a broader push to formalize and strengthen skill development to meet the demands of evolving economic sectors and reduce underemployment while preserving traditional crafts.

5.1.4. Skill Development Models – Institutional, Community-Based, PPP, CSR

Institutional (School + State)

Government schools integrate digital skilling directly into their curricula and daily schedules. Schemes such as Samagra Shiksha allocate significant funding for ICT infrastructure, smart classrooms, and vocational skill-building, enabling periodic vocational periods and after-school clubs focused on employability-relevant skills. This model institutionalizes skilling by embedding it into formal education, reaching approximately 50% of secondary students nationally, aligned with the National Education Policy (NEP)[49].

Community-Based

Leveraging existing school infrastructure beyond school hours, community models engage local NGOs and self-help groups to run evening classes, digital literacy drives for women, and micro-entrepreneurship labs. These initiatives extend skilling benefits to out-of-school youth and adult learners in rural areas. For example, community-based programs supported by national skill missions train over 30 lakh women annually in digital and vocational skills with localized curriculum content. Schools thus act as community hubs, catalyzing lifelong learning and local economic empowerment by nurturing micro-entrepreneurs and digital literates.

Public–Private Partnership (PPP)

PPPs mitigate implementation risk by incorporating private sector expertise to design and deliver industry-responsive curricula. Sector Skill Councils and the National Skill Development Corporation (NSDC) jointly accredit and monitor

[49] *https://wheebox.com/assets/pdf/ISR_Report_2025.pdf*

short courses offered through school premises. Around 40% of skill development courses currently leverage PPPs to ensure course content relevance and placement opportunities. EduTech vendors extensively collaborate with State Skill Development Missions (SSDMs) and local industries to co-design training aligned with market demands, connecting learners to employment networks in sectors such as IT, manufacturing, and green energy.

CSR / Foundation-Supported

CSR-funded pilot projects serve as innovation test beds for unconventional delivery methods including mobile skilling vans, solar-powered digital labs, and gamified micro-skills training. These pilots generate critical learning and placement data, establishing pathways for wider adoption by government programs. Interns will receive a monthly financial allowance of Rs. 5,000, with Rs. 4,500 funded by the government and Rs. 500 contributed by the company from its CSR funds. Additionally, each intern will be granted a one-time sum of Rs. 6,000 for incidental expenses, disbursed by the Ministry of Corporate Affairs at the start of the internship. The company will also cover all training-related expenses for the interns under this scheme using its CSR budget, in accordance with prevailing regulations. Should any company choose to increase the monthly assistance beyond Rs. 500, such additional payment must come from its own resources[50].

5.1.5. Stakeholder & Partner Ecosystem Mapping

5.1.5.1. Central Agencies: MSDE, NSDC, NCVET, NSDA

MSDE & NSDC: The Ministry of Skill Development and Entrepreneurship (MSDE) and the National Skill Development Corporation (NSDC) primarily target post-school skill enhancement but play a pivotal role in bridging school-based vocational initiatives with the broader skilling ecosystem. MSDE emphasizes convergence by integrating apprenticeships and micro-credentialing into skill development pathways, enabling seamless transitions for higher secondary students to workforce readiness. Through their financing models and extensive market engagement, NSDC facilitates the scaling of private skill providers, ensuring wider access to quality vocational training.

NCVET/NSDA: On the regulatory front, the National Council for Vocational Education and Training (NCVET) and the National Skill Development Agency (NSDA) ensure the quality and credibility of skill certifications, a critical aspect when aligning school-based skilling with employer expectations. With the adoption of the National Skills Qualification Framework (NSQF), they standardize the recognition of skills and facilitate stackable credentials, allowing learners to build modular competencies that can be accumulated and recognized across varied employment sectors. EduTech providers that align their learning products to NCVET/NSQF frameworks are better positioned to deliver measurable training outcomes and improve employment placements. By certifying short courses and integrating assessment and recognition standards, these agencies drive trust and transparency in the skill development ecosystem.

5.1.5.2. State Skill Development Missions (SSDMs)

State Skill Development Missions (SSDMs) play a critical role in shaping skill development priorities at the state level and managing the allocation and utilization of state-specific funds. They function as essential intermediaries that bridge national skill development objectives with localized implementation strategies, ensuring that vocational training and skilling initiatives are contextually relevant to the local workforce and economic needs.

One of the primary responsibilities of SSDMs in relation to school-based skill development programs is to evaluate, approve, and provide co-funding for vocational training pilots conducted within schools. These pilots often serve as testing grounds for innovative skilling methods and curricula tailored to the state's industrial and labor market demands, allowing states to nurture talent from a young age in line with regional employment opportunities.

Additionally, SSDMs facilitate the integration of school graduates into broader state-sponsored apprenticeship programs and placement drives. This linkage helps smooth the transition from education to employment by offering

[50] *https://www.pib.gov.in/PressReleasePage.aspx?PRID=2061909*

practical on-the-job training aligned with recognized skill standards. By connecting learners to apprenticeships and job opportunities, SSDMs enhance the relevance and efficacy of vocational training while supporting state economic development goals.

SSDMs also streamline procurement processes vital for skilling program delivery. They manage vendor selection and contracting through state tenders or Special Purpose Vehicles (SPVs), providing a structured and transparent mechanism for sourcing training hardware, software, and content. This procurement oversight ensures that resources are efficiently utilized and that quality vendors with the capability to meet the state's skilling demands are engaged.

By localizing policy implementation, funding allocation, and operational support, SSDMs empower states to tailor skill development initiatives effectively. Several states have established SSDMs with governance structures aligning with the National Skill Development Mission, including Steering Committees and Mission Directorates responsible for strategic planning and execution. These bodies coordinate skill program delivery across districts, monitor progress against targets, and foster partnerships with industries, educational institutions, and civil society actors.

Through these roles, SSDMs enable states to address unique regional skill gaps, leverage local economic strengths, and ensure that vocational education integrated within schools translates to tangible employment outcomes. This decentralized approach helps build a robust, demand-driven skill ecosystem essential for inclusive growth and workforce competitiveness. Uttar Pradesh Skill Development Mission aims to skill every eligible youth aged 14-35 in their preferred trades while upgrading competencies for unskilled and semi-skilled workers. Special provisions target vulnerable groups like women, persons with disabilities, and minorities, with 30% quotas for women and 20% for minorities. All training follows NSQF-compliant courses exclusively.[51]

5.1.5.3. Key CSR & Foundation Partners

Major corporate foundations and philanthropic trusts fund school-anchored skilling and teacher capacity programs (digital literacy, STEM labs, vocational kits). These partners often shoulder early-stage risk, fund proof-of-concepts and assist with state buy-in. Partnering strategically with foundations can de-risk pilots and create demonstrable evidence for scale.

5.1.5.4. Skilling Aggregators, Tech Platforms, LMS Providers

EduTech platforms that excel in government school contexts typically integrate compatibility with DIKSHA, the national digital education platform, ensuring alignment with state curricula and content packaging. These platforms offer offline-first Learning Management Systems (LMS), allowing students and teachers to access educational materials without continuous internet connectivity, coupled with dashboarding features that support monitoring at district and state levels. Additionally, teacher-focused Continuous Professional Development (CPD) micro-courses and in-class facilitation kits empower educators to deliver blended learning effectively. The integration with DIKSHA not only enhances discoverability but also facilitates acceptance by states and the central government, leveraging the platform's extensive content repository and user base. The widespread adoption of DIKSHA, available in multiple vernaculars and designed with low-bandwidth functionality, reflects its critical role in delivering scalable digital education solutions for diverse government school settings.

5.1.5.5. Placement and Employment Linkage Partners

For skilling initiatives targeting higher secondary students, establishing strong placement linkages is vital. Partnerships with local Micro, Small, and Medium Enterprises (MSMEs) and industry clusters create direct channels for employment, providing real-world opportunities to trained youth. Apprenticeships coordinated through bodies such as the National Skill Development Corporation (NSDC) and sector skill councils bridge the gap between training and on-the-job learning. In the digital era, on-demand and gig economy platforms further expand livelihood prospects for youth by offering flexible, technology-enabled work opportunities. EduTech providers that incorporate employer-facing micro-credential verification systems enhance placement conversion by providing verifiable proof of

[51] *https://www.upsdm.gov.in/*

competencies to potential employers, thereby increasing trust and facilitating smoother transitions from training to employment.

5.1.5.6. Community & Panchayat-Level Enablers

The success of EduTech deployments in school settings is significantly influenced by active engagement with community-level enablers such as Panchayats, Self Help Groups (SHGs), Anganwadi workers, and Common Service Centers (CSCs). These stakeholders play crucial roles in mobilizing learners, supporting local logistics, and hosting evening or supplementary classes. Their involvement bolsters community trust and ownership, which are essential for sustained participation in digital learning programs, especially in rural and semi-urban areas. By collaborating closely with these local actors, EduTech initiatives can address contextual challenges, increase learner accessibility, and ensure the long-term sustainability of skill development efforts beyond formal school hours.

5.2. Policy Landscape and Institutional Framework

India’s skill development ecosystem is underpinned by a well-defined policy framework and a network of central and state-level institutions. Over the past decade, successive governments have recognized the importance of equipping India’s youth with market-relevant skills, particularly in light of the demographic dividend and the large informal workforce. The policy ecosystem provides direction, resources, and partnerships to ensure that skilling extends beyond urban centers into rural and semi-urban areas, with a focus on government schools, vocational education, and digital skilling pathways.

5.2.1. National Policy on Skill Development & Entrepreneurship (NPSDE)

The National Policy on Skill Development & Entrepreneurship, launched in 2015, provides the overarching vision for India’s skilling ecosystem. It emphasizes:

- **Integration of Skills in Education**: Encouraging vocational subjects within secondary and higher secondary schools, ensuring early exposure to employability-oriented skills.
- **Entrepreneurship Promotion**: Building entrepreneurial mindsets, especially in rural youth, to encourage self-employment alongside wage employment.
- **Equity and Inclusivity**: Special focus on women, disadvantaged groups, and rural youth to bridge socio-economic divides.
- **Digital & Lifelong Learning**: Leveraging technology, e-learning platforms, and modular skilling frameworks for continuous capacity building.

For government schools, NPSDE provides a framework under which digital skilling programs, vocational subjects, and ICT-enabled pedagogy can be embedded, supported by state skill development missions and EduTech platforms. From 2014 to 2025, ITIs grew from roughly 9,977 to more than 14,682, including 4,605 new ones established. Enrollments climbed from about 9.5 lakh to over 14 lakh trainees, signaling increased confidence in vocational training. National Skill Training Institutes (NSTIs) rose from 25 to 33, while Institutes for Training of Trainers (IToTs) expanded from 11 to 120, supported by 17,475 sanctioned CITS seats across NSTIs and IToTs.[52]

5.2.2. Major Government Programs & Schemes

5.2.2.1. PM Vishwakarma Yojana

Designed to empower traditional artisans and craftspeople, this scheme offers financial support, modern tools, and skill upgradation. For schools, it provides inspiration for integrating craft-based vocational learning into curricula, while EduTech platforms can digitize training modules and link artisans to digital marketplaces, ensuring the preservation and modernization of traditional skills. Target: Traditional artisans and craftspeople (18 trades).

[52] *https://www.pib.gov.in/PressReleasePage.aspx?PRID=2217881&reg=3&lang=2*

- The PM Vishwakarma Scheme was inaugurated on September 17, 2023, coinciding with Vishwakarma Day. It has a financial allocation of INR 13,000 crore, covering the period from fiscal year FY2024 to FY2028.[53]
- Funding peaking at INR 4,824 crore in FY2025[54]. Based on the INR 15,000 toolkit grant per artisan, roughly one-third of the scheme's budget is dedicated to toolkit.
- procurement for beneficiaries[55]. (For example, reaching ~30 lakh artisans would imply ~INR 4,500 crore on toolkits.) This scheme is aimed at artisans (carpenters, metalsmiths, tailors, etc.) to upgrade their tools; as of one-year in, over 6 lakh artisans had already received modern equipment under PM Vishwakarma[56][57].

The Pradhan Mantri Vishwakarma Kaushal Samman (PM Vishwakarma) Yojana is designed to strengthen traditional artisans and craftspeople by upgrading their skills and expanding market opportunities for their products and services. The scheme offers comprehensive, end-to-end support across 18 identified trades, with focused outreach in both rural and urban areas. It places strong emphasis on women's empowerment and the inclusion of marginalized communities, including Scheduled Castes, Scheduled Tribes, OBCs, persons with disabilities, transgender individuals, and residents of the northeastern region, islands, and hilly areas. The initiative is jointly implemented by the Ministry of Micro, Small and Medium Enterprises (MoMSME), the Ministry of Skill Development and Entrepreneurship (MSDE), and the Department of Financial Services (DFS) under the Ministry of Finance. To enable effective nationwide implementation, 497 District Project Management Units (DPMUs) are operational across 618 districts as of July 2025. These units play a key role in spreading awareness about scheme benefits, coordinating training programs and centers, facilitating collaboration among stakeholders, and ensuring monitoring and compliance.[58] Under the PM Vishwakarma Scheme, a total of 11,48,667 toolkits have been delivered to beneficiaries across all trades, as per the data available on the RTI document up to 31.12.2025.

Under the PM Vishwakarma Yojana, eligibility is limited to individuals engaged in traditional, family-based occupations who work with their own hands and tools and operate in the unorganized sector or on a self-employment basis. Applicants must be at least 18 years of age at the time of registration and should not have availed loans under any similar Central or State Government self-employment or business expansion schemes during the past five years. Benefits are restricted to only one member per family, with "family" defined as the husband, wife, and unmarried children, and neither the applicant nor any family member should be in government service. Registration is facilitated through Common Service Centers (CSCs), where artisans and craftspeople are enrolled on the official portal using a government-established process that ensures biometric authentication and Aadhaar-based verification.[59]

The Pradhan Mantri Vishwakarma (PMV) Scheme, launched on September 17, 2023, by the Ministry of MSME, represents a transformative INR 13,000 crore Central Sector initiative to empower traditional artisans and craftspeople across 18 family-based trades such as carpentry, Metalsmithing, pottery, tailoring, and goldsmithing. By honoring their cultural heritage while equipping them with modern tools and market access, the scheme targets formalizing the unorganized sector and boosting livelihoods for over 5 crore beneficiaries by 2027-28.

The program delivers comprehensive support through recognition, skill upgradation, financial incentives, credit, and market linkages. Artisans aged 18+ and actively practicing their trade (excluding recent PMEGP/MUDRA/PM SVANidhi loan recipients) receive a PM Vishwakarma Certificate and ID following Aadhaar-based verification at gram panchayats or urban local bodies. Skill training includes 5-7 days of basic modules (40 hours, INR 500 daily stipend) covering modern tools, digital transactions, and quality standards, plus optional 15-day advanced training on entrepreneurship and technology adoption. Post-basic training, beneficiaries access a INR 15,000 e-voucher or e-RUPI

[53] *https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=155216&ModuleId=3*

[54] *ibef.org*

[55] *ibef.org*

[56] *https://www.ibef.org/government-schemes/pm-vishwakarma-yojana*

[57] *ibef.org*

[58] *https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=155216&ModuleId=3&reg=3&lang=2*

[59] *https://www.pib.gov.in/PressNoteDetails.aspx?ModuleId=3&NoteId=155221&reg=3&lang=2*

for trade-specific modern toolkits—like power drills for carpenters or advanced sewing machines with 23+ lakh e-vouchers issued by late 2025[60].

Financially, the scheme offers collateral-free term loans up to INR 3 lakh in tranches: INR 1 lakh (18-month tenure at 5% effective interest with 8% government subvention) immediately after basic training, followed by INR 2 lakh (5-year tenure) upon first tranche utilization, digital tool adoption, or advanced training. Credit guarantees cover 90% losses via CGTMSE-like mechanisms. By August 2025, approvals reached INR 41,188 crore for 4.7+ lakh loans, alongside incentives like INR 1 per UPI digital transaction (up to 100/month). Marketing support draws from a INR 250 crore corpus for branding, e-commerce onboarding (GeM/Amazon), quality certification, and expos like the PM Vishwakarma Haat 2026. With 2.7+ crore applications processed and 76+ lakh verified[61], PMV has driven 30% average income growth, preserved guru-shishya traditions, and expanded urban market reach for rural artisans.[62]

The National Small Industries Corporation (NSIC), established in 1955 under the Ministry of Micro, Small and Medium Enterprises (MSME), plays a pivotal role in integrating India's informal workforce into the formal industrial ecosystem. As a government enterprise, NSIC focuses on skill development, enterprise creation, technology facilitation, and market access, particularly for micro and small enterprises (MSEs) that employ a large share of informal and semi-skilled labor.

India has over 63 million MSMEs, contributing nearly 30 percent of GDP, 45 percent of manufacturing output, and about 48 percent of exports. A significant proportion of these enterprises operate informally or semi-formally, facing constraints related to skills, finance, and market visibility. NSIC addresses these gaps through a structured support framework. Its Technical Services Centres and Livelihood Business Incubators (LBIs) provide hands-on training in manufacturing, services, digital tools, and entrepreneurship. NSIC has supported over 1 million trainees through skill development and entrepreneurship programs, many of whom are first-generation entrepreneurs and informal workers transitioning to formal enterprises.

NSIC's Single Point Registration Scheme (SPRS) enables MSMEs to participate in government procurement by offering tender exemptions and preferential purchase benefits. Through this mechanism, NSIC has facilitated procurement opportunities worth several crore for registered MSMEs, directly improving revenue stability and employment generation. Additionally, its Raw Material Assistance Scheme helps small firms access bulk raw materials at competitive prices, improving cost efficiency and production scale.

For informal workers in urban and semi-urban clusters, NSIC provides a critical bridge between skills and sustainable livelihoods by linking training with enterprise support, credit facilitation, and market access. Its role in technology transfer, export promotion, and incubation strengthens the survival and growth rates of small businesses.

By formalizing skills, supporting enterprise viability, and enabling market integration, NSIC significantly contributes to reducing the rural-urban skilling divide and strengthening India's informal-to-formal workforce transition.[63]

Core Objectives

Figure 5.2 Core Objectives of PM Vishwakarma Yojana

Objective Area	Description
Recognition	Recognition of artisans through PM Vishwakarma certificate and ID card
Skill Upgradation	Making relevant training opportunities available to enhance skills
	Support for better and modern tools to enhance productivity and quality

[60] https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=155216&ModuleId=3&reg=3&lang=2#:~:text=quality%20certification%2C,have%20completed%20their%20basic%20training.
[61] https://pmvishwakarma.gov.in/
[62] https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=155216&ModuleId=3&reg=3&lang=2
[63] https://digeca.tatasteel.com/blogs/msme-digital-supply-chain

Credit Access	Easy access to collateral-free credit with reduced cost through interest subvention
Digital Empowerment	Incentives for digital transactions to encourage digital adoption
Market Linkages	Platform for brand promotion and market linkages for growth opportunities

Source: PM Vishwakarma Scheme Guidelines, Ministry of MSME

Traditional Trades Covered Under the Scheme

The scheme covers artisans and craftspeople engaged in 18 traditional family-based trades working in the unorganized sector with hands and tools.

Figure 5.3 Traditional Trades Covered in PM Viswakarma Yojana

S.No.	Trade Name	Traditional Skills & Products
1	Carpenter (Suthar/Badhai)	Furniture making, wooden structures, traditional carpentry
2	Boat Maker	Traditional boat construction, fishing boats, wooden watercraft
3	Armourer	Traditional armor making, protective gear, metalwork
4	Metalsmith (Lohar)	Agricultural tools, iron implements, metal forging
5	Hammer and Tool Kit Maker	Hand tools, hammers, specialized implements
6	Locksmith	Lock making, key cutting, security devices
7	Goldsmith (Sonar)	Jewelry making, gold ornaments, traditional designs
8	Potter (Kumhaar)	Clay pottery, earthenware, traditional vessels
9	Sculptor/Stone Carver	Stone carving, idol making, architectural stone work
10	Stone Breaker	Stone cutting, stone preparation for construction
11	Cobbler/Shoemaker	Footwear making, leather craft, shoe repair
12	Mason (Rajmistri)	Construction work, bricklaying, traditional masonry
13	Basket/Mat/Broom Maker	Basket weaving, mat making, coir products, broom making
14	Doll & Toy Maker	Traditional toys, handcrafted dolls, cultural artifacts
15	Barber (Naai)	Hair cutting, traditional grooming services
16	Garland Maker (Malakaar)	Flower garlands, decorative items, ceremonial products
17	Washerman (Dhobi)	Traditional laundry services, cloth washing
18	Tailor (Darzi)	Garment stitching, clothing alteration, traditional tailoring

Source: PM Vishwakarma Official Portal, pmvishwakarma.gov.in; National Portal of India

Eligibility Criteria and Registration Process

Eligibility Requirements

Under the PM Vishwakarma Yojana, eligibility is limited to individuals engaged in traditional, family-based occupations who work with their own hands and tools and operate in the unorganized sector or on a self-employment basis.

Figure 5.4 Eligibility Criteria in PM Viswakarma Yojana

Criteria	Requirements
Age	Minimum 18 years at the time of registration
Occupation	Must be engaged in one of the 18 traditional trades using hands and tools

Sector	Working in unorganized sector on self-employment basis
Active Engagement	Should be actively engaged in the trade on the date of registration
Previous Loans	Should not have availed loans under PMEGP, MUDRA, or PM SVANidhi in past 5 years
Family Restriction	Only one member per family (husband, wife, unmarried children) can register
Government Service	Persons in government service and their family members are not eligible
Authentication	Aadhaar-based biometric verification required

Source: PM Vishwakarma Scheme Guidelines, Ministry of MSME; PIB Press Release PRID 1989108

Three-Step Verification Process

Figure 5.5 Three Step verification Process in PM Viswakarma Yojana

Step	Verification Level	Process Details
Step 1	Local Level Verification	Gram Panchayat/Urban Local Body verifies details with help of Gram Sevak/Panchayat Secretary
Step 2	District Level Review	District Implementation Committee reviews and validates the registration
Step 3	Screening Committee Approval	Led by DC-MSME office officer with State Lead Bank Manager and MSDE representatives

Source: PM Vishwakarma Scheme Guidelines

Component-wise Benefits

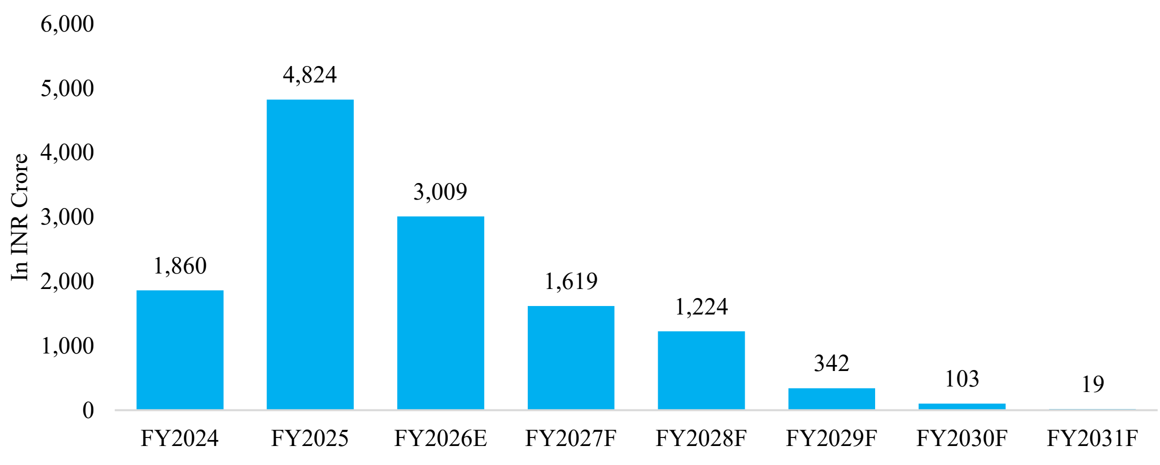
Figure 5.6 Component-Wise Benefits in PM Viswakarma Yojana

Benefit Component	Details	Quantum
Recognition	PM Vishwakarma Certificate and ID Card	Certificate + ID
Basic Training	5-7 days (40 hours) modern tools, digital transactions	INR 500/day stipend
Advanced Training	15 days (120 hours) entrepreneurship, technology	INR 500/day stipend
Toolkit Incentive	E-voucher for trade-specific modern toolkits	INR 15,000
First Loan Tranche	Collateral-free enterprise development loan	INR 1 lakh (18-month, 5%)
Second Loan Tranche	After first tranche utilization	INR 2 lakh (30-month, 5%)
Interest Subvention	Government interest rate subvention	8% (5% effective rate)
Credit Guarantee	Loss coverage via CGTMSE-like mechanisms	90% coverage
Digital Transaction	Incentive per UPI transaction	INR 1 per tx (max 100/mo)
Marketing Support	Branding, e-commerce, quality certification	From INR 250 cr corpus

Source: PM Vishwakarma Scheme Guidelines

Year-wise Budget Allocation

Figure 5.7 Year Wise allocation, PM Viswakarma Yojana, FY2024 – FY2031F, INR Crore

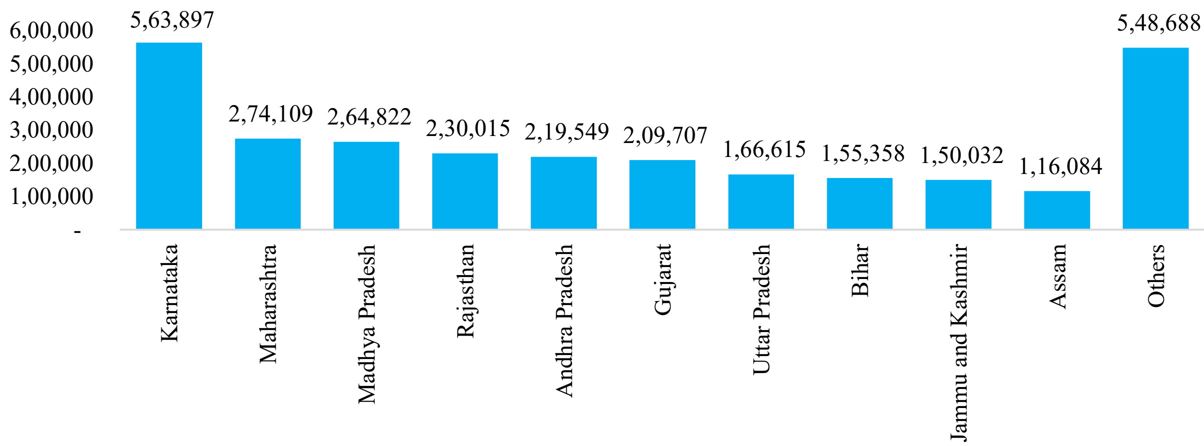


Source: PIB

The year-wise allocation for PM Vishwakarma shows a front-loaded funding pattern in INR crore. In FY2024, the allocation stood at INR 1,860 crore, rising sharply to INR 4,824 crore in FY2025, marking the peak funding phase. For FY2026 (estimated), the allocation moderates to INR 3,009 crore, followed by INR 1,619 crore in FY2027 (forecast). Funding further declines to INR 1,224 crore in FY2028F and INR 342 crore in FY2029F. The tapering trend continues with INR 103 crore in FY2030F and INR 19 crore in FY2031, indicating gradual stabilization and reduced fiscal outlay in the later years of implementation.

PM Vishwakarma State wise – Registrations

Figure 5.8 PM Vishwakarma State wise – Registrations (as of 31.01.2026)

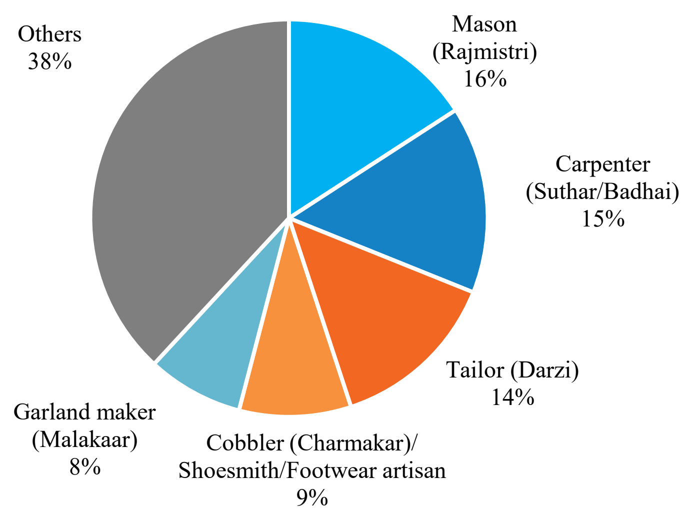


Source MSME Dashboard | Note: Others include Chhattisgarh, Odisha, Telangana, Jharkhand, Haryana, Kerala, Tripura, Uttarakhand, Himachal Pradesh, Goa, Manipur, Punjab, Arunachal Pradesh, Meghalaya, Nagaland, Ladakh, Sikkim, Mizoram, Delhi, Andaman and Nicobar Islands, The Dadra and Nagar Haveli and Daman and Diu, Puducherry, Chandigarh, Lakshadweep, Tamil Nadu, and West Bengal.

Under the PM Vishwakarma scheme, Karnataka leads state-wise registrations with 563,897 beneficiaries, reflecting strong outreach and artisan participation. Maharashtra follows with 274,109 registrations, closely trailed by Madhya Pradesh at 264,822 and Rajasthan at 230,015. Southern and western states such as Andhra Pradesh (219,549) and Gujarat (209,707) also demonstrate significant enrollment. Northern states including Uttar Pradesh (166,615), Bihar (155,358), and Jammu and Kashmir (150,032) show steady participation. Assam records 116,084 registrations, while the "Others" category collectively accounts for 548,688 beneficiaries, indicating widespread nationwide implementation of the scheme.

PM Vishwakarma - Trade wise Registrations

Figure 5.9 PM Vishwakarma – Trade wise Registrations (as of 31.01.2026)

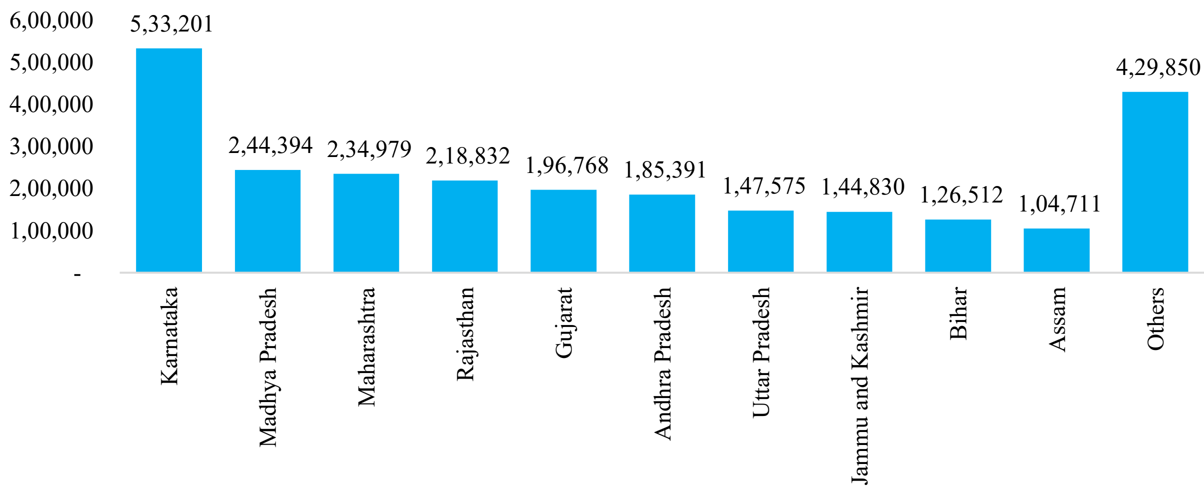


Source: MSME Dasboard | Note: Others include Basket/Mat/Broom Maker/Coir Weaver, Washerman (Dhobi), Potter (Kumhaar), Sculptor (Moortikar, stone carver) and Stone breaker, Hammer and Tool Kit Maker, Fishing Net Maker, Barber (Naai), Goldsmith (Sonar), Doll & Toy Maker (Traditional), Armourer, Boat Maker, Locksmith, and Metalsmith/Metal Caster

Under PM Vishwakarma trade-wise registrations, Others account for the largest share at approximately 38% of total enrollments. Among identified trades, Mason (Rajmistri) contributes about 16%, closely followed by Carpenter (Suthar/Badhai) at nearly 15%. Tailor (Darzi) represents around 14%, reflecting strong participation in apparel-related skills. Cobbler (Charmakar)/Shoesmith/Footwear artisan makes up roughly 9%, while Garland maker (Malakaar) comprises about 8% of overall registrations. The distribution highlights diversified artisan engagement across construction, woodworking, tailoring, leatherwork, and traditional crafts, with a substantial portion categorized under various other emerging and traditional occupations.

PM Vishwakarma State wise - Skill Verification Completed

Figure 5.10 PM Vishwakarma State wise – Skill Verification Completed (as of 31.01.2026)

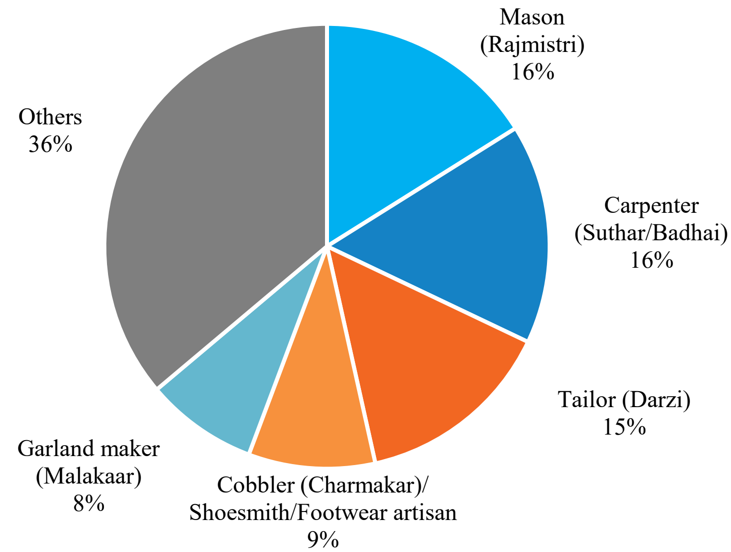


Source: MSME Dasboard |Note: Others include Chhattisgarh, Odisha, Telangana, Jharkhand, Haryana, Tripura, Kerala, Himachal Pradesh, Goa, Uttarakhand, Manipur, Punjab, Ladakh, Nagaland, Arunachal Pradesh, Sikkim, Mizoram, Delhi, Meghalaya, Andaman and Nicobar Islands, The Dadra and Nagar Haveli and Daman and Diu, Lakshadweep, Chandigarh, Puducherry, Tamil Nadu, and West Bengal.

Under the PM Vishwakarma scheme, Karnataka records the highest number of skill verifications completed at 533,201, indicating strong implementation progress. Madhya Pradesh follows with 244,394 verifications, while Maharashtra registers 234,979. Rajasthan reports 218,832, and Gujarat reaches 196,768, reflecting steady momentum across western and central states. Andhra Pradesh accounts for 185,391 completed verifications. Among northern states, Uttar Pradesh records 147,575, closely followed by Jammu and Kashmir at 144,830. Bihar stands at 126,512, and Assam reports 104,711. The “Others” category collectively contributes 429,850, highlighting broad nationwide coverage and continued advancement in skill assessment under the scheme.

PM Vishwakarma - Trade wise Skill Verification Completed

Figure 5.11 PM Vishwakarma – Trade wise Skill Verification Completed (as of 31.01.2026)

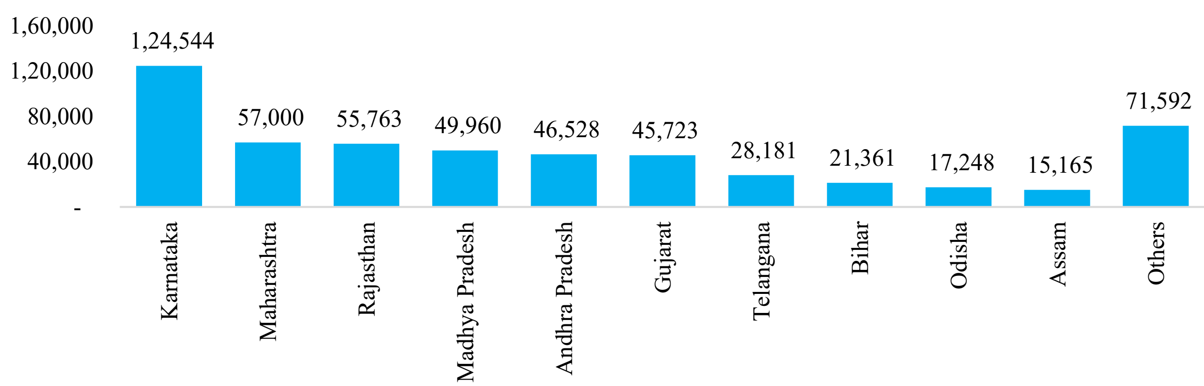


Source: MSME Dasboard | Note: Others include Basket/Mat/Broom Maker/Coir Weaver, Washerman (Dhobi), Potter (Kumhaar), Sculptor (Moortikar, stone carver) and Stone breaker, Hammer and Tool Kit Maker, Barber (Naai), Fishing Net Maker, Doll & Toy Maker (Traditional), Goldsmith (Sonar), Armourer, Locksmith, Boat Maker, and Metalsmith/Metal Caster

Under PM Vishwakarma trade-wise skill verification, Others constitute the largest proportion at approximately 36% of total verifications. Mason (Rajmistri) accounts for nearly 16%, closely followed by Carpenter (Suthar/Badhai) at about 16% as well. Tailor (Darzi) represents roughly 15% of completed verifications, indicating strong participation in garment-related trades. Cobbler (Charmakar)/Shoesmith/Footwear artisan contributes around 9%, while Garland maker (Malakaar) makes up about 8%. The percentage distribution reflects broad occupational coverage, with construction and woodworking trades forming a significant share alongside traditional craft and service-based activities.

PM Vishwakarma State wise - Loans Approved

Figure 5.12 PM Vishwakarma State wise – Loans Approved (as of 31.01.2026)

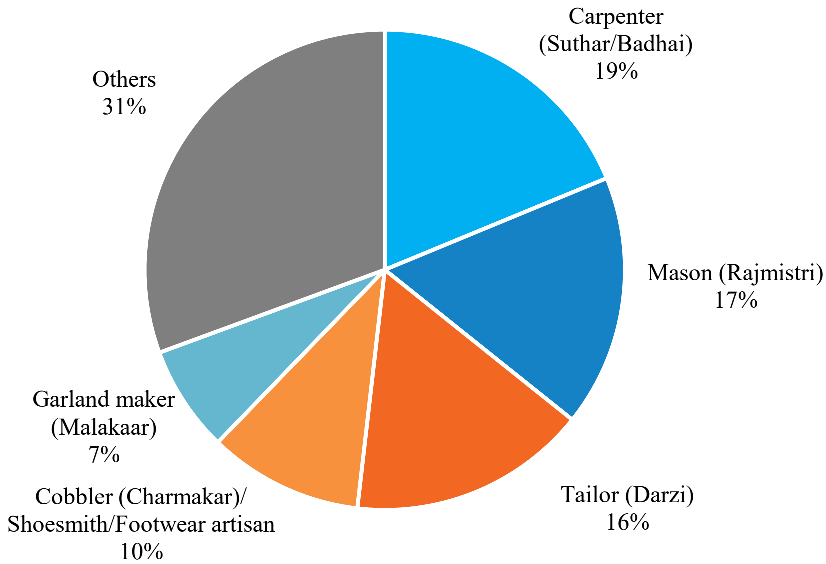


Source: MSME Dasboard | Note: Others include Jammu and Kashmir, Uttar Pradesh, Chhattisgarh, Haryana, Jharkhand, Kerala, Tripura, Manipur, Himachal Pradesh, Punjab, Uttarakhand, Goa, Ladakh, Nagaland, Sikkim, Arunachal Pradesh, Delhi, The Dadra and Nagar Haveli and Daman and Diu, Puducherry, Andaman and Nicobar Islands, Mizoram, Chandigarh, Meghalaya, Lakshadweep, Tamil Nadu, and West Bengal.

The distribution of loan approvals under the PM Vishwakarma scheme highlights significant regional participation. Karnataka stands out with 124,544 sanctioned loans, far exceeding other states. Maharashtra records 57,000 approvals, followed closely by Rajasthan at 55,763. Madhya Pradesh reaches 49,960, while Andhra Pradesh and Gujarat report 46,528 and 45,723 respectively, indicating strong financial uptake among artisans. Telangana accounts for 28,181 approvals, whereas Bihar registers 21,361. Odisha and Assam contribute 17,248 and 15,165 respectively. Additionally, the "Others" category totals 71,592, reflecting widespread access to formal credit support across multiple remaining states and union territories.

PM Vishwakarma - Trade wise Loans Approved

Figure 5.13 PM Vishwakarma – Trade wise Loans Approved (as of 31.01.2026)

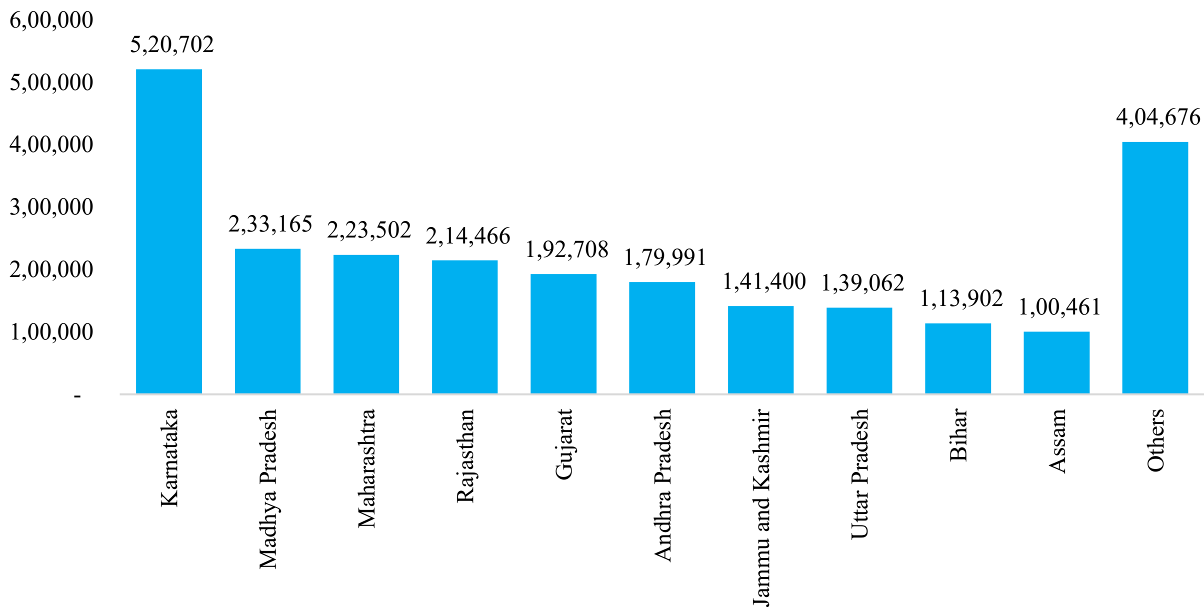


Source: MSME Dasboard | Note: Others include Washerman (Dhobi), Basket/Mat/Broom Maker/Coir Weaver, Potter (Kumhaar), Sculptor (Moortikar, stone carver) and Stone breaker, Goldsmith (Sonar), Barber (Naai), Fishing Net Maker, Doll & Toy Maker (Traditional), Hammer and Tool Kit Maker, Armourer, Locksmith, Boat Maker, and Metalsmith/Metal Caster

In trade-wise loan approvals under PM Vishwakarma, Others hold the largest share at approximately 31% of total sanctioned cases. Carpenter (Suthar/Badhai) accounts for about 19%, reflecting strong credit uptake in woodworking activities. Mason (Rajmistri) represents nearly 17%, while Tailor (Darzi) contributes around 16%, indicating balanced support across construction and garment trades. Cobbler (Charmakar)/Shoesmith/Footwear artisan comprises roughly 10% of approvals, and Garland maker (Malakaar) makes up about 7%. The percentage distribution highlights diversified financial assistance across core traditional occupations and a wide range of additional artisan trades.

PM Vishwakarma State wise - e-Voucher Issued

Figure 5.14 PM Vishwakarma State wise – e-Voucher Issued (as of 31.01.2026)

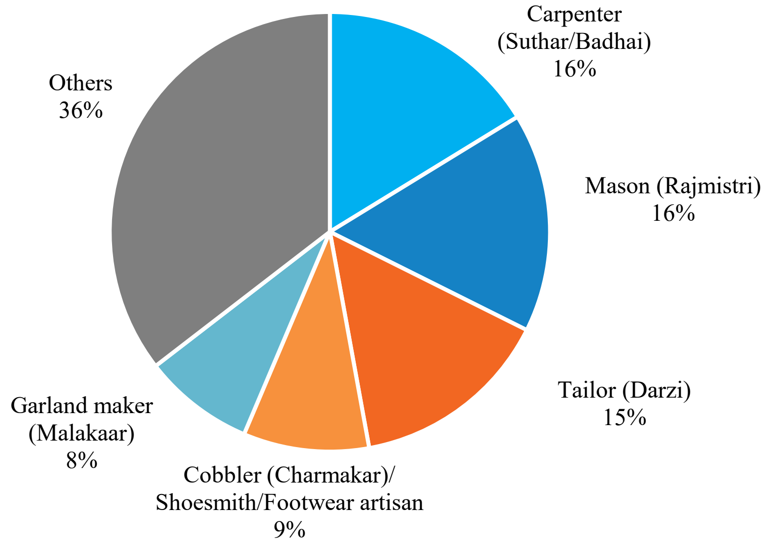


Source: MSME Dasboard | Note: Others include Odisha, Chhattisgarh, Telangana, Jharkhand, Haryana, Tripura, Himachal Pradesh, Goa, Kerala, Uttarakhand, Manipur, Punjab, Ladakh, Nagaland, Arunachal Pradesh, Sikkim, Mizoram, Delhi, Meghalaya, Andaman and Nicobar Islands, The Dadra and Nagar Haveli and Daman and Diu, Lakshadweep, Puducherry, Chandigarh, Tamil Nadu, and West Bengal

State-wise distribution of e-Vouchers under the PM Vishwakarma initiative demonstrates substantial beneficiary reach. Karnataka tops the list with 520,702 vouchers issued. Madhya Pradesh records 233,165, followed by Maharashtra at 223,502 and Rajasthan at 214,466. Gujarat reports 192,708, while Andhra Pradesh accounts for 179,991. Among northern regions, Jammu and Kashmir shows 141,400 issuances and Uttar Pradesh 139,062. Bihar stands at 113,902, and Assam at 100,461. Additionally, 404,676 vouchers have been issued across other states and union territories, highlighting strong digital facilitation of benefits and streamlined support delivery to traditional artisans nationwide.

PM Vishwakarma - Trade wise e-Voucher Issued

Figure 5.15 PM Vishwakarma – Trade wise e-voucher Issued (as of 31.01.2026)



Source: MSME Dasboard | Note: Others include Basket/Mat/Broom Maker/Coir Weaver, Washerman (Dhobi), Potter (Kumhaar), Sculptor (Moortikar, stone carver) and Stone breaker, Fishing Net Maker, Barber (Naai), Hammer and Tool Kit Maker, Goldsmith (Sonar), Doll & Toy Maker (Traditional), Armourer, Locksmith, Boat Maker, and Metalsmith/Metal Caster

Under trade-wise e-Voucher issuance in PM Vishwakarma, Others account for the highest proportion at approximately 36% of total vouchers distributed. Carpenter (Suthar/Badhai) represents about 16%, closely followed by Mason (Rajmistri) at nearly 16%, indicating strong participation in construction-linked trades. Tailor (Darzi) contributes around 15%, reflecting steady engagement in apparel services. Cobbler (Charmakar)/Shoesmith/Footwear artisan makes up roughly 9%, while Garland maker (Malakaar) comprises about 8%. The percentage pattern highlights balanced digital benefit distribution across major traditional occupations alongside a broad category of other artisan activities.

5.2.2.2. Khadi Gramodyog Vikas Yojana (GVY)

Target: Village industries artisans under Ministry of MSME/KVIC. This scheme supports rural micro-industries and artisans through training, technology upgrades and toolkit/machinery distribution. In FY2024 about INR 31.34 crore was spent on training and tool-kit distribution, benefiting 16,355 artisans under GVY[64]. The Union Budget allocation for this scheme was INR 1,037 crore in FY2025 (up from INR 810 crore the previous year)[65], and INR 1,066 crore is budgeted in FY2026[66] and INR 917 Crore in FY2024 and in FY2023 it was INR 749 Crore[67]. GVY funds are used in programs like distribution of electric potter's wheels, bee boxes, leather craft toolkits, etc., to rural artisans. For instance, KVIC reported distributing 17,000+ toolkits (pottery wheels, bee boxes, carpentry and electrician kits, etc.) to artisans' doorsteps under this scheme[68]. Toolkit spending forms a significant component – e.g. in Maharashtra alone, 3,280 electric wheels and 6,800 bee boxes have been given out under GVY to boost artisans' productivity[69].

5.2.2.3. National Handicrafts Development Programme (NHDP)

Target: Handicraft artisans (Ministry of Textiles). Under the NHDP (and the related Comprehensive Handicraft Cluster Dev. Scheme), the government provides improved toolkits to handicraft artisans in addition to design training

[64] pib.gov.in
[65] yourstory.com
[66] indiabudget.gov.in
[67] https://www.cnbctv18.com/budget/budget-2025-fm-allocates-rs-1066-crore-to-khadi-gramodyog-vikas-yojana-19550101.htm
[68] franchiseindia.com
[69] franchiseindia.com

and marketing support[70]. For example, the Development Commissioner (Handicrafts) conducts "Improved Toolkits Distribution Programmes" for artisans to modernize their tool[71]. The budget for NHDP in FY2025 was INR 236 crore (a 38% jump from INR 171 crore in the previous year)[72]. It also features an approved budget allocation of ₹837 crore for FY 2022-26.[73]While toolkit distribution is one of many components, it is an important part of enhancing artisan productivity – e.g. during FY2024, the Textiles ministry conducted 4 special toolkit distribution programs benefitting 400 artisans (alongside design workshops and training)[74]. This indicates a portion of NHDP funds each year is earmarked to supply modern toolkits to craftspeople (often on a 100% grant basis to the artisans). The toolkit component helps artisans compete in domestic and global markets by upgrading their equipment[75].

5.2.2.4. PMKVY (Pradhan Mantri Kaushal Vikas Yojana)

Target: Youth for skill/vocational training. PMKVY is a national skill development scheme (launched its 4.0 phase in FY2024) with a sizeable outlay (around INR6,000 crore total) for FY2026[76]. Annual budget allocations for PMKVY 4.0 are in the range of INR 2,300–2,700 crore (e.g. BE INR 2,685.6 crore for FY2024) to train lakhs of youth in industry-relevant skills[77]. While primarily a training scheme, PMKVY guidelines include provision of toolkits and equipment to trainees as part of the training support. Training providers/PIAs are responsible for providing necessary tool kits, tool rooms, etc., to trainees (along with uniforms and stipends)[78]. In practice, many PMKVY courses – especially in trades like plumbing, electrician, tailoring, etc. – give trainees a basic toolkit upon course completion to enable them to practice the trade. Proportion of spend: The cost norms of PMKVY factor in these toolkits, though not explicitly broken out in the budget. If we estimate ~INR 5,000 per trainee toward tool/equipment, a significant portion of the scheme's expenditure (possibly 5–10%) goes into toolkit procurement for certified candidates. This ensures that the skilling schemes also equip trainees with the tools to immediately start their vocations. Looking ahead, projections show PMKVY catalyzing approximately 37 lakh green jobs by 2030, driven by India's growing renewable energy and sustainability commitments. The scheme's adaptive design, incorporating periodic skill gap analyses and collaboration with industry, positions it to continuously align skill provision with evolving market dynamics. Further, its inclusive approach is fostering participation from women, persons with disabilities, and marginalized communities at unprecedented levels, enhancing equitable workforce integration[79].

5.2.2.5. DDU-GKY (Deen Dayal Upadhyaya Grameen Kaushalya Yojana)

Targeted at rural poor youth aged 15–35, DDU-GKY connects skill training with employment opportunities. Within the education ecosystem, it acts as a post-school bridge program for government school graduates, preparing them with employability skills, soft skills, and digital competencies. EduTech solutions can strengthen the reach of training in remote areas through blended and mobile-first delivery models. SANKALP / STRIVE

Both programs are supported by the World Bank to enhance the quality and accountability of India's skilling ecosystem.

- **SANKALP** (Skill Acquisition and Knowledge Awareness for Livelihood Promotion): Focuses on decentralization, quality monitoring, and capacity building.
- **STRIVE** (Skills Strengthening for Industrial Value Enhancement): Enhances the performance of Industrial Training Institutes (ITIs) and promotes apprenticeship.

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[70] pib.gov.in

[71] pib.gov.in

[72] livemint.com

[73] *https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=156396&ModuleId=3&reg=3&lang=2#:~:text=National%20Handicraft%20Development%20Programme%20(NHDP,NHDP%2C%20benefiting%2066%2C000+%20artisans.*

[74] pib.gov.in

[75] pib.gov.in

[76] idronline.org

[77] skillcouncils.com

[78] msde.gov.in

[79] *https://www.educationtimes.com/article/campus-beat-college-life/99737254/pmkvy-4-0-to-generate-37-lakh-green-jobs-by-2030-boosting-skilled-workforce-for-a-sustainable-future*

For government schools, these programs foster institutional linkages, where students can access ITI resources, online monitoring systems, and industry-aligned digital skilling content.

Under DDU-GKY, 17.50 lakh candidates have been trained and 11.48 lakh placed, while under RSETI, 56.69 lakh have been trained and 40.99 lakh settled since inception up to June 2025. Additionally, an MoU between the Ministry of Rural Development and the Ministry of Skill Development and Entrepreneurship was signed in June 2025[80]. The Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY) received substantial financial support during the financial years 2018–19 and 2019–20 to strengthen rural skill development initiatives. In 2018–19, a total allocation of INR 1,215.306 crore was made, of which INR 1,215.289 crore was released, indicating near-complete utilization of sanctioned funds. In 2019–20, the allocated budget increased significantly to INR 1,849.99 crore, while actual fund release stood at INR 1,418.071 crore. This reflects continued government commitment, alongside moderated disbursement aligned with program implementation and absorption capacity.[81]

5.2.2.6. Jan Shikshan Sansthan (JSS)

JSS caters to non-literate, neo-literate, and school dropouts, mainly in rural areas, offering livelihood-oriented skill development. In government schools, JSS models demonstrate community-led skilling that can be replicated for vocational labs and adult education programs. EduTech integration such as local-language e-modules, mobile apps, and community learning hubs helps extend the impact to underserved learners. As of the financial year FY2026, a total of 293 Jan Shikshan Sansthans (JSS) are operational nationwide, including 21 in Maharashtra and 29 in Madhya Pradesh. The scheme has a total budget allocation of INR 185 crore for the current year[82].

5.2.2.7. MSDE, NSDC, State Skill Missions

- MSDE (Ministry of Skill Development & Entrepreneurship): Apex policymaker for skill development.
- NSDC (National Skill Development Corporation): Facilitates public-private partnerships, funds training partners, and builds scalable skilling models.
- State Skill Development Missions (SSDMs): Adapt central policies to state contexts, working with schools, ITIs, and local partners.

For government schools, these bodies ensure policy alignment, funding support, and industry linkages. Increasingly, they collaborate with EduTech providers for digital skilling platforms, teacher training, e-assessments, and AI-driven monitoring.

- MSME-related government initiatives

Under the skill development, several MSME-related government initiatives significantly contribute to enhancing entrepreneurial capacity and workforce skills. The Entrepreneurship and Skill Development Programme (ESDP) is a flagship scheme operated by the Ministry of Micro, Small and Medium Enterprises (MSME). ESDP facilitates technical and managerial training aimed at promoting self-employment and fostering a culture of entrepreneurship, particularly targeting inclusive groups such as women, SC/ST communities, differently-abled persons, and ex-servicemen. The program offers a blend of entrepreneurship awareness, skill development, and advanced management courses, delivered through central, state, and educational institutions. Training spans various sectors including agriculture, engineering, IT, and retail, providing both basic and advanced modules to meet diverse needs.

Other complementary MSME skill initiatives include the Prime Minister's Employment Generation Programme (PMEGP), which supports the establishment and growth of micro-enterprises by providing credit-linked subsidies and training. The program has generated thousands of employment opportunities annually by motivating entrepreneurship in traditional and emerging sectors.

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[80] *http://pib.gov.in/PressReleasePage.aspx?PRID=2148466*

[81] *https://www.pib.gov.in/PressReleseDetailm.aspx?PRID=1604827&reg=3&lang=2*

[82] *https://www.pib.gov.in/PressReleasePage.aspx?PRID=2155052*

Government efforts also include capacity building through the National Institute for Micro, Small and Medium Enterprises (ni-msme), which conducts training for entrepreneurs and trainers in digital marketing, green technologies, and rural enterprise development. Additionally, the Assistance to Training Institutions (ATI) scheme and the MSME Skill Training and Employment Scheme (MSME-STES) focus on upgrading the quality of vocational education and bridging the skill gaps required by MSMEs through on-the-job training and knowledge sharing.

Furthermore, digitization initiatives such as the Udyam Registration Portal promote formalization and ease of doing business for MSMEs by simplifying registration, which stood at over 28 crore employment registrations by mid-2025. Credit facilitation remains a priority under schemes like Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) and Mudra Yojana, enabling MSMEs to secure collateral-free loans to expand operations.

Together, these MSME-focused skill development programs foster a comprehensive ecosystem supporting entrepreneurial growth, skill enhancement, and workforce productivity, aligning with India's broader economic objectives of inclusive growth and innovation-driven manufacturing.

5.2.2.8. State Government Schemes

- West Bengal – Artisans Financial Benefit Scheme 2024 – Target: Individual artisans and artisan groups across WB. Launched in the FY2025 state budget, this new scheme provides a one-time grant up to INR 15,000 per artisan for purchasing or repairing toolkits/equipment (and for work shed improvement)[83]. Artisan collectives (groups of ≥10) are eligible for grants up to INR 10 lakh for common toolkits or sheds[84]. The state allocated INR 200 crore for FY2025, targeting 2 lakh artisans in the first year[85]. Over the next 4 years, an additional 4 lakh artisans are to be covered (total 6 lakh by FY2029) with further funding[86]. Given the grant is primarily for tools and equipment, a substantial proportion (nearly all) of this budget goes into toolkit procurement or related asset creation for artisans. For instance, if each artisan avails ~INR 10,000 for toolkits on average, about INR 200 crore would directly translate to tools in artisans' hands in the first year. This scheme is specifically aimed at upgrading artisans' tools (from weavers and potters to carpenters, etc.) and improving their production infrastructure, thereby boosting productivity. (The WB budget also introduced separate support for weavers and a credit card interest subvention for micro-entrepreneurs, indicating a holistic approach[87].)
- Uttar Pradesh – Vishwakarma Shram Samman Yojana (VSSY) – Target: Traditional artisans in UP (all districts). Launched in 2018, this ongoing state scheme provides free toolkits and skill training to craftsmen like carpenters, tailors, masons, metalsmiths, potters, barbers, etc[88]. Artisans receive a 6-day training in their trade and are then given modern tool kits (latest technology) at no cost[89]. The UP government has heavily invested in this scheme: a INR 2,000 crore allocation was announced in a 2023 supplementary budget to expand VSSY's reach[90]. VSSY has been implemented at scale – as of 2023, about 4.08 lakh employment opportunities had been generated under VSSY and the related ODOP toolkit program combined[91]. The proportion of spend on toolkits is significant: virtually every beneficiary artisan gets a physical toolkit. For example, if an artisan's toolkit is valued at INR 10,000–INR15,000, roughly 60–70% of the per-beneficiary cost is the toolkit (the rest being training stipend). Thus, a large share of that INR 2,000 crore will go into procuring lakhs of toolkits (sewing machines, looms, tool sets, etc.) for UP's artisans. By strengthening livelihood means, VSSY (sometimes dubbed the "Mukhyamantri Vishwakarma" scheme in UP) aims to preserve traditional occupations while raising incomes[92].

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- Uttar Pradesh – ODOP Training & Toolkit Scheme – Target: Craftsmen and micro-entrepreneurs under One District One Product. Uttar Pradesh's flagship ODOP program (started 2018) includes a component for Skill Upgradation and Toolkit Distribution for artisans involved in each district's signature products. The Government of Uttar Pradesh has allocated INR 307 crore for the implementation of the 'One District One Product' (ODOP) Programme in FY 2024–25, with a subsequent increase to INR 337 crore in FY 2025–26 (Budget Estimates)[93] Under the ODOP Training & Toolkit Yojana (launched Feb 2019), selected artisans/youth get a 10-day training in their craft and are provided a toolkit worth INR 20,000 upon completion, plus a INR 2,000 stipend[94]. For example, a carpet weaver in Bhadohi or a brass artisan in Moradabad would be trained and given improved tools (loom kits, tool sets, etc.) relevant to their trade. The scheme also links beneficiaries to credit – after getting the toolkit, they become eligible for interest-free loans up to INR 5 lakh under UP's MYUVA entrepreneurship scheme[95]. Budget/outlay: The state has treated ODOP toolkit training as a high priority; recent plans for FY2026 indicate dedicated budget allocations for training, toolkits, and skill upgradation in every district[96]. While an exact multi-year outlay isn't published, the initiative is scaling up. (For instance, if each trained artisan costs ~INR 22,000 in benefits, training 50,000 artisans would require ~INR 110 crore.) In practice, thousands of toolkits are distributed annually. In 2021, ~75,000 artisans received free toolkits and training under ODOP across UP. The proportion of spend on toolkits is high – roughly 90% of the direct benefit (INR 20k of INR 22k) per person is a toolkit grant[97]. The ODOP scheme thus squarely focuses on artisans/MSMEs, equipping them with modern tools to improve product quality and productivity, while also fostering local entrepreneurship.
- Kerala – Tool Kit Grant for Traditional Craftsmen (OBC Department) – Target: OBC community artisans in Kerala. Kerala runs a social welfare scheme to support traditional craftspeople belonging to Other Backward Classes by providing skill training and modern toolkits. In the state's FY2026 plan (OBC Development "Green Book"), an outlay of INR 310 lakh (INR 3.10 crore) is earmarked for "Skill Development Training and Tool Kit Grant for Traditional Craftsmen among OBCs."niyamasabha.org This scheme upgrades the tools of artisans like carpenters, metalsmiths, weavers, etc., from OBC categories to improve their livelihoods. Typically, eligible artisans receive a grant to purchase new tools or equipment after completing training. While the number of beneficiaries is smaller, the entire spend is devoted to toolkits and training – for example, INR 3.1 crore could fund toolkits for ~2,000 artisans (@ ~INR 15,000 each) along with some training cost. By focusing on marginalized artisans, Kerala's scheme ensures vocational support and preservation of traditional crafts (many of which are practiced by OBC communities) through better tools. (Kerala also provides similar toolkit or machinery subsidies via its SC/ST departments and through coir/handicraft development programs, though those are separate from this OBC scheme.)
- Karnataka – Free Toolkits for Rural Artisans (District Industries Centres) – Target: Rural artisans (various trades) in Karnataka. The Government of Karnataka implements a toolkit distribution program through District Industries Centres (DIC) as part of its rural industry promotion. Each year, free improved tool kits or machinery are given to artisans in rural areas under district-level schemes. For example, in FY2025 many districts invited applications for "Free Toolkits for Rural Artisans": offering items like electric sewing machines for women tailors, masonry toolkits for construction workers, carpentry and barber kits, pottery wheels, etc., depending on local trades[98]. These initiatives are often funded under the state's district-sector allocations for rural development (Khadi & Village Industries). Budget: The funding is decentralized – e.g. one district might distribute 100 sewing machines and 50 carpentry kits in a year, spending say INR 50–60 lakh, while state-wide the program may run into several crores annually. In Kodagu district, the DIC scheme for FY2024 provided toolkits to dozens of artisans in trades like tailoring and carpentry[99]. In Bengaluru

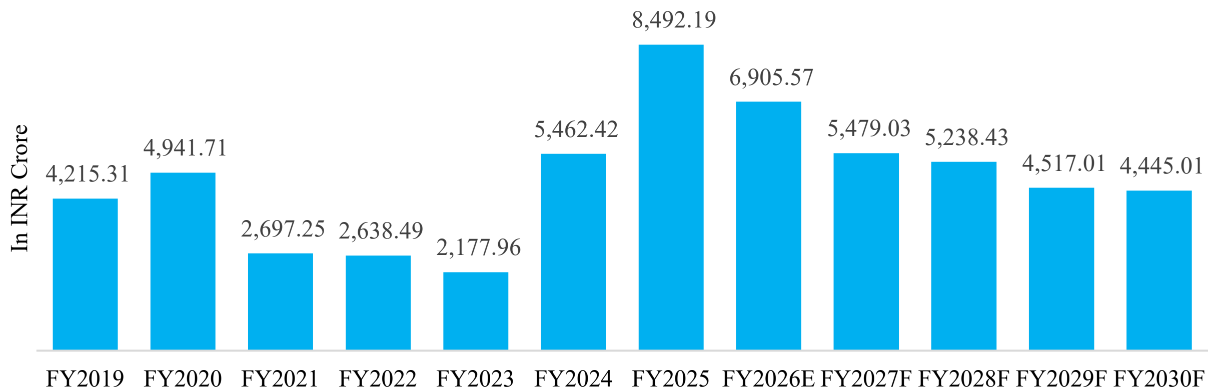
[93] https://odopup.in/en/page/budget
[94] obnews.co
[95] obnews.co
[96] economictimes.indiatimes.com
[97] obnews.co
[98] zpyadgiri.karnataka.gov.in
[99] kodagu.nic.in

(Urban), a 2024 notice advertised free power-operated toolkits (sewing machines, etc.) for rural artisans under the scheme[100]. Essentially, 100% of the scheme cost goes toward toolkit purchase (often procured centrally via tenders and then distributed). By 2025, Karnataka has expanded the range (even barbers, cobblers, and other micro-vocations are included). This direct-toolkit scheme ensures that traditional workers in villages get access to modern tools at no cost, thereby enhancing their earning capacity. The proportion of spending on toolkits is effectively the entire scheme cost (aside from minimal admin), since it is a direct distribution program. (Similar programs exist in other states – e.g. Tamil Nadu's free sewing machine scheme for women, Assam's distribution of toolkits to weavers and craftsmen, etc. – where state funds are used to supply equipment to eligible artisans or trainees.)

In conclusion, the Indian government's strategic strengthening of PMKVY post-2028 embodies a forward-looking approach that embraces innovation, inclusion, and market relevance. With sustained policy support, technological integration, and MSME collaboration, PMKVY will continue to be instrumental in transforming India's demographic dividend into a skilled workforce, underpinning long-term economic growth and social equity. The government's proactive engagement ensures that PMKVY not only meets but anticipates market needs, driving sustained livelihoods and positioning India as a leader in global talent development.

TAM for Toolkit

Figure 5.16 TAM for Toolkit, FY2019-FY2030F, INR Crore



Source: Frost and Sullivan Analysis Note: Pradhan Mantri Vishwakarma Yojana (PM Vishwakarma), Khadi Gramodyog Vikas Yojana (GVY), National Handicrafts Development Programme (NHDP), Pradhan Mantri Kaushal Vikas Yojana, DDU-GKY (Deen Dayal Upadhyaya Grameen Kaushalya Yojana), Jan Shikshan Sansthanare are the schemes consideered

The total available market (TAM) for toolkit increased from INR 4,215 crore in FY2019 to INR 4,942 crore in FY2020, followed by a decline during FY2021–FY2023 due to economic disruptions and reduced industrial activity. A strong rebound begins in FY2024 at INR 5,462 crore, reaching a peak of INR 8,492 crore in FY2025, driven by rising infrastructure development, government skill initiatives, and higher demand from construction and manufacturing sectors. Thereafter, TAM for toolkit market stabilizes between INR 4,400–6,900 crore through FY2030F, reflecting market normalization and steady replacement-driven demand.

5.2.3. Role of Corporates, NGOs, and Tech-Enablers in Skilling Ecosystem

India's skilling landscape is not driven by government alone; it thrives on a multi-stakeholder ecosystem where corporates, non-governmental organizations (NGOs), and technology providers complement public initiatives. Their contributions range from funding and infrastructure support to curriculum design, digital delivery, and placement linkages. For government schools and grassroots skilling, these stakeholders are vital in bridging resource gaps, localizing solutions, and ensuring sustainable impact.

Role of Corporates

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[100] bengaluruurban.nic.in

CSR-Driven Skilling Programs:

Through CSR initiatives, companies are investing heavily in education and vocational training for underserved communities. This includes establishing smart classrooms, funding digital literacy initiatives, and setting up vocational labs in government schools. Programs such as Infosys Foundation's "Spark," IBM's "STEM for Girls," and TATA STRIVE have introduced experiential learning models that blend digital and practical exposure. These interventions help bridge the quality gap in rural and semi-urban schools by equipping students and teachers with 21st-century skills. Importantly, CSR programs also support teacher capacity development, ensuring that technological infrastructure translates into effective classroom engagement. CSR initiatives complement government programs like the Pradhan Mantri Kaushal Vikas Yojana (PMKVY), yet skilling has received just 3.5% of the INR 2.22 lakh crore total CSR spending since FY2015.[101]

Industry-Aligned Curriculum Development:

Corporates are increasingly involved in shaping skill curricula to reflect the dynamic needs of modern industries. By collaborating with the National Skill Development Corporation (NSDC) and Sector Skill Councils (SSCs), they co-create modules in areas such as data analytics, renewable energy, logistics, retail, healthcare, and coding. This alignment ensures that students are not only educated but also employable. For instance, IT majors like Microsoft and Google have worked with educational boards to design curricula for digital literacy and cybersecurity, while manufacturing giants like Maruti Suzuki and Mahindra contribute to automotive skill programs.

Infrastructure & Technology Support:

Another crucial area of corporate engagement is infrastructure development. Companies fund the establishment of ICT-enabled classrooms, provide laptops and tablets to government schools, and invest in AR/VR-enabled experiential learning tools. These interventions not only improve the learning environment but also reduce the digital divide that hinders equitable access to education. In states like Maharashtra and Tamil Nadu, PPP-led smart classroom projects supported by corporates have demonstrated measurable improvements in learning outcomes and attendance.

Apprenticeships and Placement Linkages:

Corporates bridge the gap between education and employment through structured apprenticeship and placement programs. By partnering with state skill missions and technical training institutes, they offer students practical experience and real-world exposure. Companies such as Bosch, Siemens, and Tech Mahindra have collaborated with the Ministry of Skill Development and Entrepreneurship (MSDE) to provide apprenticeship opportunities under the National Apprenticeship Promotion Scheme (NAPS). These initiatives not only create employability pipelines but also strengthen the feedback loop for continuous curriculum improvement.

Role of NGOs

Grassroots Outreach and Inclusion:

NGOs play a crucial role in ensuring that skilling initiatives reach communities that are often left behind due to socio-economic or geographic barriers. They mobilize rural youth, women, and disadvantaged groups to participate in government and private skilling programs. Organizations like Pratham, QUEST Alliance, and SEWA have pioneered models for community engagement that emphasize inclusivity, gender balance, and equitable participation.

Localized Implementation Models:

Centralized schemes such as PMKVY (Pradhan Mantri Kaushal Vikas Yojana) and Jan Shikshan Sansthan (JSS) benefit from NGO involvement at the district and block levels. NGOs tailor these schemes to local contexts by translating content into regional languages, conducting community-based awareness sessions, and integrating

[101] *https://thecsruniverse.com/articles/csr-investment-in-skilling-crucial-to-unlocking-india-s-global-labour-potential-crisil-report*

vocational education with traditional livelihoods. They also use informal spaces such as community centers, panchayat halls, or village libraries to deliver training, expanding reach where formal institutions are limited.

Capacity Building and Training Support:

NGOs contribute significantly to teacher and facilitator training, ensuring sustainability of digital and vocational programs. They equip educators with both technical proficiency and pedagogical skills for integrating technology into instruction. Many NGOs also train community volunteers who act as on-ground facilitators, ensuring program continuity and addressing operational challenges.

Monitoring, Evaluation, and Feedback Loops:

NGOs serve as important intermediaries in assessing impact and ensuring accountability. Through field-level monitoring, learner feedback, and outcome tracking, they provide data-driven insights that help governments and corporates refine their approaches. By identifying gaps in content delivery, accessibility, or engagement, NGOs help make large-scale skilling programs more responsive and effective.

Role of Tech-Enablers

Digital Content and Learning Platforms:

EduTech companies design interactive, multimedia-rich content that caters to different skill domains and learning levels. Learning Management Systems (LMS) and AI-driven adaptive platforms allow personalized learning experiences, where students can progress at their own pace. Partnerships with platforms like DIKSHA and SWAYAM have expanded access to curated vocational and academic content for millions of learners in government schools.

Remote and Mobile Access Solutions:

To overcome geographical and infrastructural barriers, technology providers develop mobile-first and cloud-based solutions that allow students in remote areas to access content offline or with minimal bandwidth. These innovations have proven essential in bridging the urban-rural digital divide, especially post-pandemic, when remote learning became central to continuity of education.

Assessment and Certification Technologies:

Tech firms are introducing tools that enhance transparency and standardization in the evaluation process. Online assessments, e-portfolios, and blockchain-based certification systems provide learners with verifiable digital credentials that can be accessed globally. This portability of skill records is crucial for informal and migrant workers who often lack documentation.

AI, AR/VR, and Simulation-Based Learning:

Technology enablers are integrating immersive tools that simulate real-world work environments, particularly in technical and vocational training. AR/VR and simulation-based learning are being applied to trades like healthcare, electronics, and automotive repair, where practical exposure is critical. Such experiential learning improves skill retention, safety, and employability outcomes.

Data and Analytics for Decision Support:

Technology enablers also play a strategic role in generating actionable insights through data analytics. Real-time dashboards allow policymakers, corporates, and educational administrators to track training progress, learner performance, and program effectiveness. These analytics not only enhance transparency but also help in evidence-based decision-making and continuous program optimization.

5.3. Key market enablers and challenges

5.3.1. Key market enablers

Figure 5.17 Market Enablers in Skilling Ecosystem

Source: Frost and Sullivan Analysis

Policy alignment & funding windows

A key driver of EduTech and skilling integration in India's school ecosystem is strong policy coherence across national and state levels. Initiatives such as Samagra Shiksha, NEP 2020, PM e-Vidya, and Digital India explicitly promote technology adoption, digital content creation, and capacity-building for teachers. These policies create sustained funding flows for system integration (SI), ICT deployment, and skill-based education interventions. Additionally, schemes focused on vocationalization of school curricula, such as National Skill Qualification Framework (NSQF) implementation and Skill Hubs under PMKVY 4.0, enable schools to procure equipment, content, and training support.

This structured policy-finance ecosystem reduces fragmentation and brings predictability to public procurement. States are also developing dedicated digital education budgets and specialized ICT societies that streamline procurement and vendor engagement. For private players, this means clear entry points and long-term demand visibility, while schools gain access to standardized solutions supported by continuous funding windows.

School infrastructure as a delivery platform

Government schools are among the most extensive institutional networks in India, spanning from metropolitan centers to remote tribal areas. Their presence makes them ideal platforms for delivering digital learning and skilling interventions. Beyond classrooms, school premises are being repurposed as cluster-level learning hubs that house shared ICT labs, maker spaces, and after-school vocational clubs. This multipurpose utilization enables continuous learning while fostering community ownership.

The infrastructure already available in schools—such as classrooms, libraries, and labs—reduces the need for new capital investment. By layering ICT systems, vocational equipment, and interactive tools on existing assets, both governments and private implementers can achieve rapid scale at minimal incremental cost. Moreover, these schools act as local, trusted institutions, making them ideal entry points for deploying inclusive skilling programs that engage both enrolled students and out-of-school youth.

Trusted local institutions & social capital

Community participation significantly influences the success of school-linked digital and skilling initiatives. Structures such as Parent–Teacher Associations (PTAs), School Management Committees (SMCs), and Panchayati Raj Institutions (PRIs) are critical for mobilizing communities and ensuring accountability in program execution. Their involvement helps tailor interventions to local cultural and social contexts, building trust and acceptance among parents and learners.

Local NGOs and community-based organizations further extend outreach by facilitating gender-sensitive mobilization, ensuring that girls, disadvantaged youth, and marginalized groups can participate safely and confidently. This ecosystem of local institutions and social capital is particularly valuable in rural and semi-urban regions, where external implementers often face trust deficits. By leveraging these existing networks, system integrators and skilling agencies can achieve higher participation rates and community endorsement for technology-driven initiatives.

Affordable device + connectivity penetration

The declining cost of digital devices and rapid growth of mobile broadband have transformed the accessibility of education technology. With affordable smartphones, tablets, and low-cost computing devices becoming widespread, even resource-constrained schools and students can participate in digital learning. The government's investments under BharatNet, Digital India, and state-level broadband initiatives are steadily improving last-mile connectivity, enabling blended and remote learning models. under the BharatNet initiative, the Cabinet had approved total funding of about INR 42,068 crore for Phase-I and Phase-II (with around INR 39,825 crore disbursed as of late 2023) and recent plans include significantly higher allocations (including an increased budget of around INR 22,000 crore in FY 2025-26 for extended rural broadband rollout) to improve last-mile connectivity. Meanwhile, the Digital India programme an umbrella initiative to digitise services and infrastructure has been expanded with a planned outlay of about INR 14,903 crore to boost digital delivery, training, and digital services across sectors. These investments collectively strengthen broadband access and support blended and remote learning models nationwide.[102][103]

In parallel, technology providers are developing offline-first and low-bandwidth EduTech solutions that operate effectively even in areas with intermittent connectivity. These innovations ensure that learners in remote or infrastructure-poor regions are not excluded from digital skilling opportunities. Affordable devices combined with adaptive, locally hosted content solutions are thus creating a new baseline for equitable technology access across India's educational landscape.

Existing education workforce & academic anchors

India's large base of teachers, school administrators, and local training institutions provides a ready foundation for expanding school-based skilling. With targeted upskilling, these educators can evolve into facilitators of digital and

[102] https://usof.gov.in/en/bharatnet-project?utm_source=chatgpt.com
[103] https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1949426&utm_source=chatgpt.com&reg=3&lang=2

vocational learning. Teacher training institutes, polytechnics, and Industrial Training Institutes (ITIs) can act as academic anchors for modular vocational content, hands-on workshops, and digital pedagogy sessions.

By integrating teacher development with technology deployment, system integration becomes sustainable and community-led. Headmasters and local academic leaders, when empowered through digital leadership programs, can institutionalize innovation within schools. Furthermore, partnerships between schools and local technical institutions create mentoring ecosystems that link classroom learning with real-world application.

Digital credentials & national frameworks

The emergence of standardized digital credentialing systems underpins the credibility and mobility of skills acquired through school-based programs. Frameworks like the National Skills Qualification Framework (NSQF) and National Occupational Standards (NOS) provide clear mapping of competencies and learning outcomes. Complementing these are e-certification platforms and digital badges that make it easier for students to demonstrate their skills to local employers.

These digital credentials not only validate student achievements but also create formal linkages between education and employment ecosystems. Blockchain-enabled verification and integration with platforms like DigiLocker ensure authenticity and portability of certificates, empowering learners to use them across regions and industries. For system integrators, alignment with these frameworks also facilitates standardization, interoperability, and compliance with national quality benchmarks.

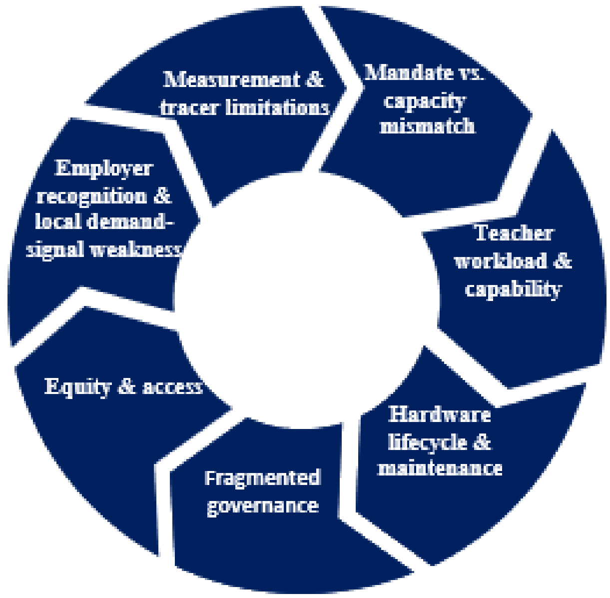
Sustainability via shared assets

Sustainability and cost efficiency are critical to the long-term viability of technology and skilling interventions in schools. Shared infrastructure models—such as cluster-based labs, mobile training vans, and AR/VR pods—reduce the cost per user while expanding reach. By pooling resources across multiple schools, these models optimize trainer deployment and enable high-value experiential learning without requiring every school to maintain its own specialized facility.

Mobile training vans equipped with digital and vocational kits can rotate between schools, ensuring continuity in regions with dispersed populations. Similarly, shared AR/VR setups and regional maker spaces allow students to engage with high-end simulation tools at manageable costs. This cluster-based resource-sharing approach is also environmentally and economically sustainable, ensuring consistent access while reducing duplication and maintenance burdens.

5.3.2. Key challenges

Figure 5.18 Key Challenges in Skilling Ecosystem



Source: Frost and Sullivan Analysis

Mandate vs. capacity mismatch

India's policy push for vocationalization of school education is ambitious, but the gap between mandates and institutional capacity remains significant. Central and state schemes often specify targets for establishing labs, training teachers, or integrating skill modules, but realistic operational budgets for maintenance, consumables, and trainer remuneration are frequently absent. Many rural and semi-urban schools receive equipment without adequate funding for ongoing operation and maintenance (O&M), rendering facilities underutilized or non-functional within a short period.

Additionally, implementing agencies face constraints in aligning procurement cycles with academic calendars, leading to delays and disruptions in delivery. Policy frameworks assume uniform readiness across schools, yet resource-poor districts lack the administrative bandwidth, trained manpower, and financial flexibility needed for execution. This mismatch between top-down mandates and local implementation capacity results in uneven quality and fragmented coverage across states and districts.

Teacher workload & capability

Teachers form the backbone of the school-based skilling ecosystem, yet their workload and skill profile often limit effective delivery. Most teachers are already burdened with multiple administrative and teaching responsibilities, leaving little time to prepare or conduct vocational sessions. Expecting them to double as skill trainers often without additional pay or recognition reduces motivation and compromises instructional quality.
Moreover, the majority of schoolteachers lack exposure to industry practices or hands-on technical training. They may also be unfamiliar with digital pedagogies or blended learning models required for ICT-enabled education. Without continuous professional development and structured incentives, schools struggle to sustain quality vocational instruction. This gap is particularly acute in rural areas, where teacher vacancies and high attrition rates further reduce program continuity.

Hardware lifecycle & maintenance

Technology-driven education and skilling programs rely heavily on hardware computers, smart boards, projectors, and lab equipment. However, many government procurement models still follow a "one-time supply" approach, with little or no provision for O&M, software upgrades, or technical support. As a result, equipment often becomes obsolete or non-functional within a few years.

E-waste management is an emerging concern, with old devices piling up due to lack of disposal or refurbishment mechanisms. Schools rarely have in-house technicians or dedicated maintenance budgets, leading to long downtimes when systems fail. The absence of lifecycle planning also discourages private partners from investing in durable, service-based models. For sustainable digital transformation, schools require predictable funding for maintenance, warranties, and replacements not just one-time procurement.

Fragmented governance

The governance landscape of school education and skill development in India is complex, involving multiple ministries and agencies at both central and state levels. The Ministry of Education, Ministry of Skill Development and Entrepreneurship (MSDE), and Ministry of Labour and Employment often operate in silos with overlapping mandates. At the state level, coordination between departments of education, technical education, and skill missions is inconsistent.

This fragmentation results in misaligned curricula, redundant assessments, and gaps in credit transfer across educational pathways. For instance, students trained under school-based vocational programs often face difficulty in transitioning to higher-level technical or industrial training institutions due to mismatched certification frameworks. Weak coordination also slows down policy feedback loops, limiting the ability to adapt programs to evolving local needs or industry requirements.

Equity & access

Despite policy emphasis on inclusivity, equity challenges persist in school-based skilling programs. Socio-cultural factors such as gender norms, safety concerns, and distance from schools often prevent girls and marginalized youth from participating in after-school or community-based training activities. In rural areas, inadequate transportation and lighting infrastructure further restrict access to evening or weekend learning opportunities.

Schools serving disadvantaged populations frequently face shortages of qualified trainers and lack flexible scheduling options to accommodate diverse learners. Without targeted outreach and gender-sensitive design—such as separate facilities for girls, female trainers, and safe commuting options—skilling programs risk reinforcing existing inequalities rather than reducing them.

Employer recognition & local demand-signal weakness

For vocational education to translate into employability, employer recognition of credentials is crucial. However, many local and small-scale employers remain skeptical of digital certificates or school-issued micro-credentials. They often rely on informal assessments or direct observation of practical skills rather than standardized documentation.

This weak linkage between school-based training and real-world labor markets limits the perceived value of such programs. In several rural and semi-urban contexts, local industry demand signals are poorly articulated, making it difficult to align course offerings with actual employment opportunities. Without active employer engagement in curriculum design, assessment, and placement facilitation, school-level skilling risks becoming supply-driven rather than demand-responsive.

Measurement & tracer limitations

Demonstrating tangible outcomes remains a persistent challenge in the school-skilling ecosystem. Few systems track students longitudinally from school-based training into higher education, apprenticeships, or employment. The lack of tracer studies and integrated data systems makes it difficult to assess the long-term impact or return on investment (ROI) of interventions.

Outcome-based financing models such as social impact bonds or performance-linked grants require robust data to validate success, yet most current monitoring frameworks focus only on inputs (labs installed, teachers trained) rather than outcomes (skills applied, jobs secured). This absence of credible measurement undermines accountability, limits evidence-based policy refinement, and discourages private and philanthropic investment in the sector.

5.4. Trends shaping the future of skill development

5.4.1. Hybrid & Phygital Models of Training

Definition: A blended approach that combines online digital resources with offline, classroom-based, and practical learning experiences.

Application: In government schools, theory can be delivered digitally via tablets, smart boards, or mobile phones, while hands-on practice happens in labs or community centres.

Benefits:

- Extends reach to rural students with limited infrastructure.
- Reduces dependence on full-time trainers by leveraging digital modules.
- Provides continuity of learning during disruptions (e.g., pandemics).

Example: A vocational course on electrical repair where students watch instructional videos online, then practice wiring in a school lab supervised by a facilitator.

5.4.2. AI/AR/VR in Vocational Training and Simulation

Definition: Use of Artificial Intelligence (AI), Augmented Reality (AR), and Virtual Reality (VR) to deliver immersive and personalized training.

Application:

- AI: Adaptive learning systems that personalize pace and identify weak areas.
- AR: On-device overlays showing real-time instructions for tasks like equipment assembly.
- VR: Simulated environments for high-risk jobs (welding, machinery operation) without safety concerns.

Benefits:

- Makes training engaging and cost-effective.
- Reduces need for expensive equipment in rural schools.
- Encourages experiential learning at scale.

Challenge: Cost of devices and bandwidth; mitigated through shared district-level labs or mobile VR vans.

5.4.3. Micro-Credentialing & Skill Badging (Digital Certifications)

Definition: Recognition of specific, short-term skill units via digital badges or micro-certificates.

Application: Students in government schools can earn digital badges for completing small modules like "Basic Solar Maintenance" or "Appliance Repair Fundamentals."

Benefits:

- Builds confidence through incremental recognition.
- Aligns with NSQF/NOS standards for national portability.
- Creates verifiable digital records accessible to employers.

Impact on Grassroots: Micro-credentials empower learners to showcase skills even before completing full-length vocational courses, improving immediate employability.

5.4.4. Skilling for Sustainability & Green Jobs

Definition: Training aligned to environmentally sustainable sectors such as renewable energy, waste management, sustainable agriculture, green construction, and ESG-linked infrastructure practices. With increasing focus on ESG compliance and sustainable infrastructure development, demand for workforce training in green and environmentally compliant operations is rising across industries, including EPC and infrastructure sectors.

Application in Schools:

- Training students to maintain solar panels installed on school rooftops.
- Modules on water harvesting, waste segregation, e-mobility maintenance and sustainable infrastructure practices.

Benefits:

- Addresses rising demand for green and ESG-aware workforce.
- Makes schools role models of sustainability by using their own infrastructure as learning labs.
- Builds community-level services (solar repair, composting, recycling) that generate livelihoods locally.
- Supports employability in sectors increasingly prioritizing ESG compliance and sustainable infrastructure development.

5.4.5. Skilling as a Service (SaaS Platforms for Skilling Ops)

Definition: Cloud-based platforms that provide end-to-end solutions for delivering, tracking, and certifying skill training.

Features:

- Course delivery (LMS modules).
- Attendance and performance monitoring.
- Digital badge issuance.
- Employer matching dashboards.

Application: Governments can license SaaS solutions at district or state level to track training outcomes across hundreds of government schools.

Benefits:

- Standardizes reporting and assessment.
- Provides policymakers with real-time insights.

- Makes programs scalable and transparent.

Challenge: Risk of vendor lock-in; can be mitigated with open APIs and portability of learner records.

5.4.6. Integration with UGC/AICTE Academic Institutions

Definition: Formal linkage between school-based skilling and higher education institutions under UGC/AICTE frameworks.

Application:

- Micro-credentials earned in schools converted into credits recognized by polytechnics or colleges.
- Joint certification programs co-branded by schools and higher education institutions.
- Access to polytechnic labs for advanced training modules.

Benefits:

- Creates upward mobility for rural students through academic-credit pathways.
- Improves employability by connecting grassroots learners to formal degrees/diplomas.
- Bridges the divide between vocational and mainstream education.

Challenge: Bureaucratic delays in credit recognition; can be addressed through pilot MoUs and state policy nudges.

6. COMPETITIVE BENCHMARKING OF KEY COMPANIES

Pragyawan Technologies operates across multiple opportunity segments including power infrastructure, water infrastructure, renewable energy solutions, education-focused system integration, digital classroom implementation and skill development services. Given the diversified nature of its business model and revenue streams, we see there is no single listed company in India whose business profile, operating model and sector exposure are directly comparable to Pragyawan Technologies.

6.1. Financial Information of Pragyawan Technologies

Particulars	Nine months period ended December 31, 2025	FY 2025	FY 2024	FY 2023
Revenue from operations (in INR million)	7,770.79	3,593.65	2,117.37	673.03
Total Income (in INR million)	7,791.64	3,608.50	2,128.06	678.87
EBITDA (in INR million)	1,368.62	572.53	319.88	118.01
EBITDA Margin (in %)	17.61	15.93	15.11	17.53
Restated Profit after tax (PAT) (in INR million)	990.90	398.81	240.70	88.44
PAT Margin (in %)	12.72	11.05	11.31	13.03
Net Worth (in INR million)	1,896.30	906.41	507.89	267.10
Return On Net Worth (in %)	52.25	44.00	47.39	33.11
ROCE (in %)	56.48	46.05	64.93	65.37
Total borrowings (in INR million)	642.99	375.84	8.61	-
Debt-equity ratio (in times)	0.34	0.41	0.02	-

Source: Frost & Sullivan Analysis

6.2. Operational Information of Pragyawan Technologies

Particulars	Nine months period ended December 31, 2025	FY 2025	FY 2024	FY 2023
Order book (in INR million)	16,483.13	10,589.67	2,919.39	2,296.65
Order book to Revenue from Operations (in times)	2.12	2.95	1.38	3.41
Presence in number of states (number)	24	8	2	2

Source: Frost & Sullivan Analysis

7. COMPANY OVERVIEW OF PRAGYAWAN TECHNOLOGIES LIMITED

Pragyawan Technologies Limited ("Company / Pragyawan Technologies / Pragyawan") is a prominent diversified solutions provider with a wide range of offerings across business verticals and demonstrated strong growth in their business operations in recent years. The Company caters to large-scale institutional and public sector programmes. The Company is engaged in the supply of Skill Development and training products and delivers varied Utility Solutions and operations & maintenance ("O&M") services.

The Company is currently operating through two business verticals, namely

- **Skill Development**: Focused on training products and capacity building solutions and
- **Utility Solutions**: Provides execution and O&M services across power, water, renewable energy and allied infrastructure segments.

Pragyawan's portfolio spans smart education solutions, surveillance systems, educational kits and training materials, renewable energy projects, power and water projects, and digitization initiatives. Through scalable, technology-driven solutions delivered under certified quality standards, Pragyawan supports India's digital transformation and infrastructure modernization.

Headquartered in Noida, the Company has pan-India operational footprint across 29 states and union territories including all site offices, warehouses, Corporate Office and Registered Office. Leveraging the Government of India's Make in India initiative, the company integrates forward-thinking sourcing through contract manufacturing while strengthening backward integration with leased manufacturing facilities under a shared-use arrangement and long-term access to advanced production infrastructure.

With a consistently expanding order book reaching INR 20,522.46 million as of April 30, 2026 and proven execution experience, Pragyawan stands out as a reliable partner for large scale national programs. Large-scale programs such as Jal Jeevan Mission, RDSS and renewable energy deployments are resulting in a rapidly growing base of operational assets that require ongoing maintenance, monitoring and performance optimization. As project execution partner increasingly focus on project execution and capital deployment, there is a visible gap in lifecycle management and maintenance of these assets, creating a strong opportunity for specialised O&M service providers.

Pragyawan Technologies Limited is focused on expanding presence as an execution partner across infrastructure-led sectors such as power, including renewable energy, water and telecom, which continue to be supported by public capital expenditure and policy-led investments in India. These sectors are witnessing sustained execution opportunities driven by transmission and distribution expansion, renewable energy integration, water infrastructure programmes such as the Jal Jeevan Mission, and digital and telecom network development. Its programs are aligned with national initiatives such as PM Vishwakarma Yojana and other social empowerment missions. Its delivery of over 500,000 toolkits under the PM Vishwakarma Scheme ("PMVY") underscores its capability to serve high-impact government initiatives, reinforcing its credibility and emerging leadership. As of December 31, 2025, Pragyawan Technologies Limited is one of the largest suppliers of customized toolkits for multiple trades in terms of number of toolkits supplied under PMVY. Supported by a robust logistics network, Pragyawan enables large-scale deployment of training materials and toolkits across rural, semi-urban, and urban communities.

By operating across both Skill Development and Utility Solutions, Pragyawan benefits from diversified revenue streams and sustained client relationships across B2G and B2B segments. The company's alignment with national initiatives such as PM Vishwakarma Yojana (PMVY), Pradhan Mantri Kaushal Vikas Yojana 4.0 ("PMKVY 4.0"), Skill India Digital Hub ("SIDH"), and other institutional programs are driving large-scale procurement of standardized toolkits, training infrastructure and technology-enabled learning systems. In addition, increasing adoption of digital platforms, smart classrooms and emerging technologies, including AI-enabled learning and simulation-based training, is expanding the scope of opportunities.

7.1. Key Strengths

- **Extensive Nationwide Footprint**

The company operates across India with a well structured supply chain network, enabling efficient project execution and seamless delivery capabilities in diverse geographies.

- **Asset Light Operating Model**

By leveraging contract manufacturing and leased infrastructure, Pragyawan maintains flexibility, reduces capital intensity, and scales operations without heavy fixed asset commitments.

- **Balanced and Diversified Order Book**

The company benefits from a broad order pipeline across multiple business segments, minimizing dependence on any single vertical and enhancing business resilience.

- **Stable Financial Performance Backed by Strong Execution**

Consistent project delivery, strong operational systems, and disciplined execution practices have contributed to the company's robust financial performance over time.