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Industry Research Report on Power Transmission sector

23rd January 2026

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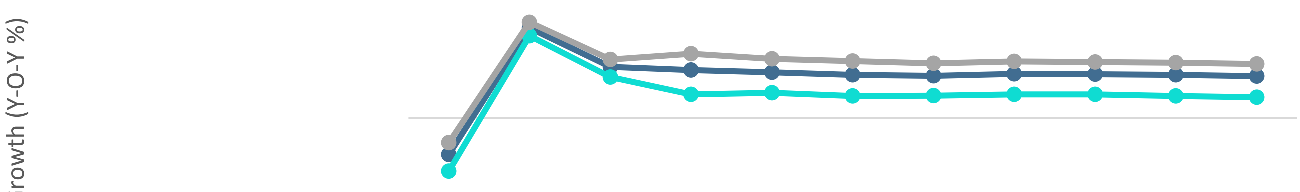
1 Economic Outlook

1.1 Global Economy

Global economic growth expected to sustain at ~3% in near term

Global growth, which reached 3.5% in CY23, stabilized at 3.3% for CY24 and projected to decrease at 3.2% for CY25. Global trade is expected to be disrupted by new US tariffs and countermeasures from trading partners, leading to historically high tariff rates and negatively impacting economic growth projections. The global landscape is expected to change as countries rethink their priorities and policies in response to these new developments. Central banks priority will be to adjust policies, while smart fiscal planning and reforms are key to handling debt and reducing global inequalities.

Chart 1: Global Growth Outlook Projections (Real GDP, Y-o-Y change in %)



	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
World	-2.7%	6.6%	3.8%	3.5%	3.3%	3.2%	3.1%	3.2%	3.2%	3.2%	3.1%
Advanced Economies	-3.9%	6.0%	3.0%	1.7%	1.8%	1.6%	1.6%	1.7%	1.7%	1.6%	1.5%
Emerging Market and Developing Economies	-1.8%	7.0%	4.3%	4.7%	4.3%	4.2%	4.0%	4.2%	4.1%	4.1%	4.0%

Source: IMF – World Economic Outlook, October 2025; Note: P-Projection

Table 1: GDP growth trend comparison - India v/s Other Economies (Real GDP, Y-o-Y change in %)

	Real GDP (Y-o-Y change in %)										
	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
India	-5.8	9.7	7.6	9.2	6.5	6.6	6.2	6.4	6.5	6.5	6.5
China	2.3	8.6	3.1	5.4	5.0	4.8	4.2	4.2	4.0	3.7	3.4
Indonesia	-2.1	3.7	5.3	5.0	5.0	4.9	4.9	5.0	5.0	5.1	5.1
Saudi Arabia	-3.8	6.5	12.0	0.5	2.0	4.0	4.0	3.3	3.3	3.3	3.3
Middle East	-2.3	4.7	6.4	2.6	2.6	3.5	3.8	3.8	3.7	3.7	3.7
Latin America	-6.9	7.4	4.3	2.4	2.4	2.4	2.3	2.6	2.7	2.8	2.6
Brazil	-3.3	4.8	3.0	3.2	3.4	2.4	1.9	2.2	2.3	2.4	2.5
Euro Area	-6.0	6.4	3.6	0.4	0.9	1.2	1.1	1.4	1.3	1.2	1.1
United States	-2.1	6.2	2.5	2.9	2.8	2.0	2.1	2.1	2.1	1.9	1.8

Source: IMF- World Economic Outlook Database (October 2025); Note: P- Projections, India's fiscal year (FY) aligns with the IMF's calendar year (CY). For instance, FY24 corresponds to CY23.

1.2 Indian Economic Outlook

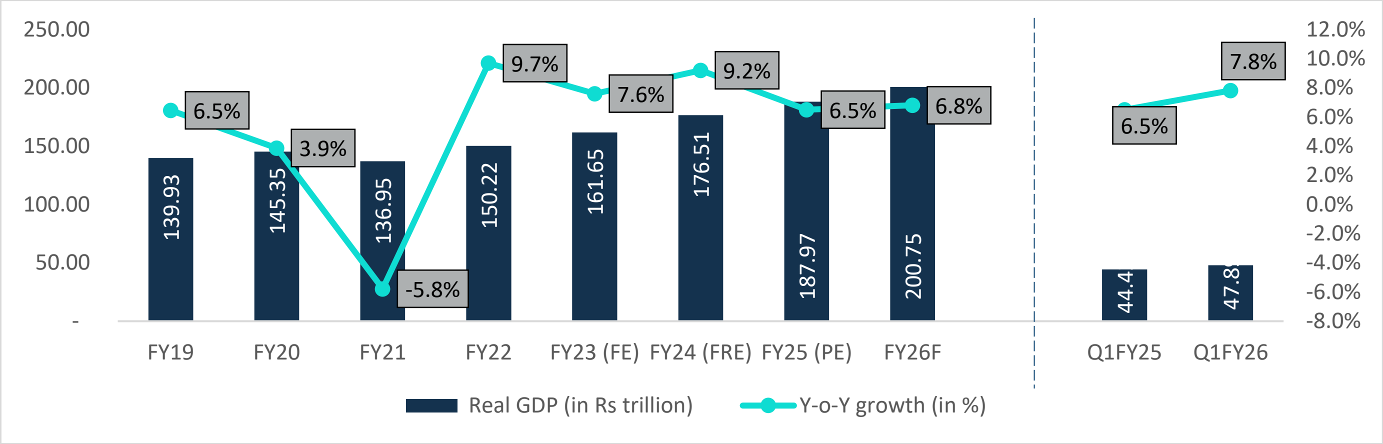
1.2.1 GDP Growth and Outlook

Resilience to External Shocks remains Critical for Near-Term Outlook

India's economy continues to show rapid growth. In the first quarter of FY26, the country's GDP grew by 7.8% compared to the same period last year, which saw a 6.5% increase. For the full year FY26, GDP is expected to grow by 6.8%, supported by rising rural demand, better job opportunities, and active business conditions.

In FY25, provisional estimates show a growth of 6.5% (Rs 187.97 trillion), led by robust performance in manufacturing, construction, and financial services. Consumer spending rose by 7.6%, and government spending increased by 3.8%, both contributing to the overall growth. In FY24, India's GDP grew by 9.2% (Rs 176.5 trillion), the highest in over a decade (excluding the pandemic year).

Chart 2: Trend in Real Indian GDP growth rate



Source: MOSPI, Reserve Bank of India; Note: FE – Final Estimates, FRE- First Revised Estimates, PE – Provisional Estimates, F - Forecasted

GDP Growth Outlook (October 2025)

FY26 GDP Outlook: The RBI projects real GDP growth at 6.8% for 2025–26, driven by strong private consumption, steady investment, and resilient rural and urban demand. A favourable monsoon, robust services sector and improving corporate balance sheets support this outlook.

However, risks from prolonged geopolitical tensions, global trade disruptions, and weather-related uncertainties remain. Taking these into account, the RBI has reaffirmed its growth projections.

Table 2: RBI's GDP Growth Outlook (Y-o-Y %)

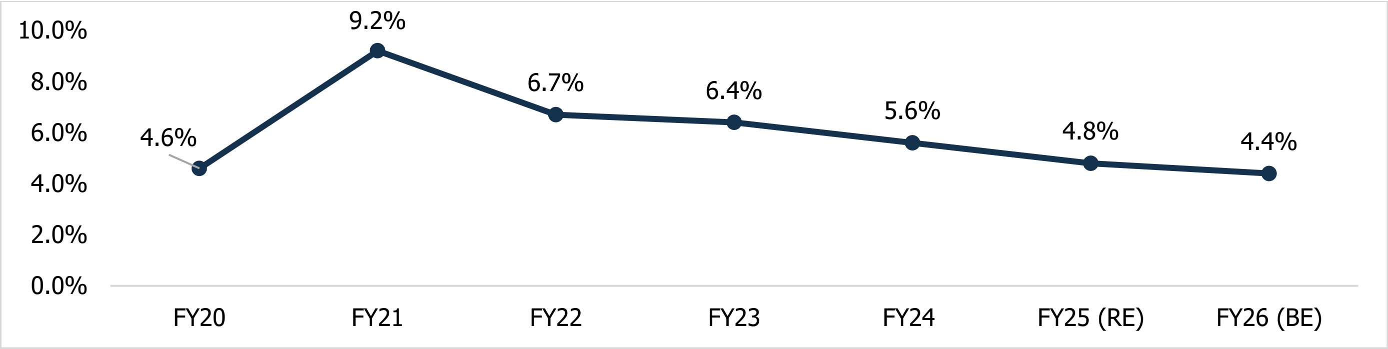
FY26P (complete year)	Q2FY26P	Q3FY26P	Q4FY26P	Q1FY27P
6.8%	7.0%	6.4%	6.2%	6.4%

Source: Reserve Bank of India; Note: P-Projected

1.2.2 Fiscal Deficit (as a % of GDP)

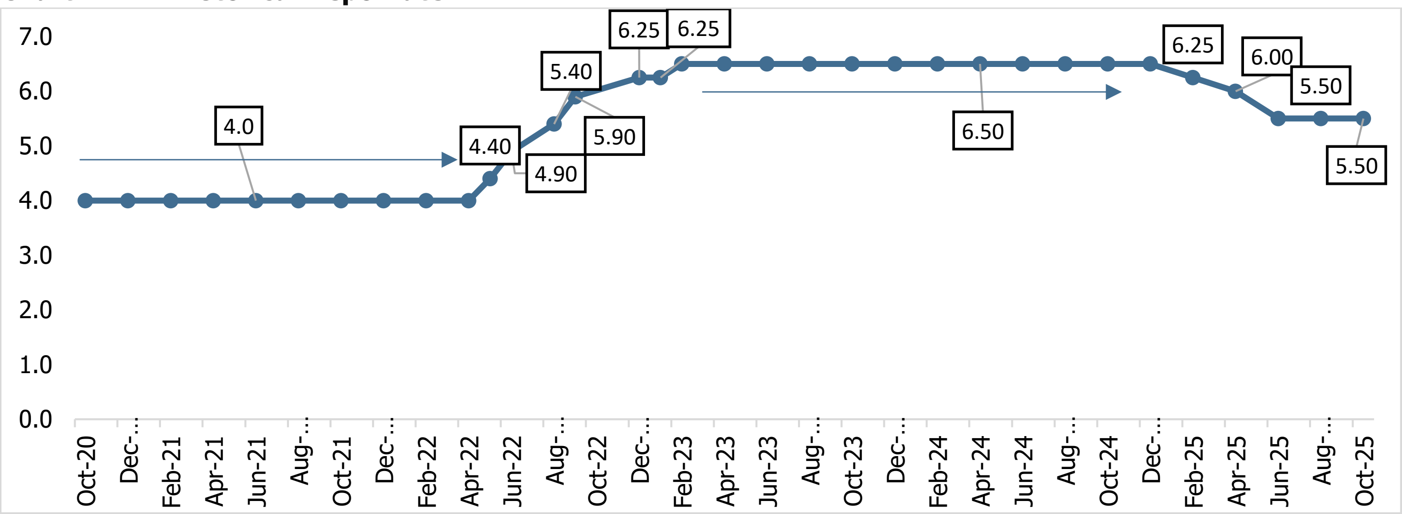
In FY21, India's fiscal deficit was 9.2% due to the impact of COVID-19, since then it has seen a steady improvement is expected to reduce to 4.8% of GDP FY25 (RE), driven by strong economic growth and higher tax and non-tax revenues. The government aims for further fiscal consolidation, setting a target of 4.4% of GDP for FY26 to maintain fiscal prudence.

Chart 3: Gross Fiscal Deficit (% of GDP)



Source: RBI; Note: RE-Revised Estimates, BE-Budget Estimates

Chart 4: RBI historical Repo Rate



Source: RBI

Further, the central bank continued it's stance as 'neutral'. The economic growth outlook for India is expected to maintain momentum, supported by private consumption and continued growth in fixed capital formation. The uncertainty has resurfaced as the temporary pause on US tariff hikes has ended and higher duties on some Indian exports now apply, even though trade talks have resumed.

The RBI has adopted for a non-inflationary growth with the foundations of strong demand and supply with a good macroeconomic balance. The domestic growth and inflation curve require the policies to be supportive with the volatile trade conditions.

1.2.3 GVA in the Industrial Sector

India's industrial sector is expected to grow by 10.8% in FY24, reaching Rs. 31.56 trillion, supported by positive business sentiment, falling commodity prices, and government initiatives like production-linked incentives. In FY25, growth is expected to slow down to 5.9% y-o-y, down from 10.8% in FY24. The growth is driven primarily by manufacturing, and utility services. The slowdown can be attributed to the manufacturing segment likely to grow at 4.5%, lower than the previous year's 12.3%.

In Q1FY26, most sectors showed a slowdown in growth, with Industry declining from 8.5% to 6.3% and Mining & Quarrying dropping sharply from 6.6% to -3.1%. However, Manufacturing maintained robust growth, slightly improving to 7.7%.

Table 3: Industrial sector growth (Y-o-Y growth) -at Constant Prices

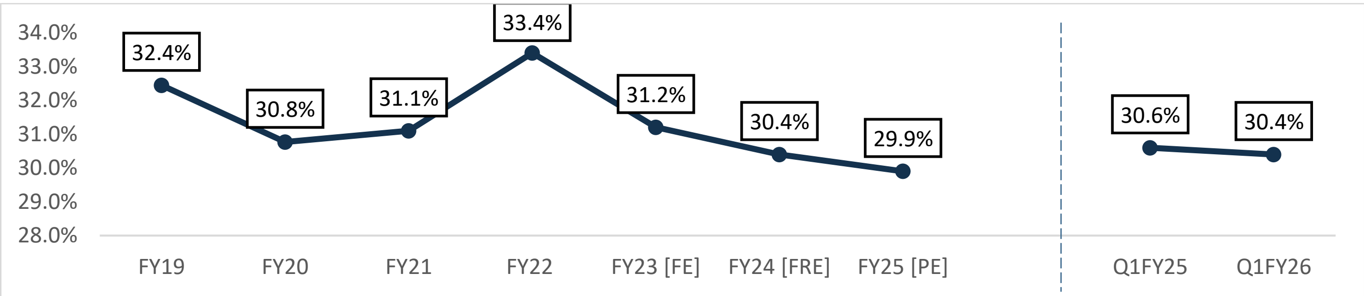
At constant Prices	FY19	FY20	FY21	FY22	FY23 (FE)	FY24 (FRE)	FY25 (PE)	Q1FY25	Q1FY26
Agriculture, Forestry & Fishing	**2.1**	**6.2**	**4.1**	**4.6**	**6.3**	**2.7**	**4.6**	**1.5**	**3.7**
Industry	**5.3**	**-1.4**	**-0.9**	**12.2**	**2.5**	**10.8**	**5.9**	**8.5**	**6.3**
Mining & Quarrying	-0.9	-3.0	-8.6	6.3	3.4	3.2	2.7	6.6	-3.1
Manufacturing	5.4	-3.0	2.9	10.0	-1.7	12.3	4.5	7.6	7.7
Electricity, Gas, Water Supply & Other Utility Services	7.9	2.3	-4.3	10.3	10.8	8.6	5.9	10.2	0.5
Construction	6.5	1.6	-5.7	19.9	9.1	10.4	9.4	10.1	7.6
GVA at Basic Price	**5.8**	**3.9**	**-4.2**	**9.4**	**7.2**	**8.6**	**6.4**	**6.5**	**7.6**

Source: MOSPI; Note: FRE – First Revised Estimates, FE – Final Estimates, PE- Provisional Estimates

1.2.4 Investment Trend in Infrastructure

Gross Fixed Capital Formation (GFCF) is a measure of net increase in physical assets. In FY23, the ratio of investment (GFCF) to GDP remained flat, as compared to FY22 which was at 33.4%. The growth stabilized at 30.4% in FY24 before falling to 29.9% in FY25. The moderation reflects cautious capital spending by both government and private corporations, which has persistently lagged overall GDP growth. In Q1FY26, GFCF as a proportion in GDP, marginally declined to 30.4% as compared to 30.6% in Q1FY25.

Chart 5: Gross Fixed Capital Formation (GFCF) as % of GDP (At current prices)



Source: MOSPI; Note: FRE- First Revised Estimates, FE – Final Estimates, PE- Provisional Estimates

Overall, the support of public investment in infrastructure is likely to gain traction due to initiatives such as Atmanirbhar Bharat, Make in India, and Production-linked Incentive (PLI) scheme announced across various sectors.

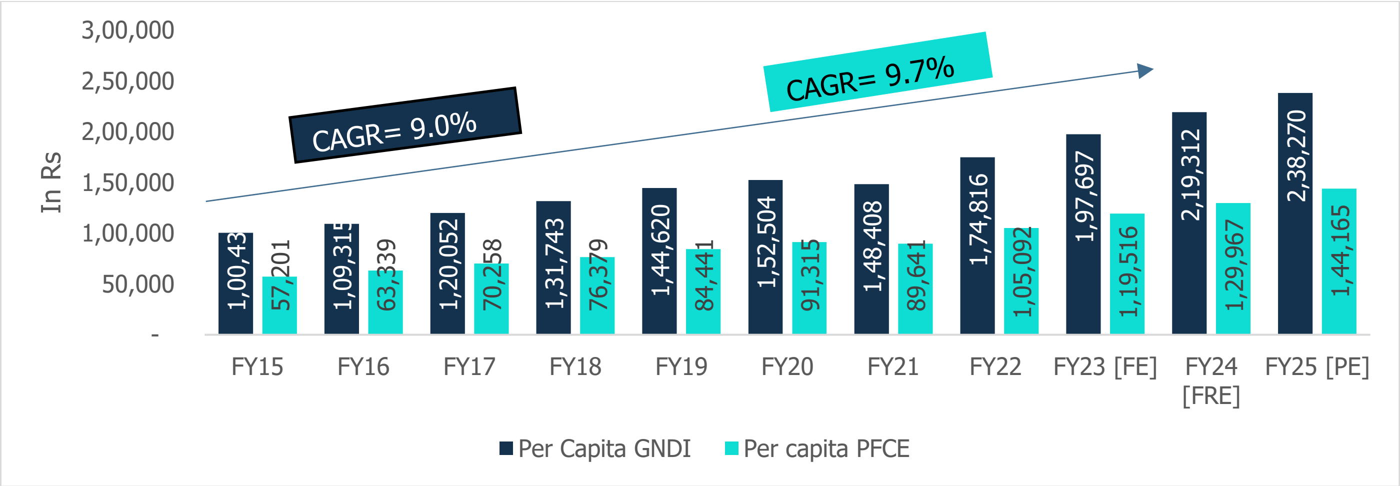
1.2.5 Per capita PFCE and GNDI

- **Increasing Disposable Income and Consumer Spending**

Gross National Disposable Income (GNDI) is a measure of the income available to the nation for final consumption and gross savings. Between the period FY15 to FY25, per capita GNDI at current prices registered a CAGR of 9.0%. More disposable income drives more consumption, thereby driving economic growth.

With increase in disposable income, there has been a gradual change in consumer spending behaviour as well. Per capita Private Final Consumption Expenditure (PFCE) which is measure of consumer spending has also showcased significant growth from FY15 to FY25 at a CAGR of 9.7%.

Chart 7: Trend of Per Capita GNDI and Per Capita PFCE (Current Price)



Source: MOSPI; Note: FRE – First Revised Estimates, FE – Final Estimates, PE- Provisional Estimates

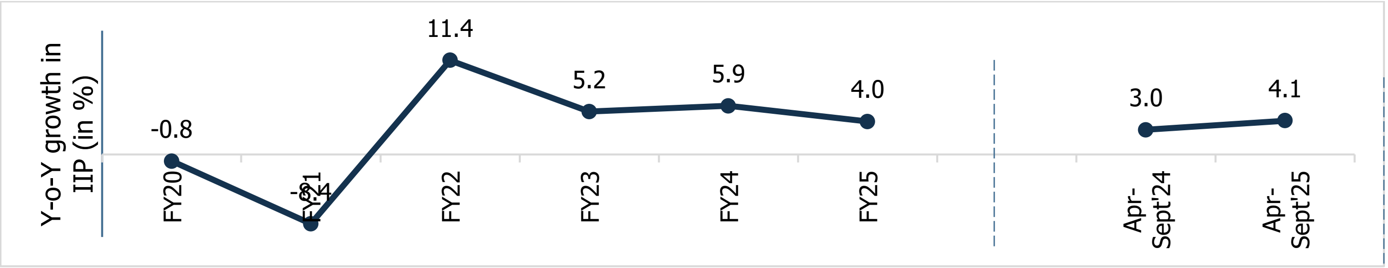
1.2.6 Industrial Growth

The Quick Estimates of the Index of Industrial Production (IIP) for September 2025 show a growth of 4.0%, remaining unchanged from August 2025. The year-on-year moderation reflects weakness across major segments, primarily due to contractions in electricity, mining, and consumer non-durables.

In September 2025, industrial growth was supported by Manufacturing (4.8%) and Electricity (3.1%). Within manufacturing, notable growth was recorded in basic metals, electrical equipment, motor vehicles, trailers and semi-trailers.

Use-based indices reflected mixed trends, with strong growth in Infrastructure Goods (10.5%), but declines in Consumer Durables and Non-Durables indicating subdued consumption and Capital goods. Manufacturing contributed significantly to overall industrial growth. This was primarily driven by strong performance in segments such as pharmaceuticals, motor vehicles, beverages, and electrical equipment.

Chart 6: Y-o-Y growth in IIP (in %)

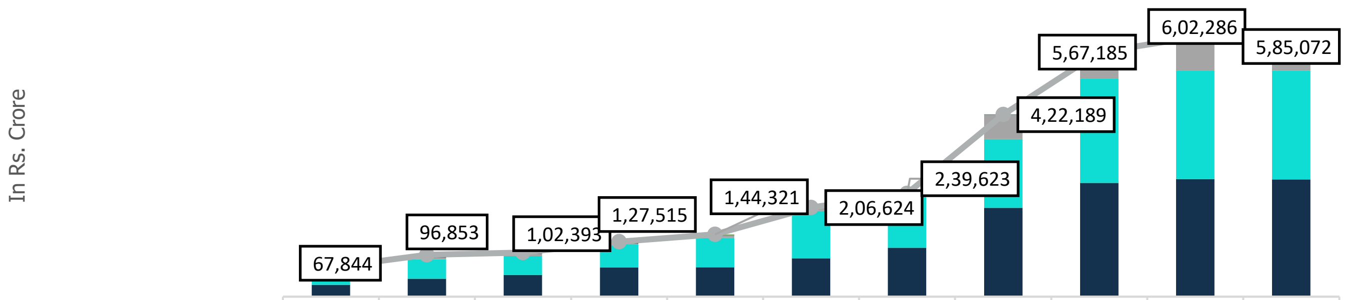


Source: MOSPI

1.2.7 Budgetary expenditure on Infrastructure

With the growing population, the long-term need for robust infrastructure is necessary for economic development. This generates the need for massive investments in the development and modernization of infrastructure facilities, which will not only cater to the growing demand but will also ensure competitiveness in the global market.

Chart 7: Budgetary outlay towards infrastructure



	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26
Power	1,276	3,816	1,941	2,043	1,615	370	2,827	23	125	1,127	658
Ports	218	330	182	154	259	169	614	678	1,149	1,342	1,761
Oil & Gas	1,153	2,451	1,131	1,908	572	2,313	347	40	41	341	6,626
Telecom	2,657	3,832	4,969	2,926	5,660	5,254	5,254	56,205	59,380	74,995	51,785
Railways	35,008	45,232	43,418	52,838	67,842	1,09,324	1,17,271	1,59,256	2,42,579	2,52,000	2,52,000
Roads and Highways	27,533	41,193	50,752	67,646	68,374	89,195	1,13,312	2,05,986	2,63,912	2,72,481	2,72,241
Total	67,844	96,853	1,02,393	1,27,515	1,44,321	2,06,624	2,39,623	4,22,189	5,67,185	6,02,286	5,85,072

Source: Union Budget FY26 document

Some of the key government infrastructure schemes include:

- The government has announced plans for the National Monetization Pipeline (NMP) and Development Finance Institution (DFI) to improve the financing of infrastructure projects
- The government has helped the growth of urbanization through a number of schemes and projects, including the **Smart Cities Mission,** the **Atal Mission for Rejuvenation and Urban Transformation (AMRUT),** and the **Pradhan Mantri Awas Yojana (Urban).**

1.3 Concluding Remarks

Global economic growth faces headwinds from geopolitical tensions, volatile commodity prices, high interest rates, inflation, financial market volatility, climate change, and rising public debt. However, India's economy remains relatively strong, with an IMF forecast of 6.6% GDP growth in CY25 (FY26 according to the fiscal year), compared to the global projection of 3.2%. Key drivers include strong domestic demand, government capital expenditure and moderating inflation.

Public investment is expected to exhibit healthy growth as the government has allocated a strong capital expenditure of about Rs. 11.21 lakh crores for FY26. The private sector’s intent to invest is also showing improvement as per the data announced on new project investments and resilience shown by the import of capital goods. Additionally, improvement in rural demand owing to healthy sowing, improving reservoir levels, and progress in south-west monsoon along with government’s thrust on capex and other policy support will aid the investment cycle in gaining further traction.

The recent 56th meeting of the Goods and Services Tax (GST) Council announced some major changes in the existing GST structure. The focus is majorly on simplifying it to a two-tiered GST tax structure of 5% and 18%, phasing out the currently existing 12% and 28% slabs. There is also a de-merit tax rate for luxury and ‘sin’ goods at a 40% tax slab. These changes are typically aimed at increasing the disposable income and in turn boosting consumption, as well as promoting the ease of doing business. The GST rationalization is expected to be a positive step towards economic growth, stimulating private consumption and ease inflationary pressures. The recent revisions in income tax rates, coupled with the reduction in GST, are expected to result in savings of over Rs 2.5 lakh crore, which is likely to further boost the consumption.

The impact of U.S. tariffs on India's export trade is anticipated to be minimal. The engineering goods sector will have a potential U.S. tariff impact, whereas steel industry is affected by the 50% tariffs although the impact is expected to be minimal given the volume of goods exported is less.

On February 13th, 2025, India and US discussed enhancing the U.S.-India trade relationship, with a target to increase bilateral trade from USD 200 billion to USD 500 billion by 2030. As of September 2025, India and the U.S discussions seem "positive and forward looking"

Thus, while U.S. tariffs may have a limited impact on India's exports, ongoing trade negotiations and India's competitive manufacturing advantage position it well for continued growth in global trade.

2 Indian Power Sector

Power is a vital component of infrastructure development and plays a crucial role in a country's economic growth and overall well-being. A robust and well-developed power infrastructure is essential for sustaining the growth of the Indian economy.

The power industry is divided into three segments:

- Generation
- Transmission
- Distribution

The value chain of power mainly comprises of three components:

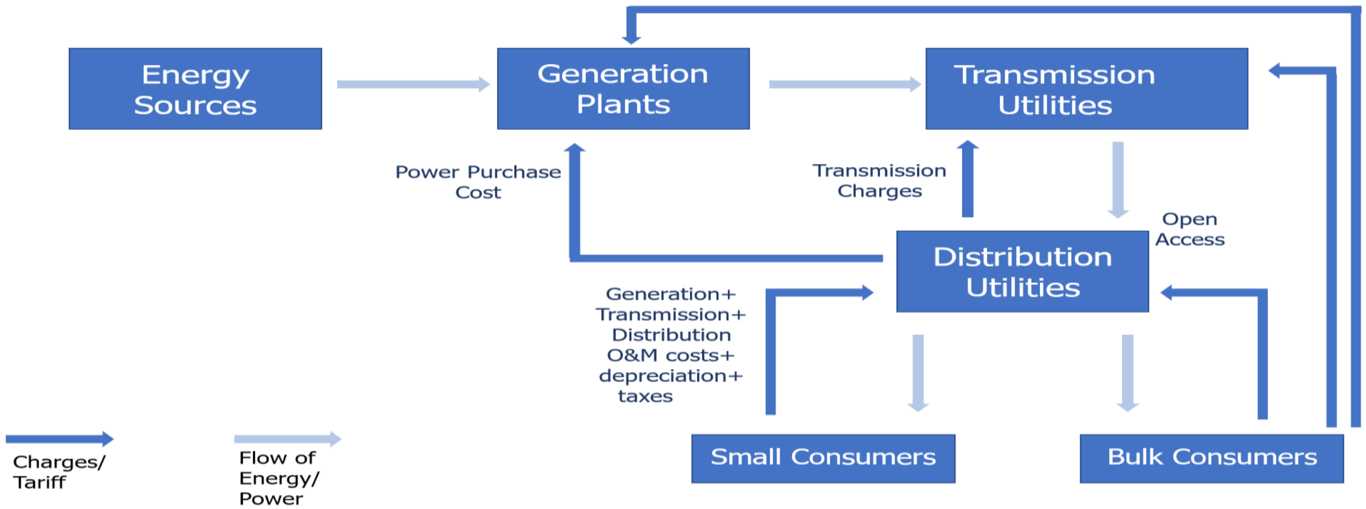
Generation: It is the process of generating power using different fuels as a source of energy. It is carried out in generation plants.

Transmission: Generated bulk power from generating units is transmitted over long distances through high voltage transmission networks and grid distribution substations

Distribution: The transmitted power received by distribution agencies is then distributed to the last mile customer. Distribution is the retail stage and operates at lower voltages.

The structure of the power industry is depicted in the figure below.

Chart 8: Structure of Power Sector in India



Source: CareEdge Research

2.1 Evolution of Power Sector and Its Structure in India

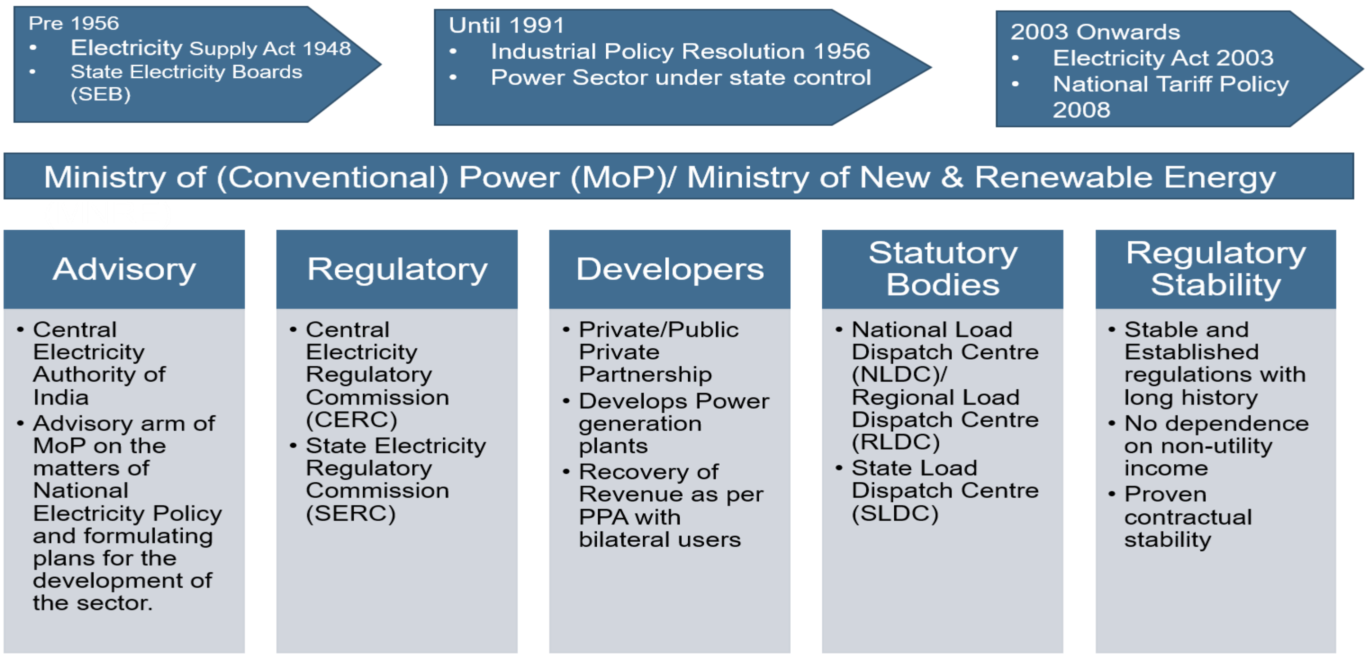
Overview

In India, the Electricity Act, 2003 governs the generation, transmission, distribution, exchange, and use of electricity. It also establishes a complex system of bodies to administer the Electricity Act's functions. The Electricity Act, among other things, delicensed all generation activities except hydropower.

The Electricity Act's principal goals are as follows:

- Promoting competition
- Protecting the interest of consumers
- Ensuring electricity supply to all areas along with a rationalization of tariffs
- Ensuring transparent policies and promotion of efficiency

The following diagram shows the regulatory structure of power sector in India:



Under the Electricity Act, the CEA is a statutory agency that advises the Government of India on policy, safety regulations, and technical standards. The Central Electricity Regulatory Commission (CERC) and the State Electricity Regulatory Commissions (SERCs) draft the regulations and the Government of India (in cooperation with the states and the CEA) develops policies (such as the Nation Tariff Policy and National Electricity Policy) as guidelines.

Table 4: Regulatory Capabilities of different bodies

	Centre	State/Private		
Policy	Ministry of Power	State Government		
Plan	CEA			
Regulations	CERC; MNRE	SERC		
System Operations	National Load Dispatch Centre, Regional Load Dispatch Centre	State Load Dispatch Centre		
Generation	Central Generation Stations, MNRE, Department of Atomic Energy	State Gencos	Captive and Co-Generation Plants, Independent Power Producers	Private Licensees in Ahmedabad, Kolkata, Mumbai, Surat, Delhi, Noida, etc.

	Centre		State/Private		
Transmission	Central Transmission Utility (PGCIL)	Transmission Licensee	State Transmission Utility	Transmission Licensee	
Distribution	-		State Distribution Company		Private Discoms
Trading	Trading Licensee	Power Exchanges	Bilateral Markets		
Appeal	Appellate Tribunal (APTEL)				

Note: MNRE – Ministry of New and Renewable Energy

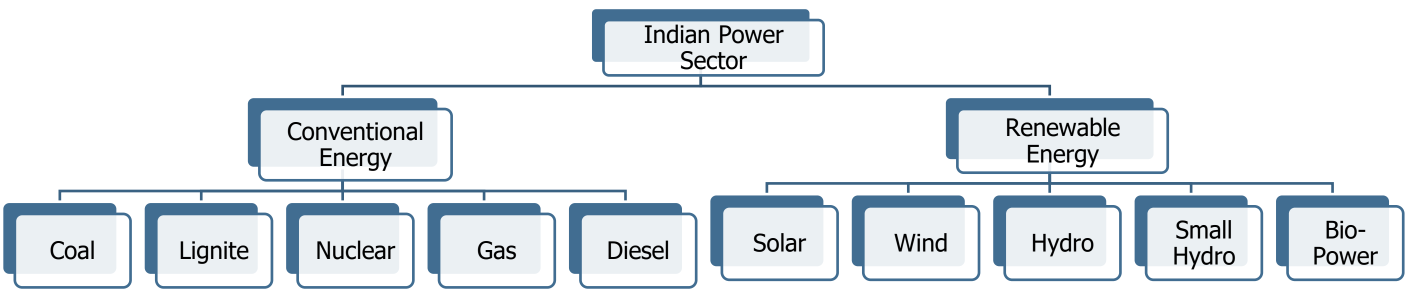
Electricity generation, distribution, and transmission are regulated and overseen by regulatory bodies at the federal and state levels. They are self-contained entities with responsibilities outlined in the Electricity Act.

2.2 Review and Outlook of the Power Demand-Supply in India

The power sector in India has undergone significant transformation in recent years, driven by government initiatives aimed at enhancing efficiency, sustainability, and accessibility. With a mix of conventional and renewable energy sources, India has made considerable strides toward achieving its energy security goals. The push for renewable energy, particularly solar and wind, has positioned the country as a leader in global clean energy efforts.

Renewable energy in India has emerged as a cornerstone of the country's energy strategy, driven by a commitment to sustainability and reducing carbon emissions. With ambitious targets set under the Paris Agreement, India aims to achieve 500 GW of renewable energy capacity by 2030.

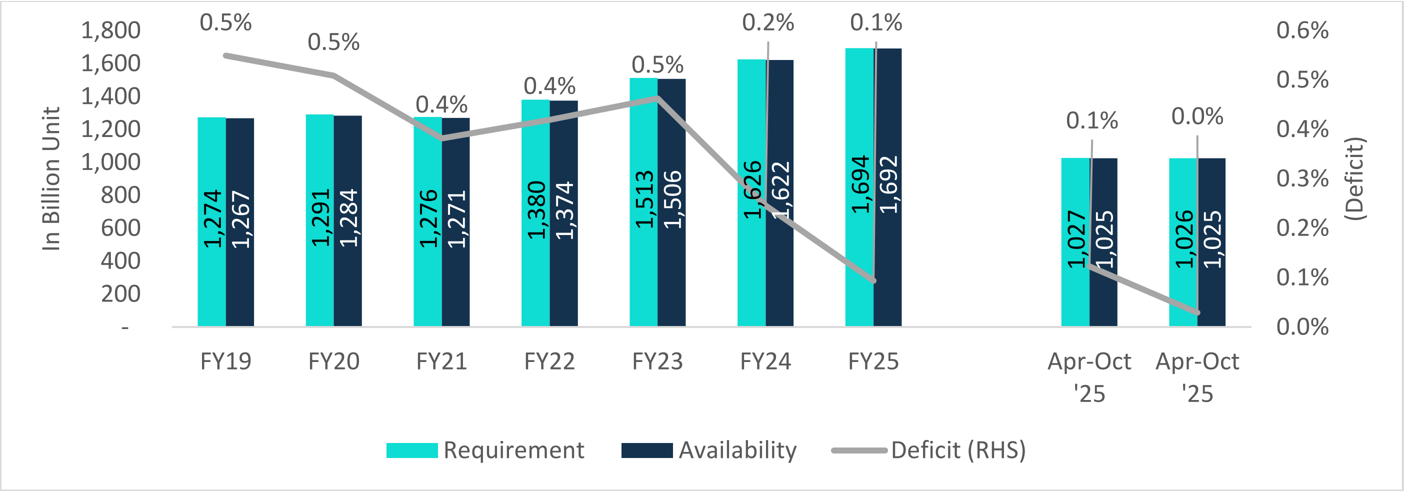
According to the International Energy Agency (IEA) global electricity demand grew by 4.3% in FY24 as compared to 2.5% in 2023. This growth was largely driven by emerging and developing economies, of the Asia-Pacific region mainly China and India emerging as the major source of demand. This highlights the need to add new capacity, especially from renewable sources, to meet the growing demand in a sustainable way.



2.3 Power Demand, Supply, and Deficit in India

Power demand in the country has been on a rise in the past decade, with an exception during FY21 due to the Covid-19 pandemic. Peak energy demand grew at a CAGR of 5.4% from 148 GW in FY15 to 250 GW in FY25, while peak supply grew at a CAGR of 5.3% over the same time period. There was a 4.2% y-o-y increase in the power requirement by the country in FY25. However, in FY25, due to high power demands, the peak demand not met was 2 GW and energy not supplied increased to 1,590 MU.

Chart 9: Power Position in India



Source: Power Ministry, CEA, CareEdge Research

The electricity requirement has grown from 1,274 BU in FY19 to 1,694 BU in FY25. There has been a continuous deficit between electricity requirement and availability in the range of 0.1%- 0.5% between FY19 and FY25.

The peak demand not met was around 1.5 GW in FY19 and the average energy not supplied was around 7,070 MU. The peak demands not met, and energy not supplied has been on an increasing trend since and substantially decreased to 2.475 GW and 5,787 MU, respectively, in FY22. However, in FY24, due to high power demands, the peak demand not met was 3.34 GW and energy not supplied increased to 4,112 MU. Whereas the peak demand not met in FY25 was relatively insignificant at 2 MW, while the energy not supplied increased to 1,590 MU.

2.4 Power Peak Demand Forecast, Energy Requirement and Supply Potential

Power demand forecasting helps India plan its electricity needs as the country grows. With rising population and industrial activity, demand for power is increasing. Agencies like the CEA use data and modelling tools to predict future demand. Smart grids and real-time data are making these forecasts more accurate. Although regional differences and infrastructure gaps remain challenges, accurate forecasting helps avoid power shortages and ensures reliable supply.

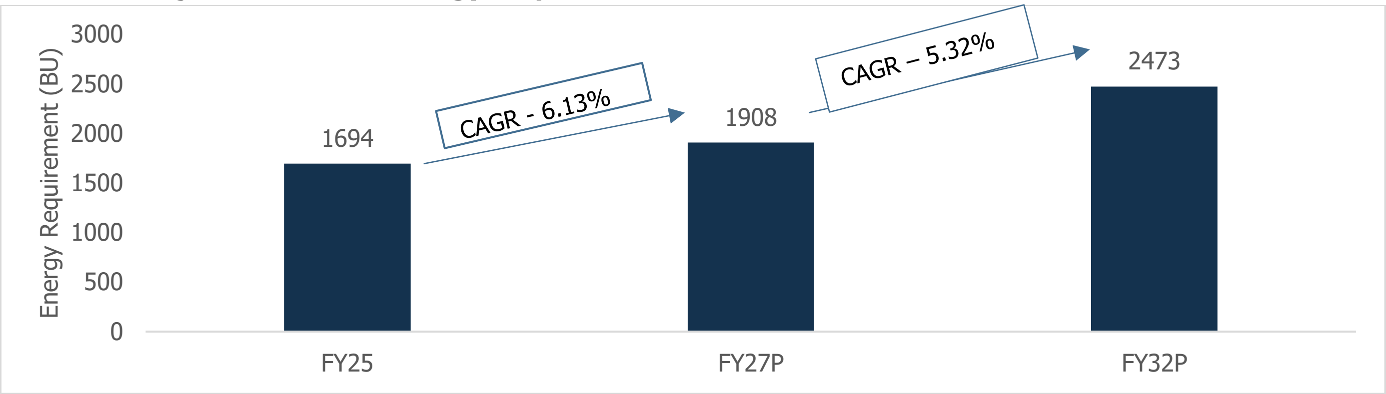
Table 5: All India Peak Demand and Energy Requirement

Region	Peak Demand (MW)		Energy Requirement (BU)	
	FY27	FY32	FY27	FY32
Northern	97,898.00	1,27,553.00	592.30	773.50
Western	89,457.00	1,14,766.00	596.80	763.20
Southern	80,864.00	1,07,259.00	460.90	596.60
Eastern	37,265.00	50,420.00	232.90	308.10
North-Eastern	4,855.00	6,519.00	24.90	32.40
All India	2,77,201.00	3,66,393.00	1,907.80	2,473.80

Source: CEA, CareEdge Research

Going forward, the Western and Northern regions are expected to continue to drive the energy requirement followed by the Southern region.

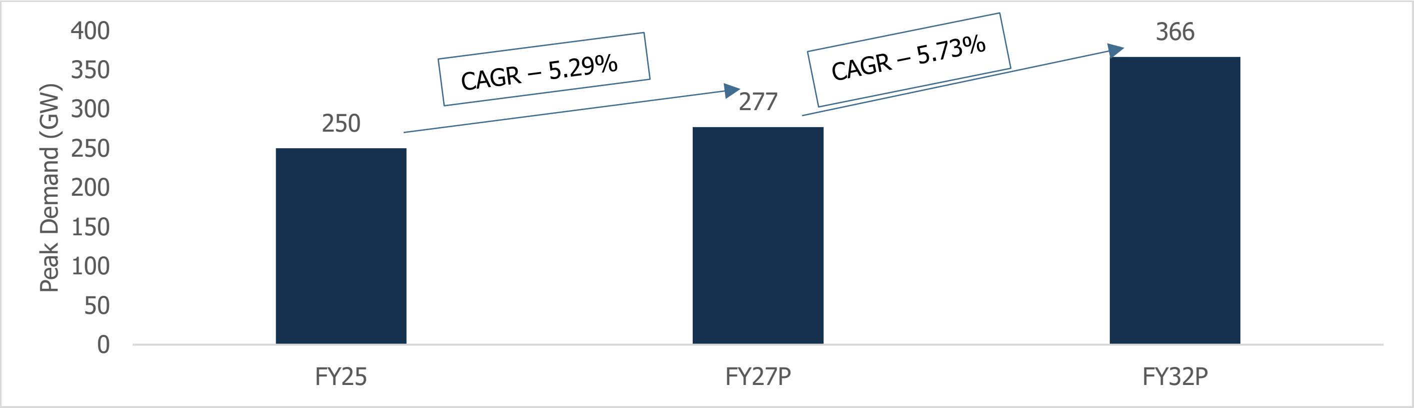
Chart 10: Projected All India Energy Requirement



Source: National Electricity Plan (NEP), CareEdge Research
Note: P is for Projections

According to the National Electricity Plan Vol 1, all India peak electricity demand is projected at 277 GW and energy requirement is projected at 1,908 BU for FY27. The power demand is further expected to rise with the growing population and increased economic activities. For FY32, the peak electricity demand is projected at 366 GW and energy requirement at 2,473 BU.

Chart 11: Projected All India Peak Demand



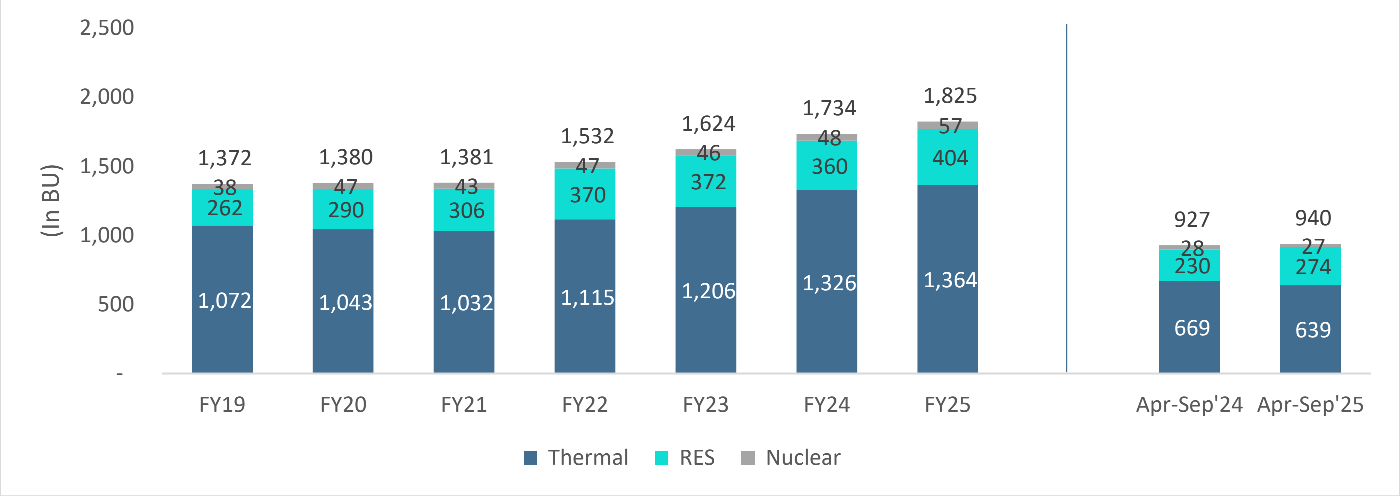
Source: National Electricity Plan (NEP) March 2025, CareEdge Research
Note: P is for Projected

The energy requirement is expected to grow at a CAGR of 6.13% and peak demand is expected to grow at CAGR of 5.3% between FY25-FY27. For FY27 to FY32, the CAGR is at 5.3% for energy requirement and 5.7% for peak demand.

2.5 Overview of the Indian Power Generation Industry

Indian power generation sector is one of the most diversified in the world. Power generation sources in India range from conventional sources such as coal, lignite, natural gas, oil, and nuclear to viable unconventional sources such as wind, solar, hydro, agricultural and household waste.

Chart 12: Power Generation over the years



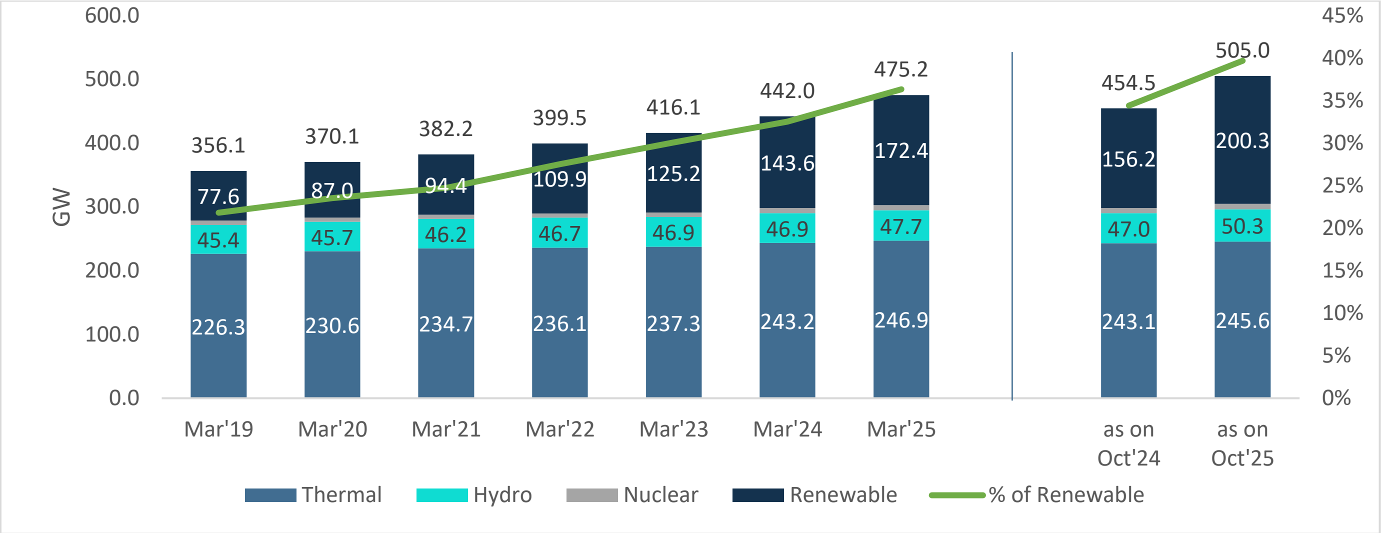
Source: CEA; RES refers to power generated from Hydro, Wind, Solar, Small hydro and Bioenergy projects

Electricity generation in India increased from 1,372 BU in FY19 to 1,824 BU in FY25, implying a compounded annual growth rate (CAGR) of 4.9%. Electricity generation increased by about 5.2% y-o-y to 1824 BU during April 2024 to March 2025. Thermal power forms the largest source of power in the country with about 75% of the electricity consumed being generated from thermal power plants. Renewable Energy Sources (RES) including solar, wind and hydro are quickly increasing their share, and their contribution has increased from 19.1% in FY19 to 22.2% in FY25.

Trend in Total Installed Capacity

The installed power capacity in India has increased from 356 GW in FY19 to 475 GW in FY25; it increased by 7.5% y-o-y as of March 2025; India is the world's third-largest producer and third-largest user of energy.

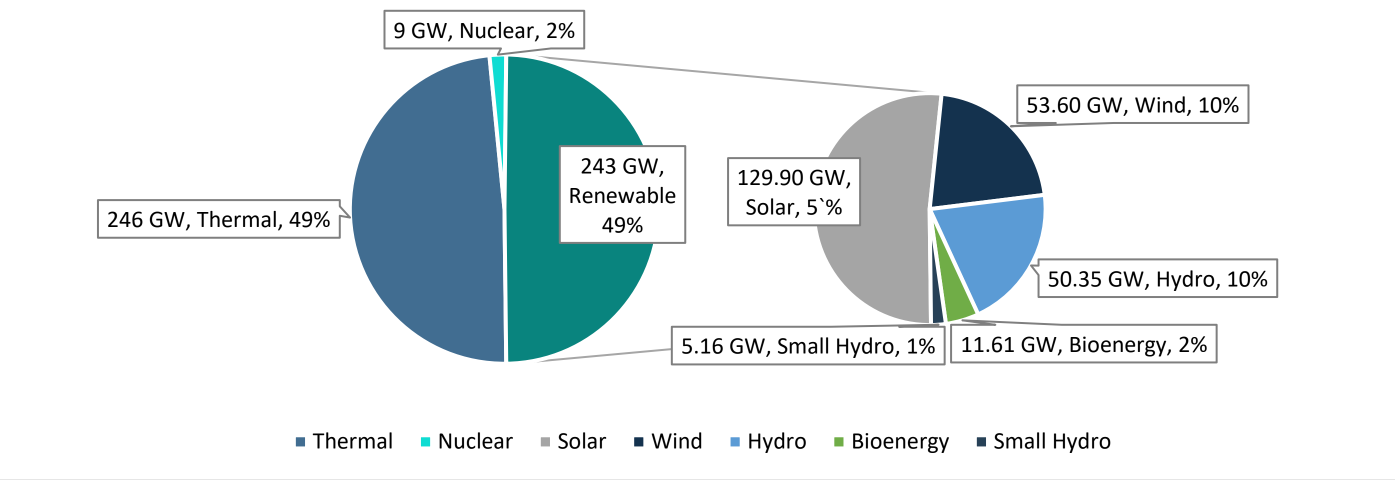
Chart 13: Installed Capacity Trend



Source: CEA, CareEdge Research

While conventional sources currently account for 54% of installed capacity, with the Government of India's ambitious projects and targets, RES installed capacity including hydro, which currently accounts for 46%, is expected to have nearly equal in contribution compared to conventional sources in the medium term. With consistent focus on renewable sector, the percentage share of installed capacity is expected to shift towards renewable energy. The country has achieved its interim target of having 50% of its installed capacity from non-fossil fuel sources for 2030, five years ahead of schedule. As of October 2025, non-fossil fuel–based capacity had reached 51.3% of the total installed capacity.

Chart 14: Mode-wise total installed capacity on 31st Oct'2025 – 505 GW

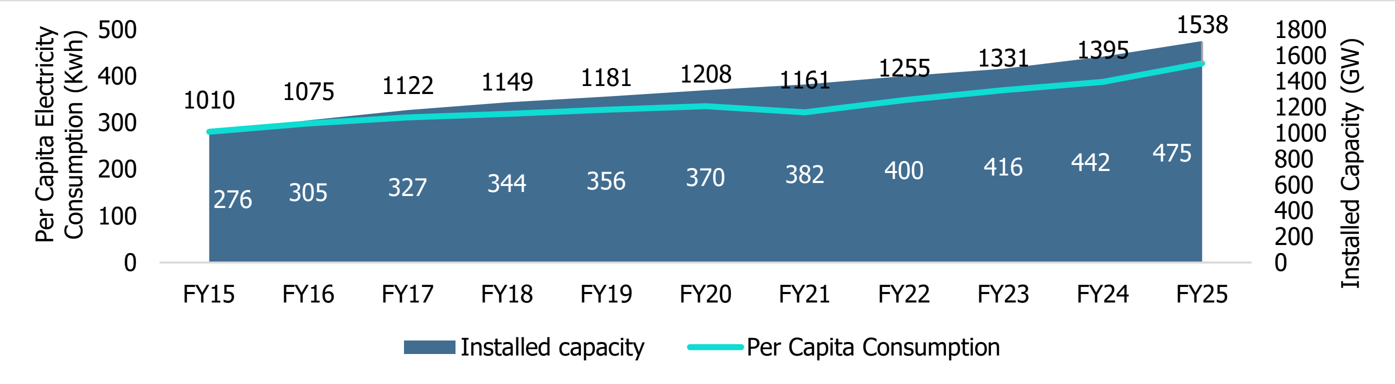


Source: CEA, CareEdge Research

Renewable accounts for 46% of the total power generation capacity of which solar accounts for the largest share of 22% followed by Wind at 11% and Hydro at 10%.

2.6 India's Per Capita Power Consumption

Chart 15: Growth of Electricity Sector in India - Installed Capacity and Per Capita Consumption*



Source: CEA, CareEdge Research
(*) Per Capita Consumption= Gross Electricity availability/ Mid-year Population

Developed countries such as Japan and the United States have the world's highest per capita electricity consumption. India's per capita consumption has remained low as compared to even the emerging countries like Brazil and Mexico, implying significant room for growth.

Table 6: Global Per Capita Consumption Comparison (MWh/Capita)

Year	World	India	Nigeria	Mexico	Thailand	Brazil	China	Japan	USA
1990	2.06	0.32	0.11	1.14	0.70	1.46	0.53	6.71	11.69
1995	2.14	0.46	0.11	1.38	1.25	1.63	0.79	7.53	12.64
2000	2.32	0.51	0.09	1.76	1.45	1.90	1.02	8.05	13.66
2005	2.58	0.61	0.13	1.98	1.91	2.02	1.81	8.30	13.68
2010	2.87	0.77	0.14	2.02	2.31	2.37	2.96	8.78	13.38

2015	3.06	1.01	0.15	2.23	2.58	2.56	4.05	8.01	12.86
2019	3.30	1.18	0.10	2.40	2.90	2.60	5.10	7.90	12.70
2022	3.43	1.08	0.14	2.35	2.87	2.72	6.11	7.81	12.99

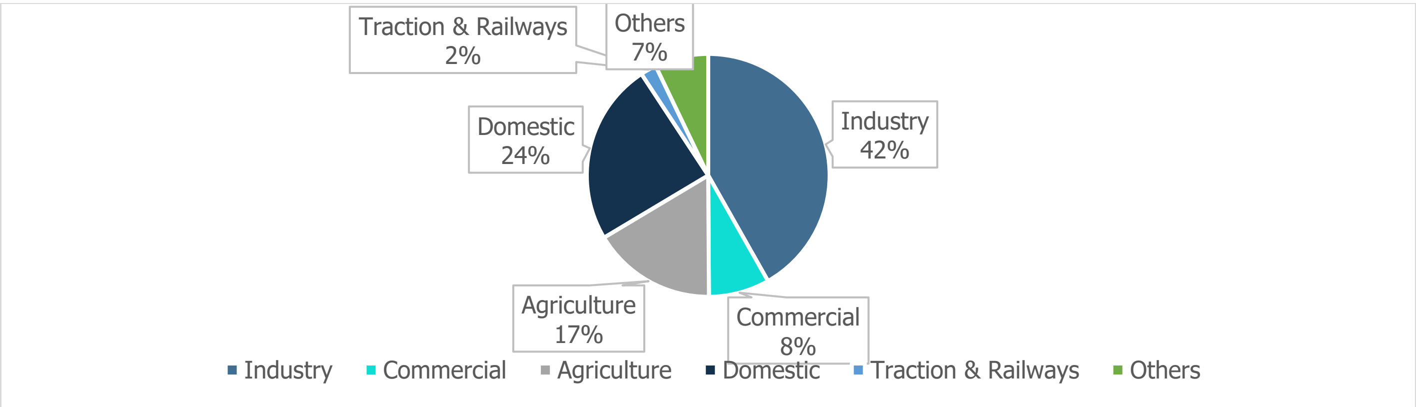
Source: IEA, CEA (For India), CareEdge Research
Data for India is as per FY-Financial Year while for others it is CY-Current Year

India is among the top nations in the world which are leading the global renewable energy growth. On technology specific installed capacity, India ranks 4th in onshore wind, 3rd in Solar, 3rd in Bioenergy and 5th in Hydro as per International Renewable Energy Agency (IRENA) renewable capacity statistics 2023.

2.7 Sector-wise Energy Consumption

The energy statistic of India, 2025 estimated electricity consumption increased from 9,48,521 GWh in FY15 to 15,43,000 GWh during FY24(P), a CAGR of 5.56%. Out of the total consumption of electricity in FY24 (P), commercial and industrial (C&I) segment accounted for largest share of consumption at 50%, followed by domestic consumption at 24.30% and agricultural consumption at 16.53%

Chart 16: Share of electricity consumption in 2023-24(P)



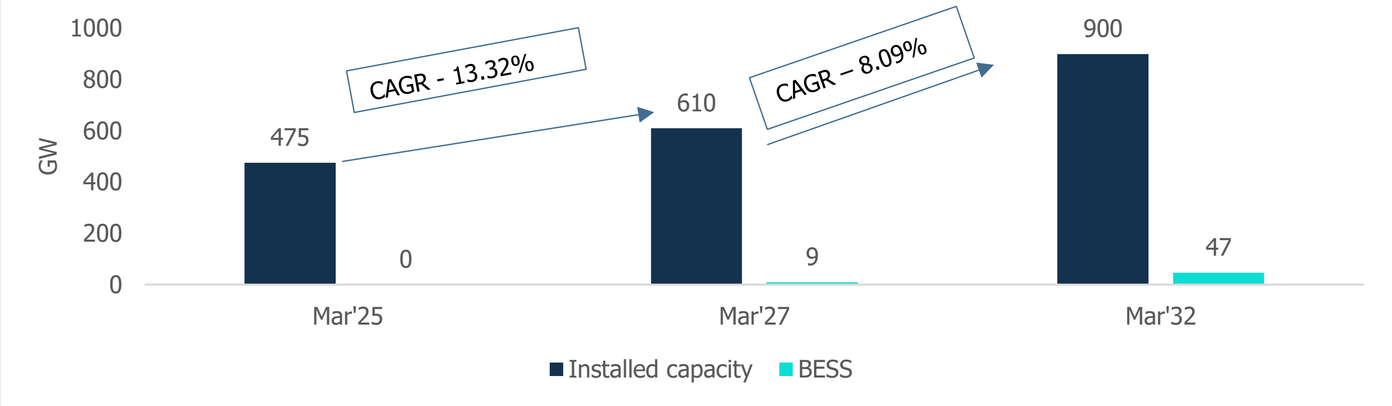
Source: MOSPI, Energy Statistics 2025, CareEdge Research

2.8 Outlook of Capacity Additions

The Indian power sector is witnessing a major transformation in terms of demand growth and energy mix. To ensure that everyone has access to reliable power and sufficient electricity, investments are being carried out to increase the installed capacity and clean energy transition. The government plans to establish a renewable capacity of 500 GW by 2030 and increase the share of non-fossil fuel-based installed capacity to around 50%.

The Battery Energy Storage System (BESS) is expected to gain traction and reach 9 GW of installed capacity and is expected to reach 47 GW by Mar’32.

Chart 17: Aggregate Installed Capacity Outlook



Source: National Electricity Plan (NEP), CareEdge Research

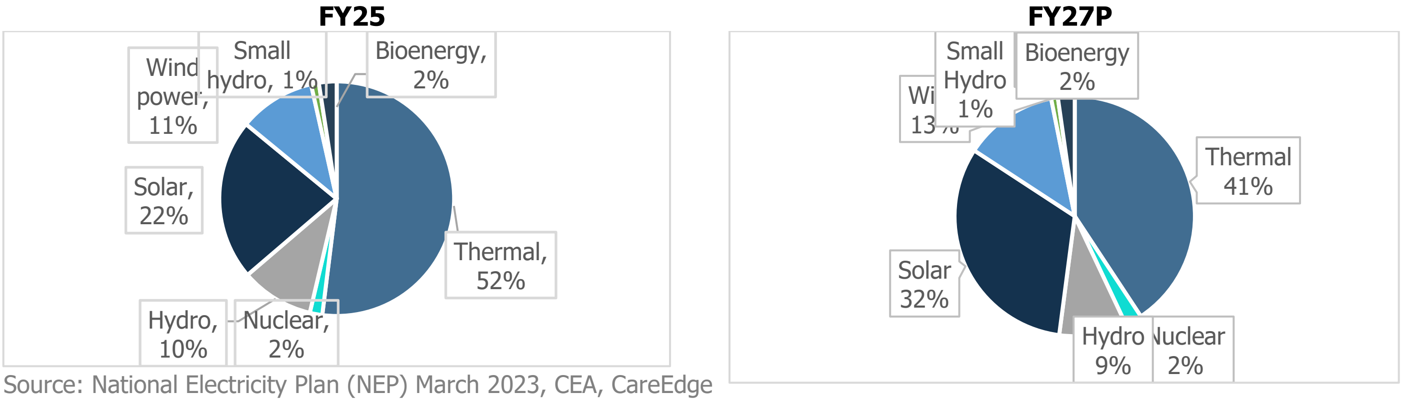
Table 7: Sector wise and fuel wise break up of Additional Capacity Requirement (MW)

	Under Construction (FY22 to FY27)	Additional Capacity Requirement (FY22 to FY27)	Total Capacity Addition (FY22 to FY27)	Under Construction (FY27 to FY32)	Additional Capacity Requirement (FY27 to FY32)	Total Capacity Addition (FY27 to FY32)
Renewable						
Hydro	10,462	0	10,462	1,032	8,700	9,732
PSP	2,700	0	2,700	80	19,160	19,240
Solar	92,580	38,990	1,31,570	0	17,900	17,900
Wind	25,000	7,537	32,537	0	49,000	49,000
Biomass	2,318	0	2,318	2,500	0	2,500
Small Hydro	352	0	352	250	0	250
Conventional						
Nuclear	6,300	0	6,300	2,400	4,200	6,600
Coal & Lignite	25,580	0	25,580	1,320	24,160	25,480
Total	165,292	46,527	2,11,819	7,582	2,84,220	2,91,802
BESS	0	8,680	8,680	0	38,564	38,564

Source: MNRE

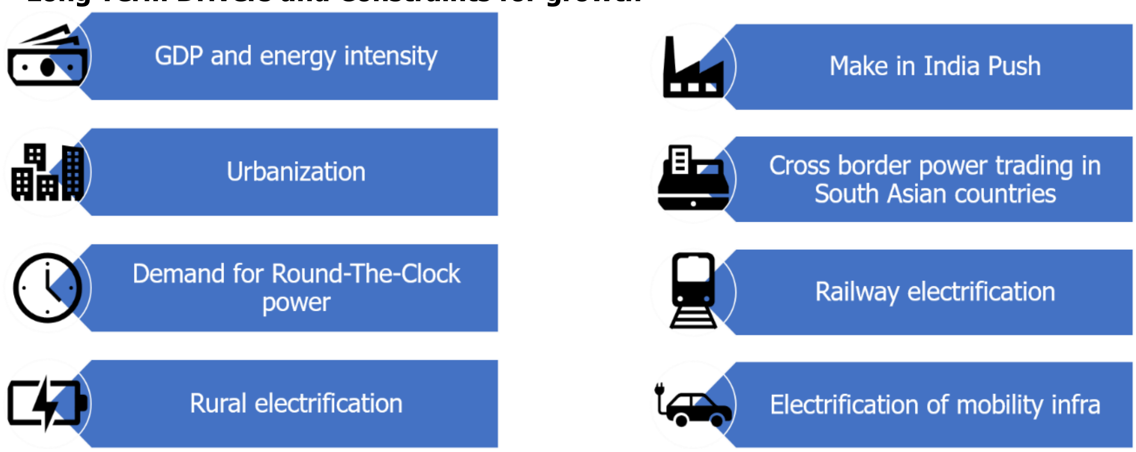
In FY25, the conventional generation capacity accounted for 52% of the total installed capacity while renewable energy accounted for the balance 48%. By FY27, it is expected that the contribution of conventional generation will decline to 41%.

Chart 18:Break-up of the total installed capacity - FY25 vs FY27



Source: National Electricity Plan (NEP) March 2023, CEA, CareEdge Research

2.9 Long Term Drivers and Constraints for growth



Source: CareEdge Research

- **GDP and energy intensity**

India has latent power demand because of its low per capita power consumption, strong GDP outlook and growing population.

- **Urbanization**

Urbanization leads to faster infrastructure development, job creation, development of the consumer and services sectors, and hence is a major driver for the growing power demand. The urban consumption is increasing due to rising disposable income, favourable demographics and the trend is likely to continue.

- **Demand for Round-The-Clock power**

Recently, there has been a significant focus on blending two or more energy sources like wind-solar hybrid to achieve better synergies, higher plant load factor and better energy gains. The wind and solar energy have complementary generation patterns and hence provide smooth and Round-The-Clock output.

- **Rural Electrification**

The government of India has taken joint initiative with the state governments for providing Power for All (PFA) to all households/homes, industrial and commercial consumers including supply of power to agricultural consumers. PFA initiative along with rural electrification across various states aims to ensure 24X7 electricity access, enhance the satisfaction levels of the consumers, improve quality of life of people and increase economic activities resulting in development. This is one of the key drivers for the growing power demand.

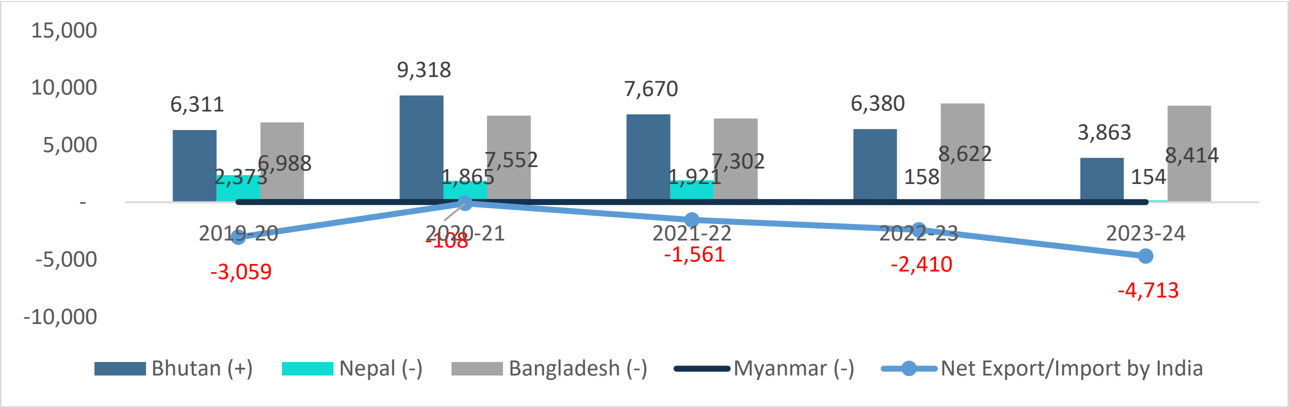
- **Make in India push**

The Make in India initiative, was introduced by the Government of India to encourage companies to develop, manufacture and assemble products in India and incentivize dedicated investments into manufacturing. This initiative targets to increase the manufacturing share of GDP from the current 17% in FY25 to 25% by 2047. As electronics, automobiles, textiles, and pharmaceuticals expand, the power sector will need stronger, reliable capacity, making infrastructure upgrades and renewable integration essential for supporting India's industrial growth.

- **Cross border power trading in South Asian countries**:

Power deficit in India has been on a declining trajectory and India is expected to further expand its generation capacity. India is also evaluating opportunities with neighbouring countries such as Nepal, Bangladesh, Sri Lanka, Myanmar and Bhutan for better integration and synergies by interlinking electricity transmission systems and allowing surplus power to be exported to other grids.

Chart 19: Cross Border Trade of Electricity between India and neighbouring countries



Source: CERC, Grid India, CareEdge Research

- **Railway Electrification**

A lot of emphasis is given to railway electrification with the view to reduce the nation's dependence on the imported coal and petroleum-based energy and with a vision of providing eco-friendly, faster and energy-efficient mode of transportation. 5,245 Rkms has been electrified during FY25 and total railway lines electrified has been extended to 98.80%.

Table 8: Trend of railway electrification in India (in route Kms)

Particulars	FY19	FY20	FY21	FY22	FY23	FY24	FY25
Electrified	35,488	39,866	45,881	52,247	58,812	63,456	68,701
Total	67,415	67,956	68,103	68,043	68,584	69,181	69,512
Railway Lines Electrified (% of Total)	52.60%	58.70%	67.40%	76.80%	85.80%	91.70%	98.80%

Source: Indian Railways

- **Electrification of Mobility Infra**

The global market for electric vehicles (EVs) is growing. As per the International Energy Agency (IEA), the global EV fleet will reach about 130 mn by 2030, a sharp rise from just more than 5.1 mn in 2018. The growth of EV segment in India has also been on an increasing trend. The penetration of EVs has increased to 7.8% of the total vehicle sales in FY25.

The Government of India has targeted 30% EV penetration across all vehicle categories combined by 2030. Whereas NITI Aayog projection is category specific for EV two and three-wheeler sales at 80%, 50% for four wheelers, and 40% for buses by 2030. As EV adoption grows, there will be additional power demand for EVs and hence readiness of the electricity grid to EV charging demand is critical to achieve rapid and large-scale transition to EVs.

Constraints:

Grid Connectivity

- Coal dominates India's power generation, but renewable capacity is rising rapidly. This growth demands major transmission expansion, as large solar and wind projects are often in remote areas. Despite government efforts like GEC, TBCB, and One Nation, One Grid, delays in transmission build-out remain a key risk.

Poor Health of DISCOMS

- DISCOMs have long struggled with rising debt, weak collections, high AT&C losses, and a large ACS-ARR gap. While reforms like UDAY, LPS, DDUGJY, IPDS, and smart metering aim to improve performance, delays in payments to power producers still pose a major financial risk.

Regulatory uncertainties

- Regulatory uncertainties from shifting policies, tariff and subsidy changes, and inconsistent state-level rules on land and permits disrupt planning and delay projects.

Fuel Availability (Coal)

- Thermal power depends on limited, depleting fuels, while renewables are abundant. Despite efforts to boost domestic coal output, the power sector still relies on imports to meet rising demand.

2.10 Investments in the Conventional and Renewable sector

Generation

As per the NEP, total power capacity is expected to increase to 900 GW by FY32 from 416 GW in FY23. The expected investments in the generation section between FY23-FY27 and FY27-FY32 are given in the following table.

Table 9: Expected investments in generation (Rs Crore)

Particular	FY23-FY27	FY27-FY32
A. Conventional		
Thermal	2,18,430	1,85,855
Nuclear	1,20,280	43,051
Sub-total	**3,38,710**	**2,28,906**
B. Renewables		
Hydro	66,148	1,29,777
PSP	54,203	75,240
Wind	2,30,946	3,30,900
Offshore Wind	0	27,401

SHP	1,859	1,669
Biomass	24,704	23,105
Solar	6,80,970	7,96,771
BESS	56,647	2,92,637
Sub-total	**11,15,477**	**16,77,500**
Total	**14,54,188**	**19,06,406**

Source: National Electricity Plan (NEP) March 2023, CareEdge Research

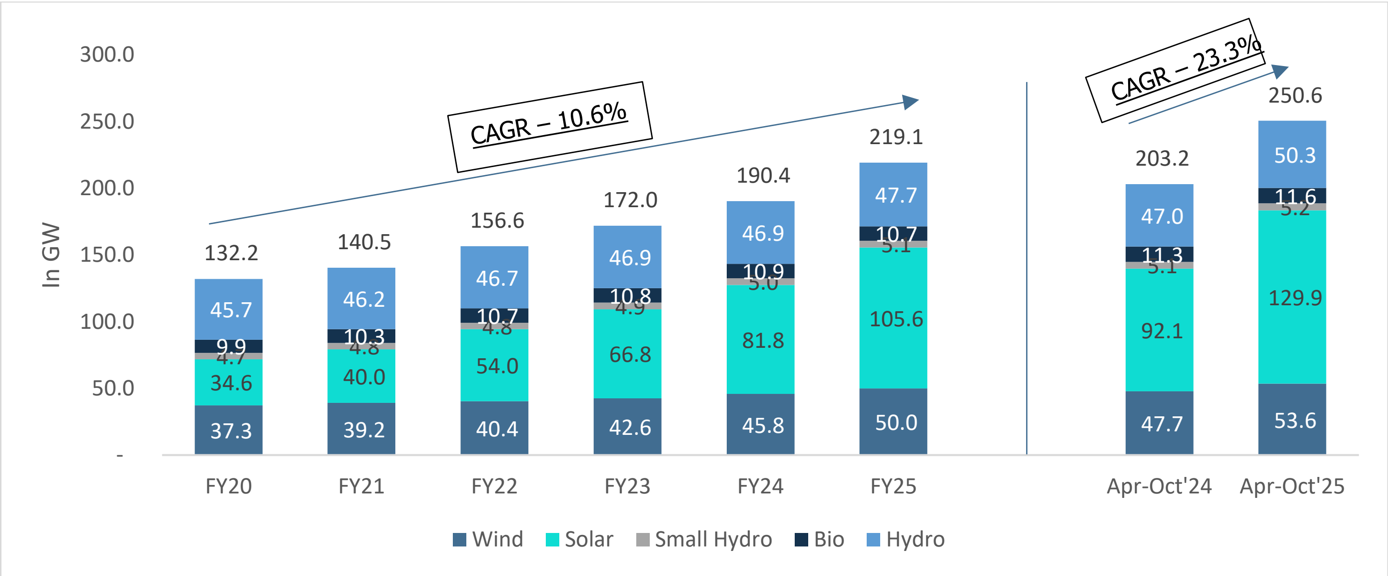
3 Renewable Energy Sector in India

3.1 Overview

There has been a significant shift globally in the generation capacity mix due to the growing concerns towards the environment and climate change. India is an active participant and has taken initiatives towards sustainable development and cleaner environment including significant additions of renewable energy generation capacity.

As per the International Renewable Energy Agency (IRENA) renewable capacity statistics 2025, India ranks 4th in the world, leading the global renewable energy growth below is the ranking based on technology-specific installed capacity, India ranks 3rd in Solar and Bioenergy, 4th in onshore wind and 6th in Hydro.

Chart 20: Renewable Energy – Source wise Installed Capacity



Note: Small Hydro denotes projects up to 25 MW, Hydro Power Plants denotes projects more than 25 MW
Source: CEA, CareEdge Research

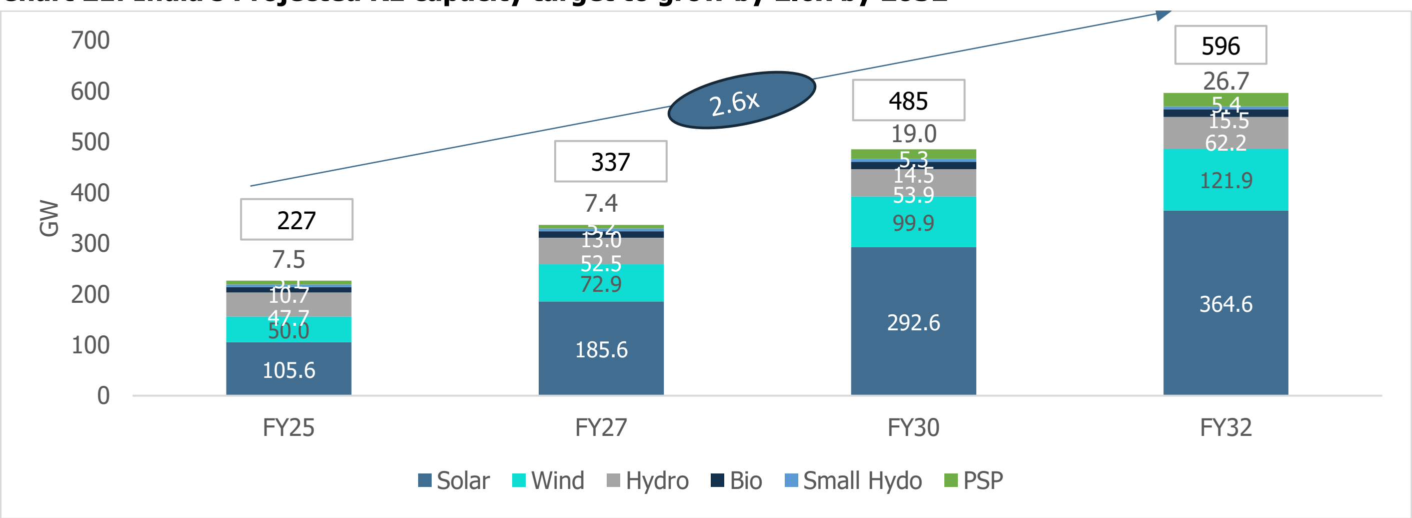
The total installed capacity of renewable energy has increased from 132 GW in FY20 to 219 GW in FY25, a CAGR of 10.6%. The solar power installed capacity grew at a CAGR of ~25% from FY20 to FY25. Total installed renewable energy capacity increased to 250.6 GW during Apr–Oct 2025, reflecting a 23.3% YoY growth compared to the same period last year.

- **Solar** - India's solar power capacity has seen remarkable growth over the last nine years, rising from 4 GW in March 2015 to 105.6 GW by March 2025, due to the efforts of the Ministry of New and Renewable Energy (MNRE). Solar tariffs in India have become very competitive, achieving grid parity. Alongside large-scale grid-connected solar PV projects, off-grid solar initiatives are also being developed to cater to local energy demands. As reported by the Central Electricity Authority (CEA), there are currently solar projects with a total capacity of 79.2 GW under construction as of March 2025.

- **Wind -** India has an installed wind power capacity of 50 GW as of March 2025, making it the fourth-largest country in the world for wind energy installations. However, the growth in capacity has slowed down in recent years due to several factors, including the limited availability of suitable wind sites, a transition in policy from the feed-in-tariff system to competitive bidding, and the removal of generation-based incentives (GBI) and accelerated depreciation (AD) benefits. According to the CEA, as of March 2025, there are wind projects totalling 26.5 GW currently under construction, along with an additional 39.4 GW of hybrid projects.
- **Hydro -** India ranks fifth in the world for installed hydroelectric power capacity, boasting a total utility-scale capacity of 47 GW as of December 2024. This represents 10.4% of the nation's overall utility power generation capacity. Currently, there are hydroelectric projects in progress with a combined capacity of 14.04 GW, expected to be completed between FY24 and FY27.
- **Small Hydro -** The Ministry of New and Renewable Energy (MNRE) is responsible for the development of Small Hydro Power (SHP) projects, which are defined as hydroelectric plants with a capacity of up to 25 MW. As of March 2025, the total installed SHP capacity is 5.1 GW, as per CEA, with additional projects totalling 4.05 GW currently under construction.
- **Bioenergy -** Bioenergy and waste-to-energy power generation present significant opportunities, especially in rural areas that lack grid connectivity. As of March 2025, India's total bioenergy-based power generation capacity stands at 10.7 GW. Ongoing projects include gasification-based bioenergy plants with a total capacity of 59.25 MW, along with 227.25 MW dedicated to waste-to-energy and co-generation initiatives.

3.2 Projected installed capacity

Chart 21: India's Projected RE capacity target to grow by 2.6x by 2032



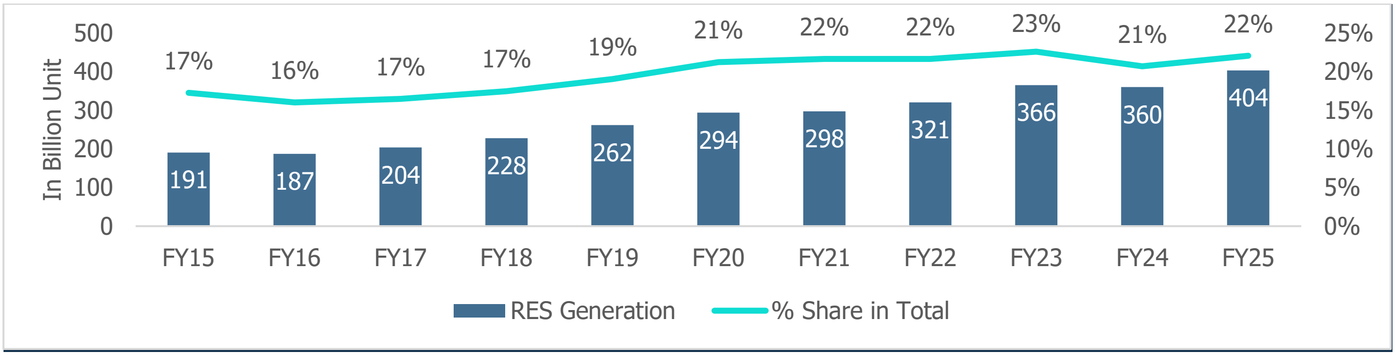
Source: CEA, NEP Volume I, CareEdge Research

India has reached a significant milestone in its renewable energy journey, with the country's total renewable energy capacity crossing the 200 GW (gigawatt). This remarkable growth aligns with the country's ambitious renewable energy target of achieving 500 GW from non-fossil sources by 2030. This achievement underscores India's growing commitment to clean energy and its progress in building a greener future. India's total renewable energy installed capacity is expected to be around 596 GW by end of FY32. MNRE increased its budget allocation for FY26 and is at Rs 265 bn which represents a 50% y-o-y increase, while for FY25 the revised estimate is at Rs 179 bn.

3.3 Trend in Renewable Generation in India

India is the world's third-largest producer of energy and is also the third largest consumer of electricity. India's total electricity generation capacity has reached 475 GW, with renewable energy contributing a sizeable portion of the overall power mix. As of March 2025, renewable energy-based electricity generation capacity stands at 220.10 GW, accounting for 46% of the country's total installed capacity. This marks a major shift in India's energy landscape, reflecting the

Chart 22: Share of Renewables in total power generation



Source: CEA, CareEdge Research
RES includes Solar, Wind, Hydro, Small Hydro and Bioenergy

In FY15, the power generated from renewable sources including hydro was 191 BU which has increased to 404 BU in FY25, growing at a compounded annual growth rate of 7.8%. The share of renewable also increased from 17% in FY15 to around 22% in FY25.

In FY15, hydro (excluding small hydro) power had the largest share in renewable energy generation at 68% followed by wind at 15%. In FY25, and solar has emerged as the largest with a share of 48%, while wind has the second largest share at 23% followed by hydro (excluding small hydro) at 22%.

Chart 23: Breakup of renewable energy generation FY15

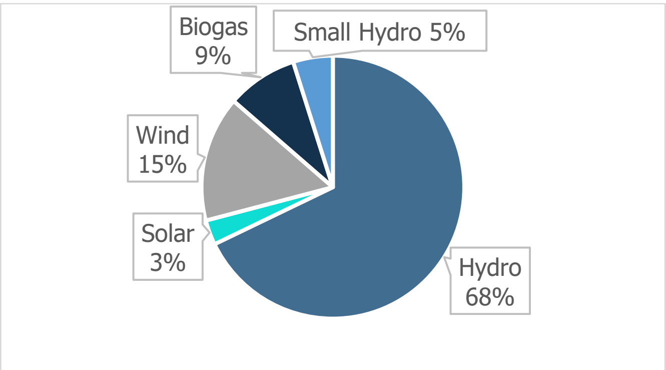
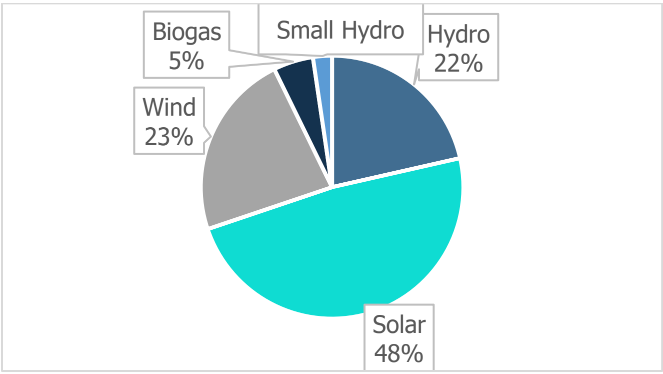


Chart 24: Breakup of renewable energy generation FY25



Source: CEA, CareEdge Research

3.4 Investments in Renewable Power Sector

Table 10: Expected investments in Renewable generation (Rs Crore)

Renewables	FY23-FY27	FY27-FY32
Hydro	66,148	1,29,777
PSP	54,203	75,240
Wind	2,30,946	3,30,900
Offshore Wind	0	27,401
SHP	1,859	1,669
Biomass	24,704	23,105
Solar	6,80,970	7,96,771

BESS	56,647	2,92,637
Total	**11,15,477**	**16,77,500**

Source: National Electricity Plan (NEP) March 2023, CareEdge Research

3.5 Technological advancements driving renewable growth

Rapid technological advancements are playing a pivotal role in accelerating the growth of renewable power across the globe. Improvements in solar photovoltaic (PV) efficiency, wind turbine design, and energy storage solutions have significantly reduced the cost of renewable energy generation, making it increasingly competitive.

Solar: innovations such as bifacial solar panels, perovskite solar cells, and advanced tracking systems are enhancing efficiency and output, thereby improving project viability.

Wind: development of larger, more efficient turbines and offshore wind technology has expanded generation capacity and reduced the levelized cost of electricity.

BESS: battery technology in lithium-ion and emerging alternatives like solid-state and flow batteries, are enabling better integration of renewables by addressing intermittency concerns.

Digitalization and Smart Grids: adoption of AI, IoT, and advanced analytics for predictive maintenance, demand forecasting, and grid optimization is further boosting reliability and efficiency of renewable power.

These technological improvements are creating a strong foundation for large-scale renewable integration. As a result, technology-led cost competitiveness and scalability are driving broader investment flows and supporting long-term sectoral growth.

3.6 Key Drivers and Constrains

Drivers

Government Policies and Incentives	•Government policies strongly support renewable energy through initiatives like the National Solar Mission and Wind Energy Policy. Incentives such as subsidies, tax benefits, and favourable regulations reduce project risks and encourage investment, driving rapid growth in the sector.
Rising Energy Demand	•India's rising energy demand from rapid urbanization and industrial growth is straining existing power infrastructure, making it essential to expand capacity and shift toward cleaner, reliable renewable sources.
Climate Change Awareness	•Growing awareness about climate change is increasing demand for renewable energy. People and businesses want to reduce their carbon footprints, support cleaner practices, and invest in green energy to help protect the environment.
Technological Advancements	•Technological advancements are making renewable energy more efficient, reliable, and affordable. Improved solar panels, better wind turbines, and advanced battery storage are reducing costs and increasing performance, making renewables more competitive with traditional energy sources.
Investment in Infrastructure	• Investment in energy infrastructure is essential to support renewable growth. Stronger grids, smart systems, and better storage solutions help integrate solar and wind power more efficiently, improve reliability, and build a resilient energy system for the future.
Energy Security	•Energy security concerns are pushing India to invest more in domestic renewable sources. Increasing the share of renewables reduces dependence on imported fossil fuels, lowers vulnerability to global price swings, and strengthens long-term energy stability and self-reliance.

Constraints

Counterparty Risk	•DISCOMs' weak finances, high losses, and delayed payments continue to affect timely PPA signing and cash flows despite government reforms.
High Import Dependence	•Solar cells, modules, and inverters are still largely imported (mainly from China), despite PLI schemes and higher import duties to boost domestic manufacturing.
Grid Integration Delays	•Transmission readiness often lags renewable capacity addition due to land and execution delays, affecting project offtake.
Intermittency Issue	•Solar and wind power are not available round the clock due to seasonal and hourly variations.
Regional Imbalance	• Renewable projects are concentrated in western and southern states, while eastern states lag, creating uneven development.
Land & Wind Site Constraints	•Good wind sites are exhausted; new projects face land scarcity, higher costs, regulatory delays, and transmission bottlenecks.

3.7 Key Government Initiatives

As part of its Nationally Determined Contribution (NDC) for the Paris Agreement obligations, the government stated that by 2030, reduction of the emissions intensity of GDP by 45% below 2005 levels and raise the percentage of non-fossil fuels in total capacity to 50% and increase share of non-fossil power capacity to 50%. Hence the government has pushed towards renewable capacity additions through policies initiatives like JNNSM, obligations of RPO, setting up of SECI, etc.

- **Green Energy Corridor**

The Green Energy Corridor scheme was launched in 2015 for setting up of transmission and evacuation infrastructure to facilitate evacuation of electricity from renewable energy projects. The Intra state transmission system (ISTS) projects has been sanctioned to eight renewable energy states i.e. Tamil Nadu, Rajasthan, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, Himachal Pradesh and Madhya Pradesh for evacuation of over 20,000 MW of renewable energy. As of October 2023, the project on Green Energy Corridor (GEC) Phase-II – Inter-State Transmission System (ISTS) for 13 GW Renewable Energy Project in Ladakh was approved. The project is targeted to be set up by FY 2029-30 with total estimated cost of Rs 20,773.70 crore and Central Financial Assistance (CFA) at 40 percent of the project cost i.e. Rs 8,309.48 crore.

- **Round-the-Clock-Power (RTC) for RE projects**

The round-the-clock power mechanism is bundling of power has been bought by the government in order to overcome the issues of intermittency and low-capacity utilization of transmission infrastructure. Here the RE power is bundled with other sources and/or storage. Further, the Government is focusing towards promoting increased adoption of renewable energy and use of green hydrogen as envisaged in the National Green Hydrogen Mission, the Ministry of New and Renewable Energy is working on the modalities for promoting the use of green hydrogen in supporting round-the-clock electricity.

- **Infrastructure Support from Government**

MNRE is implementing the scheme for the development of solar parks and ultra-mega solar power projects, under which, the infrastructure such as land, roads, transmission system (internal and external), pooling stations, etc., is developed with all statutory clearances/approvals. Thus, the solar project developers have plug-and-play benefits.

Further, under Mode 8 of the Solar Park Scheme, a facilitation charge of Rs 0.05/unit of power being generated from the projects in the parks is provided to the States to encourage the State Governments to provide necessary assistance to the Solar Power Park Developers (SPPDs) in identification and acquisition of land, to facilitate in obtaining all required statutory clearances, etc.

- **Traction in C&I segment**

The C&I segment is increasingly looking at procuring solar power for their operations either through rooftop solar projects or through open access. This preference is being driven by the following factors:

a) Commitment of corporates to decarbonizing their operations and supply chains, driven by environmental, social, and governance (ESG) considerations
b) Improvement in economic viability given the decline in project costs

Considering that the C&I segment consumes more than half of the power consumed in the country, the growing preference of this segment towards renewable energy will drive solar capacity additions.

4 Power Transmission and Distribution Sector in India

4.1 Transmission Sector

4.1.1 Review for transmission infrastructure growth

The transmission network in India operates at different voltages to cater to different needs in the industry. The different voltage levels include Extra High Voltage (EHV), high voltage, medium voltage, and low voltage.
The following table shows the distribution of the voltage lines:

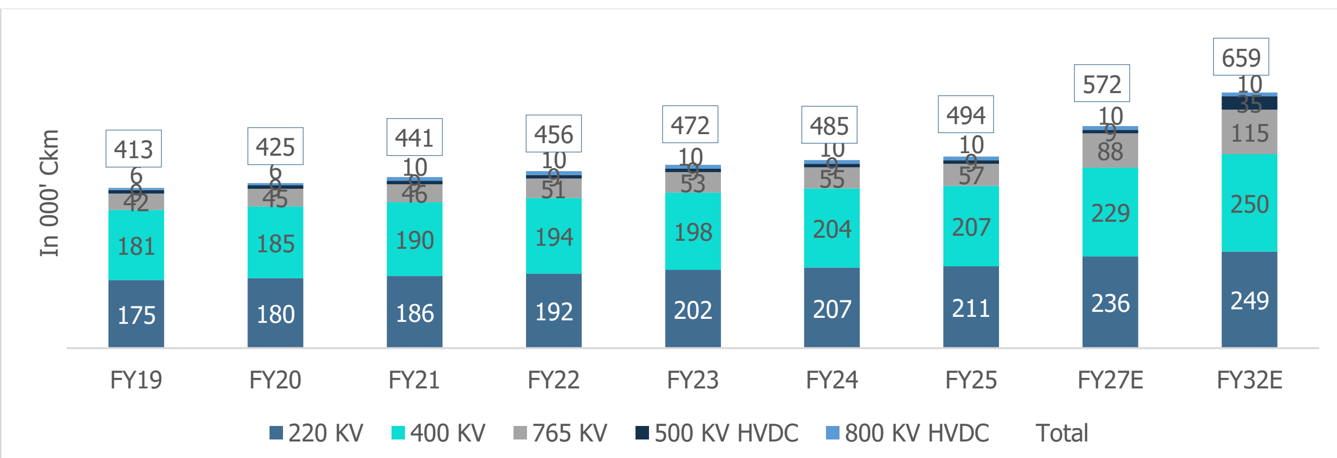
Table 11: Distribution of Voltage Lines

Extra High Voltage	Above 220 kV (220kV, 400 kV, 765 kV, ±500 kV HVDC, ±800 kV HVDC
High Voltage	Up to 220 kV (66 kV, 110 kV, 132 kV, 220 kV)
Medium Voltage	Up to 33 kV (3.3 kV, 6.6 kV, 11 kV, 33kV)
Low Voltage	Up to 1kV (single-phase)

Further, India's power transmission system has expanded at a significant pace driven by growing demand, the government's focus on providing electricity in rural areas, and the need for connecting the generation stations including integration of RE sources from the RE-rich states. In addition, with the implementation of two Central Sector Schemes namely, the North-Eastern Regional Power System Improvement Project (NERPSIP) and Comprehensive Scheme of Transmission & Distribution System in Arunachal Pradesh & Sikkim, the transmission and distribution infrastructure of Northeastern states are being strengthened.

The transmission line network grew at a CAGR of approximately 3% to 4,94,374 Ckm as of March 2025 from 4,13,407 Ckm as of March 2019. During FY25, 8,830 Ckm of transmission lines were added to the total network as compared to 14,203 Ckm of transmission lines added to the total network in FY24.

Chart 25: Transmission Line Network (220 kV & above)



Source: Central Electricity Authority, NEP, CareEdge Research

Overall Intra and Inter transmission lines

In FY25, India saw a line addition of ~8800 Ckm of lines where~2900 Ckm of lines was added in 400kV segment followed by ~3700 Ckm of lines was added in 220 kV. By FY27 ~19,000 Ckm of lines are expected to be added in 220 kV from FY24 where overall line additions will be ~86,000 Ckm lines. It is expected to reach a total addition of 1,63,000 Ckm lines till FY32 where 400kV will have a maximum share of line additions.

Table 12: Inter State Transmission Lines

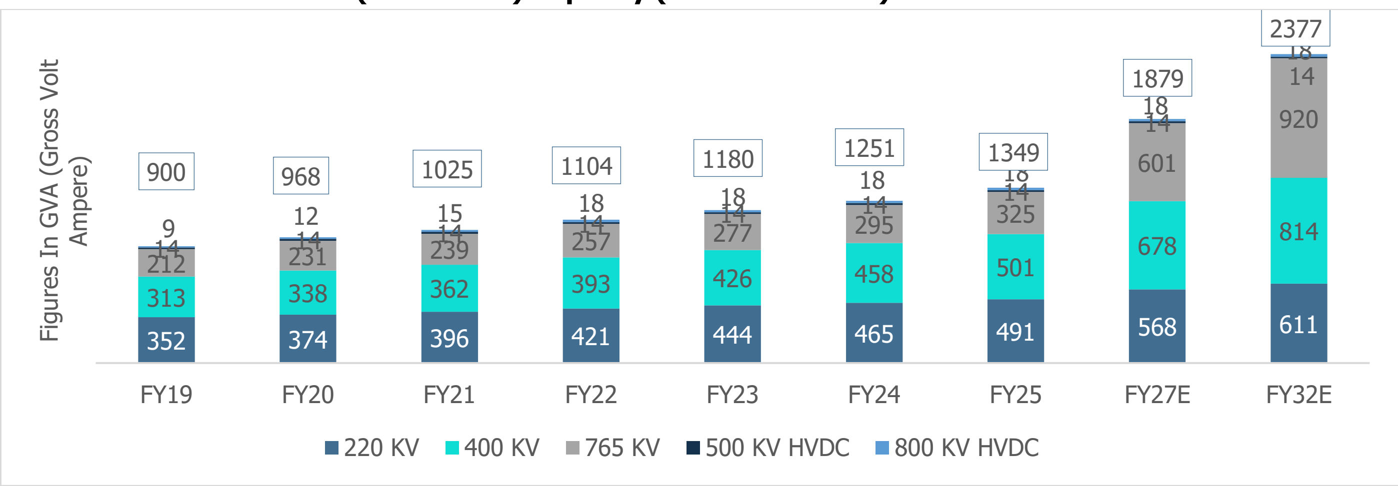
Transmission Lines ISTS in '000 Ckm	At the end of 2017	At the end of 2022	At the end of 2027	At the end of 2032
	158.9	200.0	251.2	294.5

Source: NEP, CareEdge Research

4.1.2 Details on Transformation capacity growth

The transformation (Substation) capacity (in GVA) for various voltage levels in India's electricity transmission network from FY19 to FY32E, including 220 kV, 400 kV, 765 kV, and HVDC systems (500 kV and 800 kV). The 220 kV, 400 kV, and 765 kV capacities show steady growth to meet rising electricity demand and support renewable energy integration, with projections reaching 611 MW, 814 MW, and 920 MW, respectively, by FY32E. HVDC systems, critical for long-distance transmission, maintain stable or slow growth, with 500 kV HVDC at 14 MW and 800 kV HVDC gradually increasing to 18 MW. Overall, the transformation capacity is expected to grow significantly, especially in higher voltage categories, to support India's energy goals. Transformation capacity includes Overall Intra and Inter transmission capacity.

Chart 26: Transformation (Substation) Capacity (220 kV & Above)



Source: Central Electricity Authority, NEP, CareEdge Research

Table 13: Inter- State Transformation Capacity (Substation)

Transformation Capacity (MVA) ISTS	At the end of 2017	At the end of 2022	At the end of 2027	At the end of 2032
	284.2	461.0	933.2	1,281.4

Source: NEP, CareEdge Research

4.1.3 Structure of Indian electricity transmission sector

India's electricity transmission system is a key part of the overall power infrastructure. It connects electricity generation sources like thermal, hydro, nuclear, and renewable plants to the distribution networks that deliver power to homes, industries, and businesses. The sector operates across vast regions and involves several central and state-level agencies. Its structure includes regulatory authorities and a combination of public and private companies working together to ensure reliable and efficient power transmission.

The Indian electricity transmission sector is structured as a three-tiered system, comprised of inter-state, intra-state, and distribution networks. The central government, through the Power Grid Corporation of India Limited (PGCIL), manages the inter-state transmission, while state governments and private entities handle intra-state and distribution networks, respectively. The national grid is interconnected, meaning power can be transmitted across different regions.

Central Transmission Utility (CTU):

Power Grid Corporation of India Limited (PGCIL): is the primary entity responsible for inter-state transmission, connecting the regional grids and facilitating power transfer between states.

State Transmission Utilities (STUs):

Each state has its own STU, which is responsible for managing and maintaining the intra-state transmission network, connecting power generation sources within the state to substations and distribution networks. Private transmission companies also operate within states, often complementing the STUs.
Some of the state transmission utilities are:

- Maharashtra State Electricity Transmission Company: (MAHATRANSCO)
- Karnataka Power Transmission Corporation: (KPTCL)
- West Bengal State Electricity Transmission Company
- Telangana Transmission Company: (TSTransco)
- Odisha Power Transmission Corporation: (OPTCL)
- Assam Power Distribution Company Limited (APDCL)
- Delhi Transco Limited: Delhi Transco Limited (DTL)
- Gujarat Energy Transmission Corporation: (GETCO)
- Tamil Nadu Transmission Corporation: (TANTRANSCO)
- Rajasthan Rajya Vidyut Prasaran Nigam Limited (RRVPNL)

Distribution Networks:

Distribution companies (DISCOMs), majorly owned by states but with some private players, are responsible for the distribution of electricity to end-consumers. These DISCOMs provide last mile delivery of power, managing local grids and substations.

Interconnection and the National Grid:

The five regional grids mainly Northern, Southern, Eastern, Western, and Northeastern have been interconnected to form a single national grid, enabling "One Nation-One Grid-One Frequency". This has allowed efficient power transfer across regions, ensuring a more reliable and stable electricity supply. The grid operates using various voltage levels including 66 kV, 100 kV, 110 kV, 132 kV, 220 kV, 400 kV, 765 kV, and HVDC (High Voltage Direct Current) lines.

Regulatory Framework and Key Authorities

The transmission sector operates under the Electricity Act, 2003, which brought major changes like allowing open access to the transmission network, separating generation and distribution functions, and encouraging competition. At the central level, the Ministry of Power (MoP) is responsible for policy decisions and overall coordination. The Central Electricity Authority (CEA) acts as the technical advisor, involved in transmission planning, setting performance standards, and monitoring the health of the grid. The Central Electricity Regulatory Commission (CERC) regulates tariffs for electricity transmitted between states and works to improve efficiency and competition. At the state level, each state has its own State Electricity Regulatory Commission (SERC), which manages tariffs, licensing, and policies for power transmission within the state.

Grid Operation and Load Despatch Structure

India uses a three-tiered system to manage the smooth flow of electricity across the country. The National Load Despatch Centre (NLDC) oversees the national grid, ensuring coordination among different regions. Regional Load Despatch Centres (RLDCs) manage power supply and grid operations at the regional level, while State Load Despatch Centres (SLDCs) handle operations within individual states. These load despatch centres ensure that power supply and demand are balanced in real time, maintain grid stability, and support open access transactions by allowing different users to use the network fairly.

4.1.4 Measures Taken by Government to Facilitate Execution of Transmission Projects

Tariff-Based Competitive Bidding (TBCB)

- The government introduced TBCB for the development of transmission projects to encourage private sector participation and drive efficiency through competitive processes.
- Under TBCB, transmission projects are awarded to the lowest bidder, ensuring cost-effectiveness. This also we can put in form of some smart art.

Inter-State Transmission System (ISTS)

- The government identified specific transmission projects as ISTS, which are vital for the national grid.
- The costs of these projects are shared across all states, reducing the financial burden on individual states and ensuring their execution.

Green Energy Corridors

- Special attention has been given to the development of Green Energy Corridors, which include funding from international agencies like the World Bank and KfW to ensure timely execution of projects aimed at integrating renewable energy into the grid.

Revamped Distribution Sector Scheme (RDSS)

- Launched to improve the operational efficiencies and financial sustainability of DISCOMs, which in turn supports the transmission sector by ensuring reliable payments for transmission services.

Ease of Doing Business

- The government has streamlined the process of acquiring clearances and approvals for transmission projects, reducing delays and facilitating faster project execution. This includes the introduction of single-window clearance systems.

PLI Scheme for Power Sector

- The Production-Linked Incentive (PLI) scheme has been extended to the power sector, encouraging the manufacturing of key transmission components within India, thereby reducing dependency on imports and ensuring timely project execution.

4.1.5 Investment in Inter & Intra Transmission Sector

The estimated expenditure for implementing additional transmission systems in India is projected to be Rs 4,252.2 bn for the period 2022-27 and Rs 4,909.2 bn for the period 2027-32. This expenditure will cover the development of transmission lines, sub-stations, reactive compensation, and other related infrastructure. However, since States/UTs are still finalizing their intra-State transmission plans for 2027-32, the final cost estimates for intra-State transmission systems and the overall investment may change in the future.

The projections for transmission lines, transformation capacity, and likely investment amounts in different states and Union Territories (UTs) in India for two periods: 2022-27 and 2027-32 is given below: Among the states, Gujarat, Uttar Pradesh, and Maharashtra stand out as the largest contributors to investments and infrastructure growth. For the 2022-27 period, Gujarat leads with the highest likely investment of Rs 228,590 mn, followed by Uttar Pradesh with Rs 223,860 mn, and Maharashtra with Rs 199,590 mn. Gujarat also dominates the transmission line and transformation capacity metrics, with the highest values in both categories (10,449 Ckm of transmission lines and 37,445 MVA of transformation capacity). Uttar Pradesh and Maharashtra are also major contributors, with Uttar Pradesh having the most significant transmission line coverage (9,858 Ckm) and transformation capacity (50,205 MVA), while Maharashtra focuses more on transmission (6,705 km) and relatively lower transformation capacity (31,950 MVA).

Table 14: Summary of Intra-State Transmission System planned for the Period 2022-32

State/ UT	For 2022-27			For 2027-32		
	Transmission lines (Ckm)	Transformation Capacity (MVA)	Likely Investment (Rs Mn)	Transmission lines (Ckm)	Transformation Capacity (MVA)	Likely Investment (Rs Mn)
Haryana	1,934	14,805	47,670	369	3,500	12,910
Himachal Pradesh	393	2,521	10,410	370	320	3,540
Uttar Pradesh	9,858	50,205	223,860	4,230	23,250	161,140
Uttarakhand	294	2,660	10,890	347	2,430	7,970
Rajasthan	3,932	21,720	145,370	1,857	15,160	89,140
Maharashtra	6,705	31,950	199,590	179	2,370	8,260
Gujarat	10,449	37,445	228,590	15,870	90,430	494,940
Madhya Pradesh	2,923	10,525	59,000	1,369	6,190	30,080
Chhattisgarh	1,497	5,090	26,150	1,210	3,460	25,900
Tamil Nadu	4,940	32,857	169,930	864	3,000	36,410
Karnataka	702	14,800	29,380	121	2,300	4,700
Andhra Pradesh	4,005	13,040	81,760	2,704	14,300	56,240
Odisha	2,143	5,000	37,500	1,625	7,000	39,980
Others	13,727	62,487	290,620	2,347	8,230	21,750
Total (Intra-state)	**63,502**	**305,105**	**1,560,720**	**33,462**	**181,940**	**992,960**

Source: NEP, CareEdge Research

For the 2027-32 period, Gujarat continues to hold the lead, with a massive projected investment of Rs 494,940 mn, alongside the highest increase in both transmission lines (15,870 Ckm) and transformation capacity (90,430 MVA). Uttar Pradesh follows with Rs 161,140 mn in investments, showing a decrease in transmission line additions (4,230 Ckm) compared to the previous period but still maintaining significant growth. Maharashtra's investments drop to Rs 8,260 mn in the 2027-32 period, with minimal transmission line and transformation capacity additions.

Green Energy Corridor (GEC)

There is a sustained commitment of the government to promote renewable energy. In the same line, Green Energy Corridor was set up in 2015. The Green Energy Corridor Project aims at synchronizing electricity produced from renewable sources, such as solar and wind, with conventional power stations in the grid. GEC comprises both Inter State Transmission System (ISTS) and Intra State Transmission System (InSTS) along with the setting up of the Renewable Energy Management Centre (REMC) and control infrastructure like reactive compensation and storage systems.

- **Inter-State Transmission System Green Energy Corridor Phase-I**

The ISTS GEC project with a total of 3,200 Ckm inter-state transmission lines and 17,000 MVA substations was implemented by PGCIL between 2015 to 2020. The project cost was Rs 113.69 bn with a funding mechanism consisting of 30% equity by PGCIL and 70% loan from KfW (EUR 500 mn) & ADB (approx. Rs 28 bn). The project was implemented to evacuate approx. 6 GW of RE power and included transmission system for 8 solar parks including Ananthapur (1,500 MW), Pavagada (2,000 MW), Rewa (750 MW), Bhadla-III (500 MW), Bhadla-IV (250 MW), Essel (750 MW), Banaskantha (700 MW), and Fatehgarh (1000 MW).
REMC has been installed at the following 11 locations:

a. REMC-SR (Tamil Nadu, Andhra Pradesh, Karnataka SLDCs and SRLDC)
b. REMC-WR (Gujarat, Maharashtra, Madhya Pradesh SLDCs and WRLDC)
c. REMC-NR (Rajasthan SLDC, NRLDC and NLDC)

The InSTS GEC scheme with a total target of 9,700 Ckm intra-state transmission lines and 22,600 MVA sub-stations was approved by the Cabinet Committee on Economic Affairs (CCEA) in 2015. The InSTS GEC scheme is currently under implementation by the State Transmission Utilities (STUs) of 8 RE-rich states, i.e., Andhra Pradesh, Gujarat, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, and Tamil Nadu. The project cost is Rs 101.41 bn with a funding mechanism consisting of a 40% central grant by MNRE, a 40% loan from KfW Germany, and a 20% equity by the STUs.

Moreover, the projects are being set up for the evacuation of about 24 GW of RE power in the aforementioned 8 states. Of this, about 16.4 GW RE has been commissioned and connected to the grid through the project's setup under InSTS GEC.

As of July 31, 2023, the status of the project is as follows:

Table 15: Status of Intra-State Transmission System Green Energy Corridor Phase-I

	Transmission Lines Ckm		Substation (MVA)	
State	**Target**	**Achievement**	**Target**	**Achievement**
Tamil Nadu	1,068	1,068	2,250	1,910
Rajasthan	1,054	984	1,915	1,915
Andhra Pradesh	1,073	814	2,157	1,265
Himachal Pradesh	502	485	937	773
Gujarat	1,908	1,526	7,980	7,980
Karnataka	618	618	2,702	2,702
Madhya Pradesh	2,773	2,773	4,748	4,748
Maharashtra	771	672	-	-
Total	**9,767**	**8,940**	**22,689**	**21,293**

Source: MNRE, CAREEDGE Research

- **Intra-State Transmission System Green Energy Corridor Phase-II**

The ISTS GEC-II scheme with a total target of 10,750 Ckm intra-state transmission lines and 27,500 MVA sub-stations was approved by the CCEA in January 2022. The project cost is Rs 120.31 bn with central financial assistance from MNRE of Rs 39.7 bn (i.e. 33% of project cost). The balance 67% of the project cost is available as a loan from KfW/REC/PFC. The transmission schemes would be implemented by the STUs of seven states, i.e. Gujarat, Himachal Pradesh, Karnataka, Kerala, Rajasthan, Tamil Nadu, and Uttar Pradesh for evacuation of approx. 20 GW of RE power in the seven states. Currently, the STUs are preparing the packages and are in the process of issuing tenders for implementing the projects. The scheduled commissioning for the projects under this scheme is March 2026.

The state-wise brief of the projects under the scheme is as under:

Table 16: Target under Intra-State Transmission System Green Energy Corridor Phase-II

State	Estimated Project Cost (Rs Cr)	Length of Transmission Lines (Ckm)	Capacity of Substations (MVA)	RE Addition (MW)
Gujarat	3,637	5,138	5,880	4,000
Himachal Pradesh	489	62	761	317
Karnataka	1,036	938	1,225	2,639
Kerala	420	224	620	452
Rajasthan	881	1,170	1,580	4,023
Tamil Nadu	720	624	2,200	4,000
Uttar Pradesh	4,848	2,597	15,280	4,000
Total	**12,031**	**10,753**	**27,546**	**19,431**

Source: Ministry of Power, CAREEDGE Research

Green Transmission

India has a target of 500 GW of non-fossil fuel capacity by 2030, and hence, significant investments have commenced toward increasing and upgrading the transmission infrastructure.

The transmission system has been planned for the following RE capacity to be commissioned by 2030:

Table 17: Transmission System Planned for Renewable Energy

Sr. No.	Category	Capacity (GW)
1.	66.5 GW RE capacity to be integrated into Inter-State Transmission System (ISTS) network (8.861 GW already commissioned)	53
2.	Additional RE capacity totalling 236.58 GW is to be integrated into the ISTS network	225
	Total (RE)	**278**

Source: CEA Report- Transmission System Integration of over 500GW RE Capacity by 2030, CAREEDGE Research

For the integration of additional wind and solar capacity by 2030, the estimated length of the transmission line and sub-station capacity planned is around 50,890 Ckm and 4,33,575 MVA, respectively. The investment required for the green transmission is estimated to be around Rs 2,440 bn as per the Ministry of Power. Out of this, Rs 281 bn will be required for the integration of offshore wind capacities while Rs 2,160 bn will be required for new solar and wind (onshore) plants.

Table 18: Tentative cost of Additional Transmission System

	RE Capacity (GW)	Tentative cost of the Transmission System (Rs. bn)	Average cost of Transmission System (Rs. Mn/MW)
On-shore RE Capacity (Solar & Wind)	268	2,161	8.06
Offshore RE capacity (Wind)	10	281	28.10
Total RE capacity	**278**	**2,442**	**8.76**

The tentative cost includes the cost of ISTS transmission schemes for (i) 66.5 GW RE capacity (excluding commissioned transmission schemes and associated RE capacity) (ii) 55.08 GW RE capacity and (iii) 181.5 GW RE capacity

Source: CEA Report- Transmission System Integration of over 500GW RE Capacity by 2030, CAREEDGE Research

4.1.6 Major Upcoming Transmission Lines and Substation Projects under Consideration

There are total of 1,190 transmission and distribution projects under planning stage split across India amounting to Rs 2,244 bn. Rajasthan, Gujarat and Maharashtra accounts for highest number of projects under planning stage with a total amount of Rs 1,339.12 bn.

4.1.7 Inter-Regional projected installed capacity

Inter-regional transmission links have been built to connect India's five regional grids Northern, Western, Southern, Eastern, and Northeastern. As of 2022, the links had a total transfer capacity of 112,250 MW. With new corridors being developed, this capacity is expected to rise to 1,67,540 MW by 2032. The inter-regional transmission capacity addition planned during 2027-32 is 24,600 MW.

4.1.8 Demand Drivers in India

The Global and Indian transmission sector is experiencing significant transformation and expansion due to multiple growth drivers that vary by region but share common themes of modernization, sustainability, and connectivity. Below is a detailed explanation of these drivers:

Integration of Renewable Energy Sources	Global Push for Clean Energy has shifted the demand for transmission infrastructure that can integrate renewable energy sources like solar, wind, and hydroelectric power into existing grids. Technologies like high-voltage direct current (HVDC) transmission are crucial in this integration, providing efficient long-distance electricity transmission
Electrification Initiatives in Emerging Economies	Electrification drives in emerging economies are increasing the deployment of regional transmission lines, which need bulk power transformers to distribute electricity effectively across vast distance. Extending transmission networks to rural or hilly regions necessitates custom-built, compact, and high-voltage transformers that can operate under tough environmental and logistical conditions
Cross-Border and Regional Interconnections	Cross-border transmission projects and regional interconnectors require standardized and compatible high-voltage transformers that can manage power transfer between national grids. Inter-regional balancing of renewable and conventional power involves flexible, high-capacity transformers to manage varying loads and maintain grid stability across geographies
Technological Advancements	High-voltage direct current (HVDC) transmission is a preferred technology for long-distance power transmission due to lower power losses. FACTS technologies enhance the controllability and efficiency of power grids, supporting the integration of renewables and the stability of complex grids Modern grids incorporate smart technologies that facilitate better monitoring and control, improving efficiency and allowing for real-time adjustments to manage power flow
Economic Growth and Urbanization	Rapidly expanding cities in countries like India demand robust grid infrastructure, driving investments in high MVA and high kV transformers to handle increased urban electricity loads. Growth in manufacturing and industrial zones requires high-capacity transformers to ensure stable and uninterrupted power supply at higher voltage levels. Economic corridors and smart city initiatives are boosting the need for bulk power transmission.

5 Government support schemes and initiatives

Revamped Distribution Sector Scheme (RDSS)

Launched in 2021 with an outlay of Rs 3 trillion, the RDSS focuses on modernizing power distribution networks. Key components that bolster transformer demand include replacement of aging distribution transformers, feeder segregation, and feeder metering. As of March 2025, utilities have sanctioned Rs 1,480 billion worth of loss reduction projects and smart metering solutions across over 5.23 mn transformers.

Green Energy Corridor (GEC) Initiative

Under the GEC, the government is enhancing transmission infrastructure to facilitate renewable energy evacuation. GEC Phases I and II have commissioned thousands of megavolt-amperes in substation capacity and circuit kilometres of transmission lines.

Phase I, launched in 2015, covered 8 states and aimed to build 9,767 circuit kilometres of transmission lines and 22,689 MVA of substation capacity to support 24 GW of renewable energy. It was funded through a mix of central grants, state equity, and loans from Germany's KfW Bank. Phase II, approved in 2022, expands to seven states with a goal of 10,750 circuit kilometres and 27,500 MVA capacity, enabling evacuation of 20 GW of renewable energy. The total cost is Rs 12,031 crore, with 33% central financial assistance from MNRE.

Together, both phases will support 44 GW of renewable energy and are key to achieving India's 500 GW non-fossil fuel target by 2030.

Plans for GEC Phase III are underway, backed with an anticipated budget of Rs 560 billion (40% central funding), aimed at boosting transformer procurement in the 132-400 kV range and beyond.

HVDC and Renewable Transmission Expansion

India aims to significantly scale up HVDC capacity to 66.75 GW by 2031-32. This expansion necessitates specialized converter transformers at both ends of HVDC links. Alongside, the expansion of thermal and renewable generation capacities continues to generate demand for high-capacity transformers.

Central Testing & Certification Facilities (CPRI & NHPTL)

CPRI (Central Power Research Institute): CPRI offers extensive testing and consultancy services covering routine type, and special tests for power transformers, as well as support for transmission systems through grid planning, insulation coordination, HV/EHV transformer testing, and system stability studies.

NHPTL (National High Power Test Laboratory): A joint undertaking of NTPC, NHPC, POWERGRID, DVC, and CPRI, NHPTL provides high-power short-circuit testing, enabling certification of transformer fault withstand capacities. The first commercially tested transformer was a 400/11.5 kV, 120 MVA unit by BHEL, tested using a 400 kV grid at NHPTL.

These institutes play a vital role in quality assurance, enabling Indian transformer manufacturers to meet global standards and secure high-voltage certifications.

6 Projected investments in the Indian electricity transmission & distribution sector

6.1 Projected Investments in the Indian Electricity Transmission Sector

A total of Rs 42,998 cr. by the end of FY28 with highest investments in the Western Region of Rs19,298 cr.

Table 19: Transmission Line Investments (In Cr)

FY	West Region	South Region	North Region	East Region	North-East Region	Total
FY24	7,365	6,659	10,770	285	417	25,495
FY25	11,320	3,391	1,077	594	77	16,459
FY26	614	-	-	-	430	1,044
FY27	-	-	-	-	-	-
FY28	-	-	-	-	-	-
Total	**19,298**	**10,050**	**11,847**	**879**	**925**	**42,998**

Source: ISTS Rolling Plan 2027-28, CareEdge Research

Distribution

A total of Rs 7.42 lakh crore is expected to be added under this section from FY22 to FY30.

Table 20: Projected Investments in The Indian Electricity Distribution Sector

Investment Required from 2022-27	Total Investment available with the Discom from various sources for period 2022-27 including RDSS	Investment Required from 2027-30	% of required investment already sanctioned up to 2027 under RDSS and other schemes
Rs 4.28	Rs 1.89	Rs 2.86	44%

Source: Distribution Perspective Plan 2030, CEA

6.2 Major investments announced by private players in industry

Toshiba Transmission & Distribution Systems India (TTDI) has announced a substantial investment of Rs 562 crore over the next three years to expand its manufacturing capabilities at the Rudraram facility in Telangana. The expansion plan includes establishing a CRGO (Cold Rolled Grain Oriented) core processing centre with an annual capacity of 12,000 tonnes, which will strengthen the company's control over a critical raw material used in transformer manufacturing. In addition, a surge arrester production line capable of manufacturing 80,000 units per year will be set up, further diversifying the product portfolio. A major part of the investment will go towards expanding the EHV (Extra High Voltage) power transformer plant, increasing its annual production capacity from 30,000 MVA to 42,000 MVA.

Siemens Ltd., at its Kalwa facility in Maharashtra, has approved an additional investment of Rs 100 crore to further enhance its transformer manufacturing operations. This new investment supplements an earlier Rs 360 crore expansion plan, bringing the total expansion investment to Rs 460 crore. The combined projects aim to double the plant's capacity from 15,000 MVA to 30,000 MVA annually while also enabling the production of large power reactors, a capability that positions Siemens to cater to advanced grid applications and large-scale energy projects. The expansion is expected to be completed by December 2025 and is strategically aligned with the growing global demand for grid technologies, renewable integration, and advanced energy transition products.

Hitachi Energy India has committed to investing approximately USD 250 mn (around Rs 2,100 crore) over the next five years to significantly strengthen its manufacturing footprint in the country. The investment plan focuses on expanding production capacity at its large power transformer factory, which will allow the company to meet the rising demand for high-capacity transformers required for India's rapidly growing transmission network. Additionally, Hitachi Energy will relocate its bushing production facility in Gujarat to enhance operational efficiency and capacity. The company will also invest in upgrading its testing facilities for specialty transformers, ensuring that its products meet the most stringent global performance and safety standards. These initiatives are aimed at supporting India's grid modernization, renewable energy integration, and overall energy transition goals.

CG Power & Industrial Solutions Ltd. has announced a capacity expansion program with an investment of USD 15 mn (approximately Rs 130 crore) across its manufacturing plants in Malanpur and Bhopal. This expansion will increase the company's transformer production capacity from 17,000 MVA to 35,000 MVA annually, enabling it to better serve both domestic and export markets. The increased capacity will allow CG Power to meet the growing demand for both power and distribution transformers, driven by rising infrastructure development, transmission network upgrades, and renewable energy projects across India. This investment underscores CG Power's strategy to strengthen its position in the competitive transformer manufacturing industry by improving production scale and efficiency.

Table 21: Types of Transformers Manufactured

_	Kanohar Electricals Ltd	Hitachi Energy India Ltd	CG Power & Industrial Solutions Ltd	Transformers & Rectifiers (India)	Siemens Energy	BHEL	Schneider Electric Infrastructure Ltd	KEC
765 KV Transformers	_	■	■	■	■	■	_	_
765 KV Reactors	_	_	■	■	■	_	_	_
400 KV Transformers	■	■	■	■	■	■	_	_
STATCOM	_	_	_	_	■	_	_	_
500 MVA Auto S. ckt	■	■	_	_	_	_	_	_
HVDC	_	■	_	_	_	_	_	_
400 KV Reactors	■	■	■	_	_	_	_	_
<220 KV Transformers	■	■	■	■	■	■	■	_
Trackside Transformers	■	_	■	_	_	_	_	_
Scott Connected Transformers	■	■	_	_	_	_	_	_
Trackside Auto	■	_	_	_	_	_	_	_
EPC Substations	■	_	_	_	_	_	_	■
EPC Transmission Lines	■	_	_	_	_	_	_	■

7 Investment Driver and challenges

Investment Drivers

Renewable energy integration and 2030 targets	India's commitment to achieving 500 GW of non-fossil fuel capacity by 2030 is a major driver of transmission investments. Large-scale renewable projects in resource-rich states such as Rajasthan, Gujarat, and Tamil Nadu require extensive inter-state and intra-state transmission capacity to deliver power to demand centres across the country. With the rapid growth of renewable energy, the transmission grid is experiencing additional load, making investments in transmission infrastructure essential to ensure grid stability.
General Network Access (GNA) reforms and Grid modernization and digitalization	The introduction of GNA modernizes the transmission access framework, allowing more flexibility for developers and improving utilization of the inter-state transmission system (ISTS). This regulatory evolution makes the sector more transparent and bankable for investors. As renewable penetration rises, investments in advanced technologies such as Supervisory Control and Data Acquisition (SCADA) systems, phasor measurement units (PMUs), and HVDC are necessary for grid stability. These technological upgrades are creating new avenues for investment in the transmission sector.
Private participation and financing innovations	Tariff-Based Competitive Bidding (TBCB) has opened transmission projects to private players, increasing competition and efficiency. Additionally, asset monetization structures such as Infrastructure Investment Trusts (InvITs) are helping recycle capital and attract long-term investors.
Emerging opportunities in offshore wind and green hydrogen	Government schemes for offshore wind and green hydrogen are expected to require dedicated evacuation corridors and grid-scale flexibility, further boosting the need for transmission investments.

Challenges

Congestion and curtailment risks and Phased reduction of waivers and policy uncertainty	In several regions, renewable energy projects face curtailment due to delays in transmission readiness. A mismatch between project commissioning timelines and availability of evacuation infrastructure is a recurring challenge. The gradual withdrawal of ISTS waivers after 2025 increases the cost of power delivery. Uncertainty around the future of such incentives affects project economics and investor confidence.
Implementation issues with GNA	While GNA is a progressive step, its transition phase has created procedural challenges, including connectivity queue management and coordination between central and state transmission utilities. This leads to temporary uncertainties for developers and financiers
Land acquisition and right-of-way (RoW) issues and financial health of utilities	Acquiring land and obtaining environmental and forest clearances for transmission lines remain significant bottlenecks. Delays in RoW approvals often lead to project overruns. The weak financial position of distribution companies (DISCOMs) indirectly impacts the transmission sector, as tariff pass-throughs and payment security mechanisms influence the risk perception of investors.

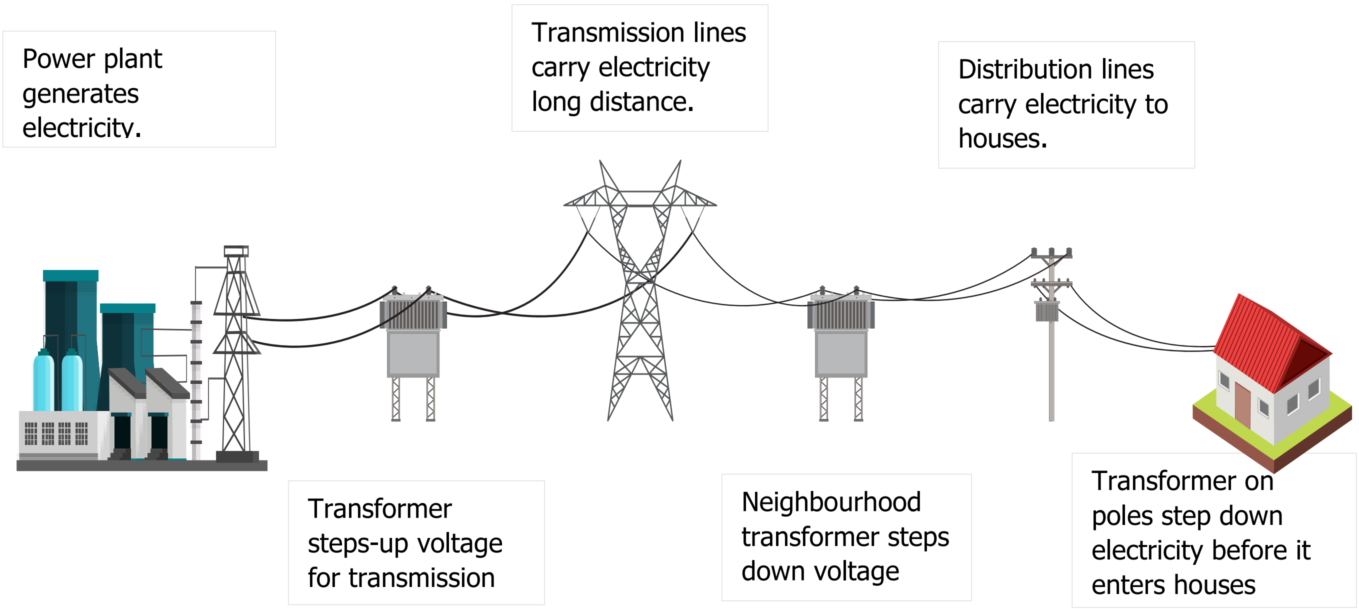
8 Transformer Market in India

8.1 Overview

A transformer is an electrical device used in power systems to transfer electrical energy from one circuit to another through the principle of electromagnetic induction. It operates without any direct electrical connection between the two circuits. The primary function of a transformer is to either step up (increase) or step down (decrease) voltage levels based on the requirement of the system. This voltage transformation makes it possible to transmit electricity efficiently over long distances and safely distribute it for residential, commercial, and industrial use.

A transformer consists of several key components. The magnetic core, typically constructed from laminated steel, provides a path for magnetic flux. Conductive windings, usually made of copper or aluminium, are wound around the core and facilitate the flow of electric current. Insulating materials prevent electrical faults by maintaining separation between the windings. Transformer oil serves dual purposes—as an insulator and as a coolant. A dedicated cooling system, often incorporating radiators or fans, prevents overheating during operation. Additionally, many transformers feature a tap changer, which adjusts the output voltage to ensure a consistent and stable power supply.

Chart 27: Role of Transformer in Electricity transmission



Source: CareEdge Research

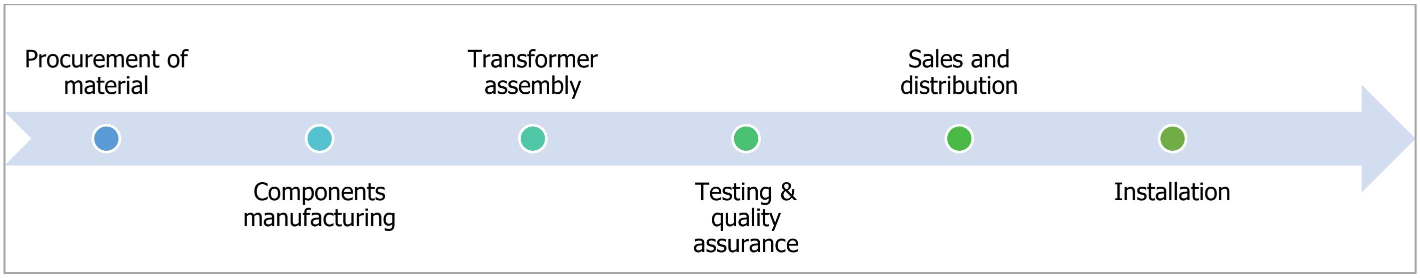
There are several types of transformers used in the power system, each serving a specific purpose. **Power transformers** are used in transmission networks to handle high voltages and heavy loads, typically in power plants and substations. **Traction transformers** are used in electric trains to convert high-voltage power from overhead lines to levels suitable for traction motors. **Scott transformers** convert three-phase power to two-phase and are used in specific industrial and railway applications, particularly in **high-speed railways**. **Distribution transformers** operate at the final stage, stepping down voltage for safe use in homes, offices, and small industries. **Other special-purpose transformers** include induction transformers for industrial heating, earthing transformers to provide system grounding, and instrument and isolation transformers for measurement, safety, and protection. Each type is essential for ensuring safe, efficient, and reliable power delivery in India's growing electrical network.

Transformer Type	Usage	End-use Applications
Distribution Transformers	Step down medium-voltage (11–33 kV) to low-voltage (400/230 V) for safe use	Homes, apartments, offices, shops, small industries, commercial buildings
Traction Transformers	Convert high-voltage power (25 kV AC) from overhead lines to levels suitable for traction motors	Railway locomotives, metro systems, suburban trains, high-speed rail corridors
Scott Transformers	Convert three-phase to two-phase power (and vice versa)	Railway traction systems (legacy), specific industrial setups, load balancing in power networks

Transformer Value Chain

The transformer value chain in India begins with raw material sourcing, involving key inputs such as copper, aluminium, CRGO steel, and insulation oil, where CRGO steel is largely imported from Japan, South Korea, the USA, and Germany due to limited domestic availability. Component manufacturing is next process where specialized vendors produce essential parts like windings, cores, bushings, tanks, and tap changers, increasingly aligning with BIS (Bureau of Indian Standards) standards and energy-efficient designs. These components are then assembled by major OEM hubs spread across states like Maharashtra, Gujarat, Tamil Nadu, and West Bengal. Once assembled, transformers undergo rigorous testing for insulation, load performance, and safety compliance as per BIS (Bureau of Indian Standards) and BEE (Bureau of Energy Efficiency) norms, although large-scale testing infrastructure remains a constraint.

Chart 28: Transformer Value chain



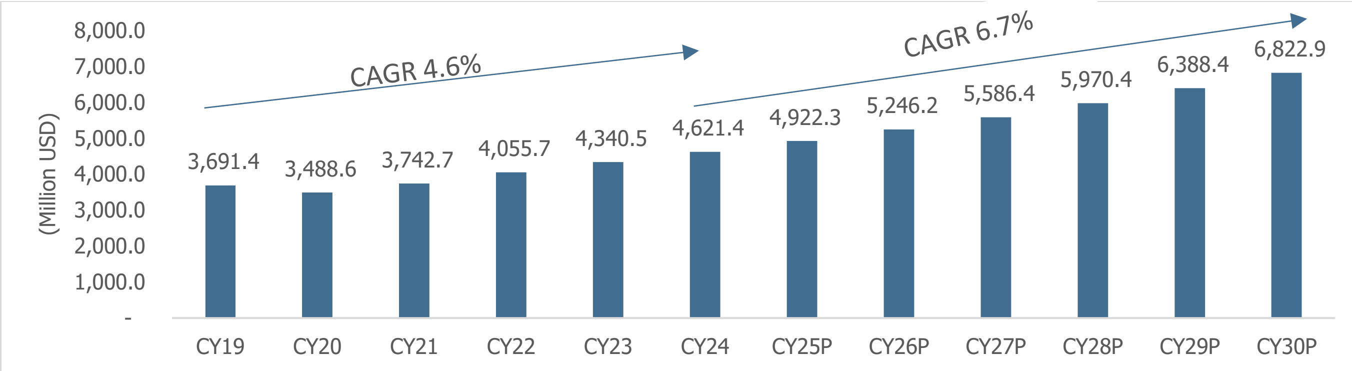
Source: CareEdge Research

Distribution occurs via direct sales to utilities, EPC firms, and industrial customers, with government tenders, especially from DISCOMs which plays a vital role. Installation and commissioning involve activities like site setup, mounting, oil filling, and energisation, often handled by contractors or OEM service teams. During operation, routine maintenance is critical to ensure optimal performance, and there's a growing shift toward smart transformers with remote monitoring. Finally, end-of-life handling includes safe decommissioning, oil recovery, metal recycling, and disposal, with rising interest in circular economy models for sustainability.

8.1.1 Total market size of transformer in India

The transformer market in India has been growing steadily. Between CY19 and CY24, the market increased from USD 3,691.4 mn to USD 4,621.4 mn, with a CAGR of 4.6%. This growth is mainly due to more areas getting electricity and new infrastructure projects. From CY24 to CY30, the market is expected to grow faster, reaching USD 6,822.9 mn, with CAGR of 6.7% during this period.

Chart 29: Total market size of transformer in India



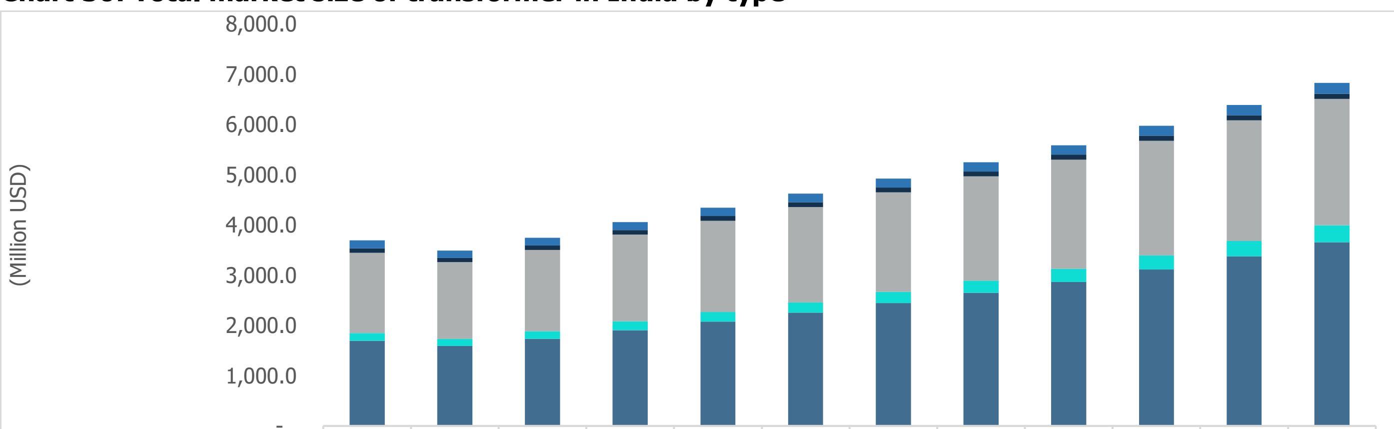
Source: MAIA Research, CareEdge Research
P: Projected

The strong growth in transformer demand reflects robust policy support and rising investment in energy infrastructure. Key government initiatives such as "Power for All," the National Electricity Plan (Transmission), the National Rail Plan 2030, and the National Infrastructure Pipeline (NIP), along with the development of Green Energy Corridors aligned with India's 500 GW renewable energy target, decarbonization, and energy transition goals, are driving modernization of the grid, improving reliability, and enabling large-scale integration of renewable power. Beyond new capacity, demand is also fuelled by the replacement of ageing transformers in urban and industrial areas, with modern, efficient models better equipped to handle higher and more variable loads. At the same time, policy thrust through "Make in India" and "Atmanirbhar Bharat" is promoting local manufacturing, while initiatives such as smart grids and smart metering are further boosting domestic production and exports of transformers.

8.1.2 By type - Transformer market size in India

From CY19 to CY24, the transformer market in India grew gradually and steadily. In CY19, power transformers had the highest share, valued at 1,691.3 mn USD, followed closely by distribution transformers at 1,601.1 mn USD.

Chart 30: Total market size of transformer in India by type



	CY19	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
Other Special Purpose Transformer	154.9	147.0	152.7	160.4	167.1	171.3	178.3	183.5	189.3	197.2	203.8	213.3
Scott Transformer	91.9	84.4	88.1	90.7	92.5	94.3	95.1	98.3	99.4	101.3	104.2	105.6
Distribution Transformer	1,601.1	1,525.5	1,615.0	1,723.4	1,812.0	1,895.7	1,979.0	2,073.6	2,170.2	2,278.0	2,399.2	2,514.9
Traction Transformer	152.3	140.3	158.3	180.5	194.5	209.1	225.3	243.0	262.7	283.0	306.7	332.3
Power Transformer	1,691.3	1,591.5	1,728.7	1,900.7	2,074.4	2,250.9	2,444.7	2,647.9	2,864.7	3,110.8	3,374.4	3,656.9

Power Transformer, Traction Transformer, Distribution Transformer, Scott Transformer, Other Special Purpose Transformer

Source: MAIA Research, CareEdge Research
P: Projected

Traction transformers 152.3 mn USD, Scott transformers at 84.4 mn USD, and other special-purpose transformers at 154.9 mn USD. Over the years, all these segments showed moderate growth. By CY25, power transformers are expected to 2,444.7 mn USD and distribution transformers 1,979.0 mn USD. The traction transformer segment also expected to grow from 152.3 mn USD in CY19 to 225.3 mn USD in CY25, supported by metro rail projects and railway electrification. The Scott transformer market size increased from 91.9 mn USD in CY19 to 94.3 mn USD in CY24, further it is expected to reach 105.6 mn USD in CY30.

Between CY24 and CY30, the transformer market is projected to expand at a higher pace across all segments. Power and distribution transformers are expected to see significant growth, while the traction transformer segment is also likely to continue its upward trend. Special-purpose transformers, such as Scott transformers, are expected to see steady demand, driven by the expansion of high-speed rail connectivity. These transformers are vital for converting three-phase to two-phase power, ensuring efficient and reliable railway traction. Their role in rail and industrial applications is further supported by rising investments in infrastructure.

8.1.3 Government Initiatives

Initiative / Scheme	Description
DDUGJY, IPDS, National Electricity Fund (NEF)	The Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) and Integrated Power Development Scheme (IPDS) were launched to strengthen rural and urban electricity distribution networks. These programmes focus on feeder separation, system strengthening and metering, which drive the requirement for new distribution transformers. The National Electricity Fund (NEF) further supports investments in modernising power distribution.
Make in India & PLI Scheme	The Make in India initiative promotes domestic manufacturing of electrical equipment, including transformers. Under the PLI Scheme 1.1, incentives are offered for specialty steel such as cold-rolled grain-oriented (CRGO) steel, a critical input for transformer cores. This reduces import dependence, strengthens upstream supply chains and encourages investment in transformer component production.
BEE Star Labelling Programme	The Bureau of Energy Efficiency (BEE) introduced a star labelling programme for distribution transformers to promote energy-efficient designs. The scheme sets performance benchmarks, pushing manufacturers to innovate and adopt advanced technologies. This ensures reduced losses, improved operational efficiency and alignment with India's energy efficiency goals.
Saubhagya Scheme (Universal Electrification)	The Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya) was launched to achieve universal household electrification across India. By expanding last-mile connectivity to rural and remote households, the scheme generated substantial demand for distribution transformers. It has been instrumental in driving electricity access and supporting transformer deployment nationwide.

8.2 Power transformer

8.2.1 Overview

Power transformers play a critical role in modern electrical infrastructure by enabling the efficient transmission and distribution of electricity. They operate on the principle of electromagnetic induction to transfer electrical energy between circuits without direct electrical contact. These transformers are primarily responsible for modifying voltage levels to suit different stages of the power supply chain. At generation sites, they raise the voltage to high levels to reduce transmission losses across long distances. Closer to end users, they lower the voltage to levels appropriate for domestic, commercial, or industrial applications.

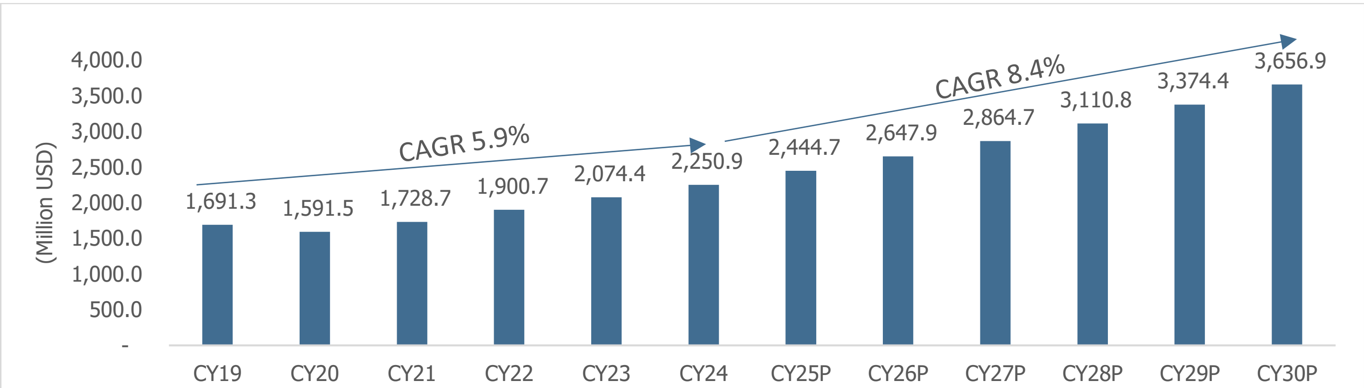
Alternating current (AC) flowing through the primary winding generates a magnetic field in the transformer's iron core, which in turn induces a voltage in the secondary winding. This allows energy to be transferred efficiently from one circuit to another without any direct electrical connection.

The power transformer manufacturing sector in India faces high entry barriers, resulting in limited competition. A few established players dominate the market, leveraging their scale, expertise, and vendor approvals to serve high-growth segments and benefit from sustained demand and market consolidation.

8.2.2 Market size and outlook of Power transformer

The Power transformer market size grew from CY19 to CY24, rising from approximately USD 1,691.3 mn to USD 2,250.9 mn, reporting a CAGR of 5.9%. This growth reflects a recovery from the temporary decline in CY20, which was largely attributed to the COVID-19 pandemic and its impact on infrastructure investments and industrial activity. The recovery was supported by the revival of delayed projects and a consistent rise in power demand across urban and semi-urban areas.

Chart 31: Market size and outlook of Power transformer



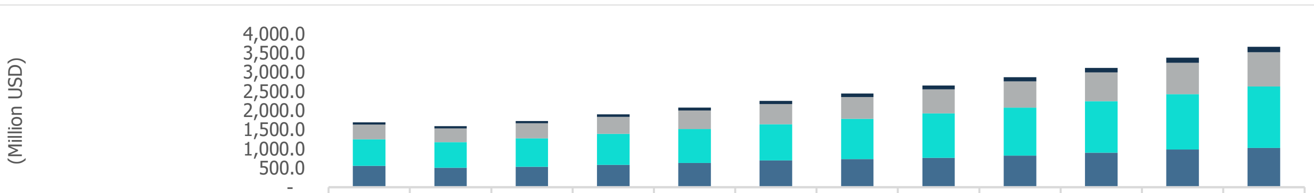
Source: MAIA Research, CareEdge Research
P: Projected

Between CY24 and CY30, the market is expected to grow from USD 2,250.9 mn to USD 3,656.9 mn at a higher pace, with a projected CAGR of 8.4%.

8.2.2.1 Market size and outlook of Power transformer by rating

The Power transformer market is categorized into four voltage levels: Ultra High Voltage, Extra High Voltage, High Voltage, and Medium Voltage. Between CY19 and CY24, all segments experienced moderate growth.

Chart 32: Market size and outlook of Power transformer by Rating



	CY19	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
Ultra High VT (765kV and above)	61.7	58.6	63.1	70.0	77.0	84.0	91.9	98.8	107.8	117.9	128.6	140.6
Extra High VT (400kV)	378.5	358.2	392.8	435.8	479.6	524.2	572.7	626.1	683.6	748.5	817.9	891.5
High VT (66kV to 220kV)	697.1	671.0	744.6	814.3	882.7	944.7	1,049.4	1,161.2	1,249.6	1,347.7	1,442.0	1,598.4
Medium VT (11kV to 33kV)	553.9	503.7	528.3	580.6	635.2	698.0	730.7	761.9	823.7	896.7	985.9	1,026.5

Medium VT (11kV to 33kV) | High VT (66kV to 220kV) | Extra High VT (400kV) | Ultra High VT (765kV and above)

Source: MAIA Research, CareEdge Research
P: Projected

High Voltage transformers consistently accounted for the largest share of the market, increasing from USD 697.1 mn in CY19 to USD 944.7 mn in CY24. This reflects steady demand from major transmission networks and industrial areas. Medium Voltage transformers also grew during this period, supported by rising distribution needs in urban and semi-urban regions.

From CY24 onward, growth across all voltage categories is expected to accelerate. By CY30, High Voltage transformers are projected to reach USD 1,598.4 mn, while Medium Voltage transformers are expected to grow to USD 1,026.5 mn. Further, the extra high voltage segment (which includes 400 kV transformers) and ultra-high voltage segment (which includes 765 kV and above transformers) are expected to expand significantly. Between CY24 and CY30, the market for Ultra High Voltage, Extra High Voltage, High Voltage, and Medium Voltage transformers is expected to grow at a CAGR of 9.0%, 9.3%, 9.2%, and 6.6%, respectively. The competitive intensity varies across these segments, with higher voltage categories requiring greater technological prowess, advanced design capabilities, and stringent quality benchmarks. In particular, short-circuit testing is critical for establishing reliability and differentiating products, making it a key factor for manufacturers aiming to stand out among peers in this evolving market.

8.2.3 End user industries of Power transformer

Power transformers are essential components across various sectors in India, with the power generation and transmission segment being one of the leading users. Central entities such as the Power Grid Corporation of India, along with multiple state-level transmission companies, rely heavily on these transformers for efficient power transfer. The renewable energy sector also plays a significant role in transformer demand, particularly for solar and wind projects, where transformers enable smooth integration of energy from remote generation sites into the national grid.

Power transformers across different voltage categories perform distinct and essential functions within the electrical infrastructure. Ultra-High Voltage (UHV) transformers are used to transmit electricity over long distances with minimal energy loss. These units are typically installed in large substations and along critical transmission corridors to ensure grid stability on a national scale. Extra High Voltage (EHV) transformers facilitate the bulk transfer of electricity from generation facilities to major load centres. They support the reliable supply of power to urban areas and heavy industrial zones, where energy demand is particularly high. High Voltage (HV) transformers act as the interface between transmission and distribution networks. They play a key role in supplying electricity to industrial clusters, public infrastructure, and large transport systems such as metro and rail networks. Medium Voltage (MV) transformers are primarily deployed at the distribution level to deliver electricity to residential areas, small businesses, and semi-urban or rural communities. Typically managed by distribution companies or local authorities, these transformers ensure a consistent and safe power supply at the consumer end.

8.2.4 Key Players in Power transformer Segment

India's power transformer manufacturing industry is led by a few major companies.

• **Bharat Heavy Electricals Limited (BHEL)**, a government-owned company, is a key player that makes high-voltage transformers used in power grids. Its products meet ISO (International Organization for Standardization) and BIS standards.
• **Siemens Energy India** is known for making eco-friendly and smart grid-ready transformers that follow international standards like IEC (International Electrotechnical Commission) and ISO (International Electrotechnical Commission).
• **CG Power and Industrial Solutions** (formerly Crompton Greaves) is also a key player, offering powerful transformers for large-scale power systems. Their products meet BIS and ISO standards.
• **Hitachi Energy India** offers power transformers with smart monitoring and digital integration, widely used in utilities and industrial applications. Its products comply with ISO, IEC, and RoHS standards.
• **Transformers & Rectifiers (India) Ltd. (TRIL)** manufactures power transformers for utilities, renewable projects, and industrial use. The company's products adhere to BIS and ISO standards**.**
• **CG Power and Industrial Solutions** provides power transformers designed for transmission and distribution networks, meeting BIS, ISO, and IEC standards.

• **Voltamp Transformers Ltd. Manufactures** specializes in power and distribution transformers catering to utilities, industrial plants, and infrastructure projects. Its products follow ISO and BIS standards.
• **Toshiba Transmission & Distribution Systems (India) Pvt. Ltd.** manufactures power transformers for utilities and industrial applications, with a focus on technology and reliability. Its products conform to IEC, ISO, and BIS standards.
• **GE Vernova** provides power transformers integrated with digital solutions and grid-modernization features, supporting utilities and renewable projects. Its products comply with IEC, ISO, and RoHS standards.
• **Kanohar Electricals Limited** manufactures of power transformers, Traction transformers, Scott connected transformer, shunt reactors and high voltage gas insulated switchgear.

8.3 Traction transformer

8.3.1 Overview

A traction transformer is a specialized type of power transformer used in railway electrification systems, especially in electric locomotives and high-speed trains. Its primary role is to step down the high voltage supplied through overhead lines to a lower voltage suitable for traction motors that drive the train. While a regular power transformer is used to transfer electricity between different parts of the power system, a traction transformer is specially designed to handle the fast-changing and tough conditions found in railway systems. It helps run electric trains by converting high-voltage electricity from overhead wires into a lower voltage that the train can use to move.

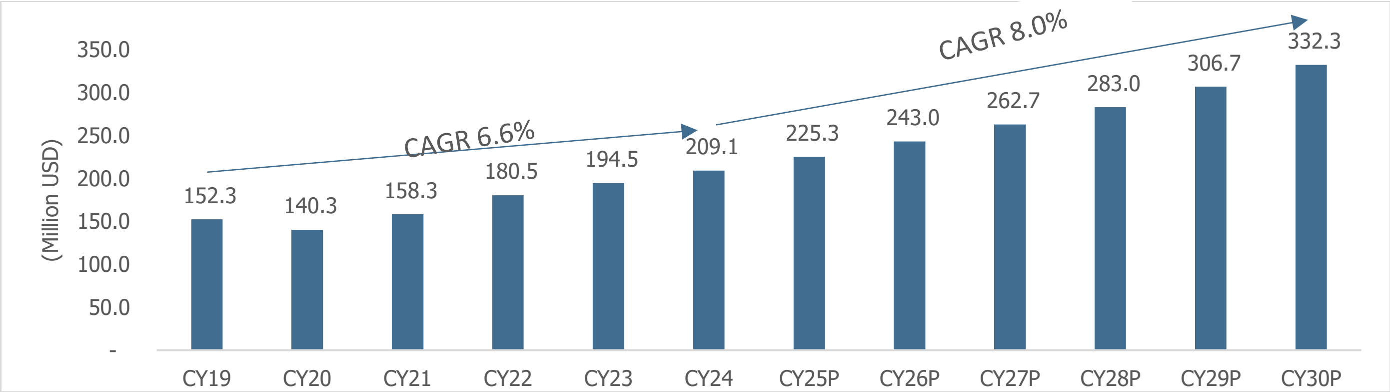
In India, where the rail network is one of the largest and busiest in the world, traction transformers play a crucial role in electrified railway routes. As Indian Railways advances towards complete electrification and cleaner modes of transport, the demand for efficient and reliable traction transformers has risen markedly. Traction transformers are installed in electric locomotives, EMU (Electric Multiple Unit) trains, and individual coaches to convert alternating current (AC) from overhead lines into the required voltage levels for operating traction motors and auxiliary systems such as lighting, air conditioning, and signalling. In addition to these onboard applications, trackside traction transformers used in 25 kV traction substations drawing power from the 132 kV/220 kV grid represent a substantial share of the market. These transformers are critical for railway electrification and metro projects, as they step down high-voltage grid supply to suitable levels for traction systems, thereby enabling efficient and reliable power delivery for expanding rail infrastructure.

Traction transformers are compact, lightweight, and capable of withstanding high mechanical and thermal stress due to frequent acceleration, braking, and changing loads. They are often oil-cooled or air-cooled and are built with advanced insulation and safety features to ensure long-term durability under tough operating conditions.

8.3.2 Market size and outlook of Traction transformer

In CY19, the traction transformer market in India stood at USD 152.3 mn. There was a slight dip in CY20, with the market declining to USD 140.3 mn, likely due to disruptions caused by the pandemic. However, the market rebounded in CY21 to USD 158.3 mn and continued to grow steadily, reaching USD 209.1 mn in CY24. From CY19 to CY24, the market grew at a CAGR of 6.6%. The rollout of Vande Bharat trains and the Namo Bharat rapid rail system have significantly impacted traction transformer technology. These electric trains use distributed traction and regenerative braking, requiring compact, high-efficiency transformers that can manage dynamic power flows. With higher operating speeds and growing integration of solar energy for traction loads, transformers are now designed for improved thermal management and grid compatibility. These initiatives over the past five years have significantly boosted the demand for traction transformers across India.

Chart 33: Market size and outlook of Traction transformer



Source: MAIA Research, CareEdge Research
P: Projected

Looking ahead, the market is projected to grow at a faster pace, with a CAGR of 8.0% between CY24 and CY30. By CY30, the market size is estimated to reach USD 332.3 mn. This growth is likely driven by the Indian government's continued investments in railway electrification, modernization of locomotives, and a shift toward energy-efficient rail transport.

8.3.3 End user industries of Traction transformer

Their primary end-user is the railway sector, particularly the Indian Railways, which is undergoing extensive electrification and modernization. Traction transformers are installed in electric locomotives and electric multiple units (EMUs), helping convert high-voltage electricity from overhead lines into usable voltage levels for train propulsion. As Indian Railways shifts more routes from diesel to electric traction, the demand for these transformers is increasing steadily.

Another major end user is the urban metro rail networks being developed and expanded in several cities like Delhi, Mumbai, Bengaluru, Hyderabad, and Pune. These metro systems depend on efficient traction systems to ensure smooth and reliable public transportation, creating a strong market for traction transformers.

Additionally, state-run railway manufacturing units, such as those producing locomotives and trainsets (like ICF, RCF, and CLW. This integrates traction transformers during the manufacturing process of electric locomotives and train coaches. Furthermore, with India pushing for high-speed rail (bullet train) projects and dedicated freight corridors, specialized traction transformers will be in greater demand to support high-load and high-speed requirements. These developments indicate that the transportation sector, especially railway and metro infrastructure, will remain the dominant consumer of traction transformers in India for the foreseeable future.

Key Players in Traction transformer Segment

Key players in traction transformer manufacturing in India include **CG Power & and Industrial Solutions Ltd.**, **Hitachi Energy India Ltd.**, **Kanohar Electricals** and **Vishvas Power Engineering Services Pvt. Ltd.** These manufacturers have been approved under the Schedule of Technical Requirements (STR) issued by the Research Designs and Standards Organisation (RDSO), the technical authority under Indian Railways. This approval signifies that the companies have met stringent criteria related to manufacturing infrastructure, production capacity, quality control systems, and in-house testing facilities, ensuring reliability and performance in critical railway applications.

8.4 Scott transformer

8.4.1 Overview

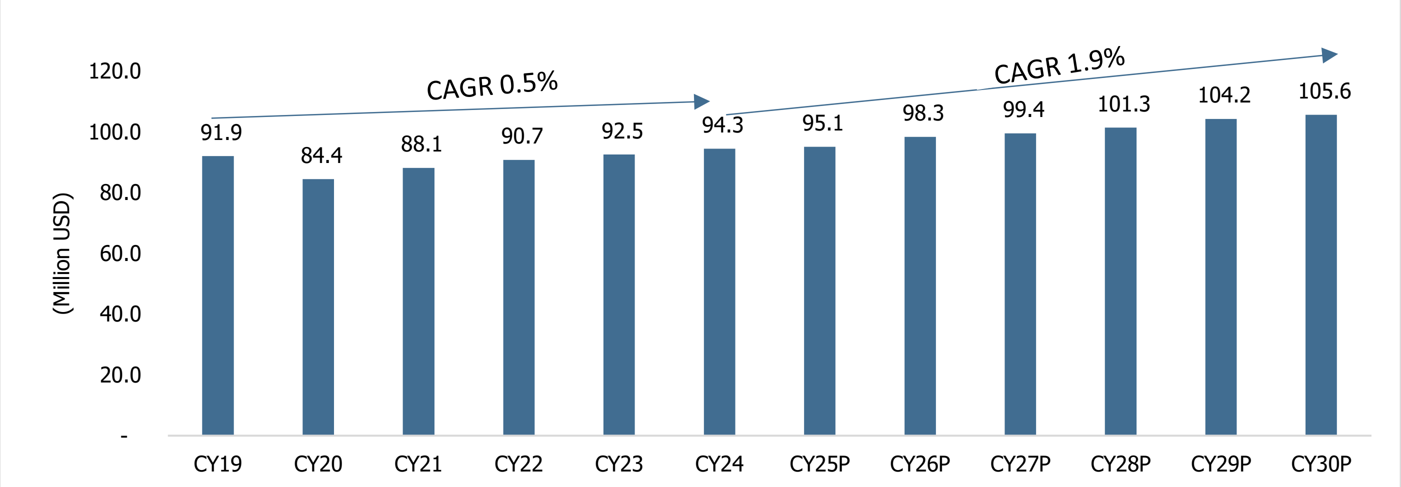
A Scott transformer is a specialised power transformer used to convert three-phase power into two-phase, or vice versa. Unlike standard transformers that primarily adjust voltage, it connects systems with differing phase configurations which is useful when two-phase equipment must operate on a three-phase network. It consists of two single-phase units; the main and teaser transformers connected in a specific manner to produce balanced two-phase output. This configuration is particularly relevant in applications such as electric furnaces, railway traction systems, and older industrial machinery. While not common in modern distribution systems due to the dominance of three-phase networks, Scott transformers remain valuable in High-speed railways and legacy infrastructure where phase conversion is still required.

8.4.2 Market size and outlook of Scott transformer

In CY19, the Scott transformer market size was USD 91.9 mn. It experienced a slight dip in CY20 to USD 84.4 mn, which was likely due to slowed industrial and traction demand during the COVID-19 pandemic.

From CY21 to CY24, the market gradually rebounded, reaching USD 94.3 mn by CY24. This phase reflects a modest growth trend at a CAGR of 0.5%, supported by demand in industrial setups, traction substations, and metro projects. A significant driver comes from the railway sector, where Scott transformers are widely used to convert three-phase power to two-phase systems required for traction. The rapid expansion of railway electrification, along with upcoming high-speed railway corridors, is emerging as a key growth area, as these projects demand reliable traction power solutions to handle high load factors and operational efficiency requirements.

Chart 34: Market size and outlook of Scott transformer



Source: MAIA Research, CareEdge Research
P: Projected

From CY24 onward, the market enters a phase of accelerated growth, reaching a projected USD 105.6 mn by CY30 with a higher CAGR of 1.9%. This uptick can be attributed to modernization of metro traction systems and expanding usage of dual-phase equipment in rail and metro applications.

8.4.3 End user industries of Scott transformer

Scott transformers in India are mainly used by Indian Railways, enabling high-speed, high-load train operations, metro systems like Delhi and Mumbai also use them to balance traction and auxiliary loads. In older industrial zones, they support legacy two-phase equipment in sectors like glass manufacturing and electrical heating. Under the National Rail Plan 2030, Scott transformers play a key role in electrifying 11,000 km of rail routes, supporting speed, load upgrades, and power efficiency.

Key Players in Scott transformer Segment

Kanohar Electricals Ltd. and **Hitachi Energy India Ltd.** are key players in Scott-connected transformers in India. Kanohar Electricals has been supplying traction transformers to Indian Railways and metro projects, including applications in high-speed rail corridors where Scott-connected designs are required for phase conversion from three-phase to two-phase systems. Hitachi Energy India, through its global portfolio and local operations, provides Scott-connected transformer solutions that support traction substations and railway electrification needs. Together, these companies play an important role in meeting the growing demand for reliable traction power infrastructure in India.

8.5 Distribution transformer

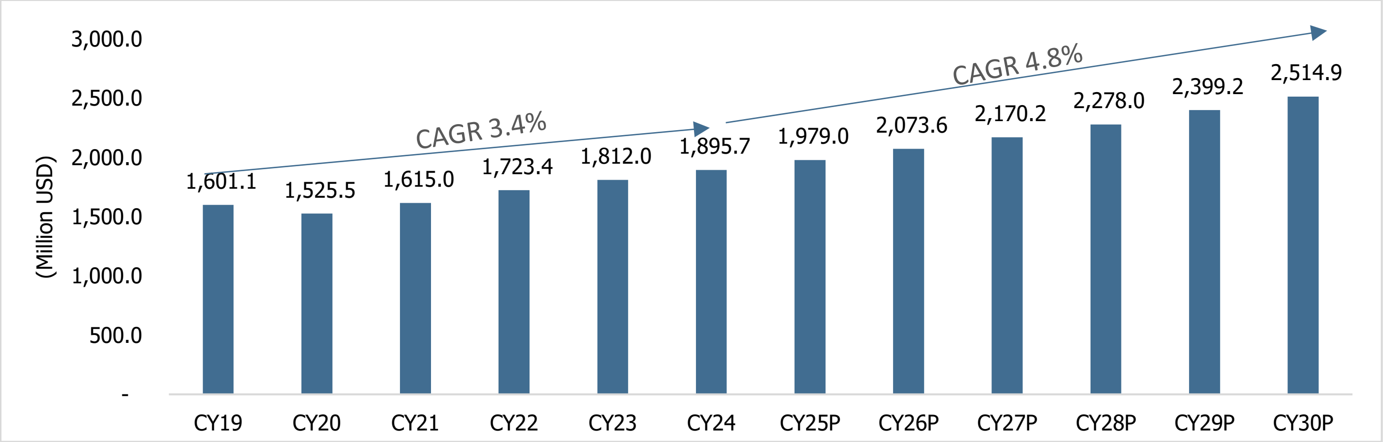
8.5.1 Overview

A distribution transformer is a type of power transformer used in the final stage of the electricity supply system to reduce high voltage from the power lines to a lower voltage suitable for use in homes, shops, offices, commercial spaces and small industries. Unlike general power transformers, distribution transformers are designed to step down high-voltage electricity to lower levels for safe use in homes, shops, and small industries. They play a key role in delivering power efficiently to end users.

8.5.2 Market size and outlook of Distribution transformer

India's distribution transformer market expanded from USD 1,601.1 mn in CY19 to USD 1,895.7 mn in CY24, growing at a moderate CAGR of 3.4%. This growth was mainly driven by the country's continued electrification push, increased electricity demand in urban areas, and government initiatives like the Saubhagya scheme, which focused on extending electricity access to rural households.

Chart 35: Market size and outlook of Distribution transformer



Source: MAIA Research, CareEdge Research
P: Projected

Going forward, the market is expected to grow at a higher pace, reaching USD 2514.9 mn by CY30, with a projected CAGR of 4.8%. This growth will be driven by grid modernization efforts under programs such as the Revamped Distribution Sector Scheme (RDSS), as well as the rising use of smart meters, rooftop solar systems, and electric vehicle (EV) charging stations.

8.5.3 End user industries of Distribution transformer

In India, distribution transformers are used across a wide range of end-user industries that rely on reliable and efficient power supply. The residential sector is a major user, where transformers step down voltage for homes, apartments, and rural households. Programs like the Saubhagya Scheme and growing housing developments have driven demand in both urban and rural areas. In the commercial sector, distribution transformers power offices, malls, hospitals, hotels, and schools, with rising demand fuelled by smart city projects and infrastructure growth in Tier 1 and Tier 2 cities.

The industrial sector also heavily relies on distribution transformers to operate machinery and production processes in manufacturing, cement, steel, and textile industries, where energy-efficient designs are preferred to cut operational costs. State electricity boards and distribution companies (DISCOMs) use these transformers to deliver grid-level power under schemes like the Revamped Distribution Sector Scheme (RDSS), which focus on grid modernization and reducing losses.

In the renewable energy sector, distribution transformers connect rooftop solar systems and wind farms to local grids, supporting net metering and variable load handling. Lastly, infrastructure and real estate projects such as airports, highways, logistics hubs, and smart townships depend on compact and reliable distribution transformers to meet expanding energy needs. Together, these sectors reflect the widespread and growing demand for distribution transformers in India's evolving energy landscape.

8.5.4 Key Players in Distribution transformer Segment

Bharat Heavy Electricals Limited (BHEL), a government-owned enterprise, manufactures BIS-certified distribution transformers for utility and industrial applications. **CG Power and Industrial Solutions Ltd**, formerly Crompton Greaves, produces transformers across a broad voltage range for DISCOMs and infrastructure projects. **Siemens India Ltd** manufactures transformers at multiple facilities across the country. **Hitachi Energy India** produces dry-type and liquid-filled transformers with monitoring systems for utility and renewable energy applications. **Transformers & Rectifiers India Ltd (TRIL)** produces transformers for DISCOMs and EPC contractors and exports to international markets.

8.6 Other special purpose transformers

8.6.1 Overview

Special-purpose transformers are a category of transformers designed for specific industrial or electrical functions beyond the regular voltage conversion performed by general power transformers. While standard transformers are mainly used to step up or step-down voltage levels in power transmission and distribution systems, special-purpose transformers cater to unique requirements such as electrical isolation, system grounding, high-frequency operations, or current and voltage measurement. These transformers are critical in maintaining the safety, efficiency, and stability of various electrical and industrial systems.

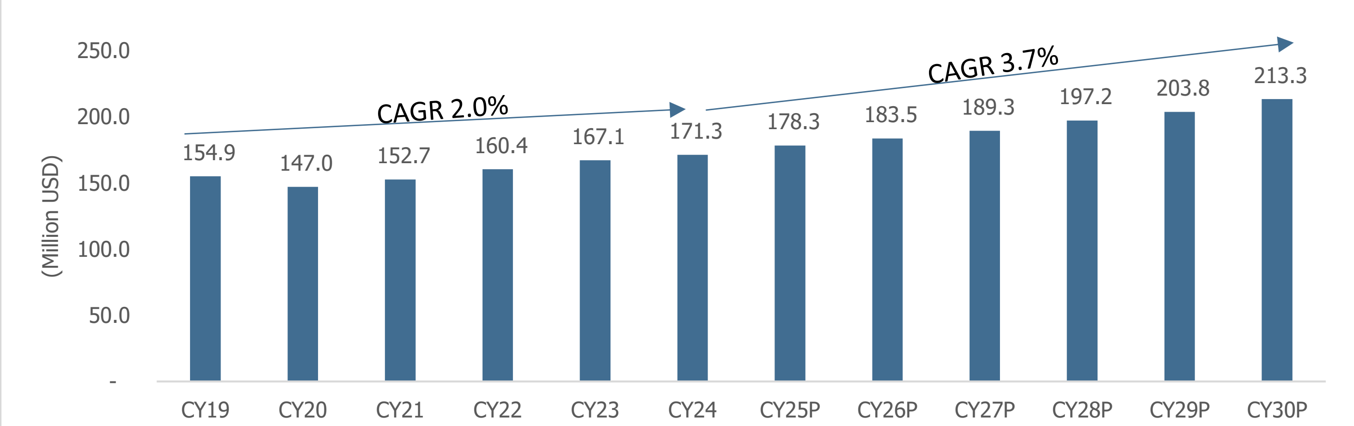
Induction transformer, commonly used in induction heating systems such as induction furnaces. These are widely used in industries like steel, metalworking, and manufacturing for melting, forging, or heat-treating metals. Induction transformers are built to handle high-frequency alternating currents and rapidly changing loads, making them suitable for industrial applications that demand quick and controlled heating. In India, where steel and metal processing industries are rapidly growing, induction transformers play a crucial role in improving energy efficiency and process control in production environments.

Another key special-purpose transformer is the earthing transformer, also known as a grounding transformer. It is used to provide a neutral point in a three-phase system, particularly in delta-connected networks where a neutral wire is not naturally available. This transformer ensures that the system can be properly grounded, which is essential for handling ground faults and maintaining system protection and voltage balance. Earthing transformers are widely deployed in power stations, substations, wind farms, and industrial facilities, especially where ungrounded systems require safe fault current paths and voltage stabilization during disturbances.

8.6.2 Market size and outlook of Other special purpose transformer

In CY19, the market size was USD 154.9 mn but fell to USD 147.0 mn in CY20 due to the. The CAGR for CY19 to CY24 is 2.0%, showing a gradual recovery supported by growth in infrastructure, automation and mining.From CY24, the market is expected to reach USD 213.3 mn by CY30, with a higher CAGR of 3.7%.

Chart 36: Market size and outlook of Other special purpose transformer



Source: MAIA Research, CareEdge Research
P: Projected

8.6.3 End user industries of Other special purpose transformer

Special purpose transformers are widely used in heavy industries such as steel, metallurgy, and defence, where they support equipment like electric arc furnaces, induction heating systems, and machinery that requires non-standard voltage or high heat tolerance. Their role is also expanding in renewable energy applications, particularly in hybrid substations that combine solar, wind, and battery systems.

Earthing transformers are important in large substations, wind farms, and industrial settings like chemical and mining operations. They help with system grounding and fault protection, ensuring safety and grid stability. These transformers are also used in metro rail systems, data centres, and pharmaceutical plants to manage surge currents and reduce electrical interference.

Induction transformers are used in industries that require accurate heating, such as automotive, plastic moulding, textiles, and railway workshops. They support processes like forging, brazing, and annealing through electromagnetic induction. They also find application in areas like medical equipment production and pipeline heating.

8.7 Key Components of Transformers

8.7.1 Conductors

The conductor, also known as windings, is made from copper or aluminium for high electrical conductivity. Windings consist of primary (connected to the power source) and secondary (connected to the load) coils, wound around the transformer core to enable the transfer of electrical energy through electromagnetic induction. Each winding is carefully insulated to prevent short circuits, minimize energy losses, and ensure safe and efficient operation.

8.7.2 Tanks

The transformer tank is a robust, welded steel enclosure designed to house and protect internal components such as the core, windings, and insulating oil (in oil-filled transformers). It provides mechanical strength, supports the insulation system, and serves as a container for the cooling fluid. To ensure durability, especially in outdoor installations, the tank is typically painted or coated to resist corrosion.

8.7.3 Radiators

Radiators are external components connected to the transformer tank that play a crucial role in dissipating heat generated during operation. As the transformer runs, heat is absorbed by the insulating oil, which circulates through the radiators. These radiators then release the heat into the surrounding air, using natural convection or forced cooling methods such as fans or pumps. Radiators are especially vital in large power transformers to maintain a safe and efficient operating temperature.

8.7.4 Other components

Transformers consist of several key components that ensure efficient and safe operation. The insulating oil acts as both a coolant and an insulating medium, circulating heat away from internal parts. Bushings allow high-voltage conductors to pass through the tank while maintaining insulation. The tap changer regulates output voltage by adjusting active winding turns, either manually (off-load) or automatically (on-load). A conservator tank accommodates oil expansion and contraction due to temperature changes, while the connected breather uses silica gel to prevent moisture from contaminating the oil. Cooling fans and pumps assist in heat dissipation in larger transformers, ensuring uniform cooling. The core, made of laminated silicon steel, provides a low-resistance magnetic path and minimizes energy losses. Finally, protection devices such as Buchholz relays, pressure relief valves, oil level indicators, and temperature sensors help detect faults early and ensure safe shutdown.

8.8 Benefits of inhouse manufacturing of transformer components

Benefit Area	Details
Cost Efficiency and Margin Improvement	In-house production reduces dependency on third-party suppliers, eliminating intermediary markups and logistics costs. By controlling the entire value chain from raw material to final component, manufacturers can optimize pricing, reduce procurement costs, and improve profit margins. This also cushions the business against price volatility in the supply market.
Quality Control and Standardization	Manufacturing critical components like windings, cores, bushings, tanks, and radiators internally allows for strict quality monitoring. Companies can enforce uniform technical standards and ensure consistency across batches. This minimizes the risk of defective parts, reduces rework and warranty claims, and enhances the overall reliability and performance of the final transformer unit.
Design Flexibility and Customization	Having internal capabilities enables rapid modifications to component designs as per project-specific or client-specific requirements. This is particularly beneficial in specialized applications like traction transformers, furnace transformers, or solar grid-connected systems, where standard components may not be useful. It allows manufacturers to offer tailored solutions and compete in niche or high-spec markets.
Faster Production and Delivery Timelines	In-house component manufacturing significantly shortens the lead time for transformer production. Companies can synchronize component supply with assembly schedules and avoid delays caused by external vendors. This speed is critical when meeting project

	deadlines or fulfilling emergency or short-cycle orders, such as those from utilities, metros, or infrastructure projects.

Raw Material Supply and Security Implications of Increased T&D Capital Expenditure
The rising demand from the T&D sector is increasing pressure on the supply chain for certain critical raw materials. In some cases, delays in raw material availability can lead to slippages in equipment delivery timelines, which may impact the timely strengthening of the transmission grid and, in turn, have broader economic implications. Additionally, increased competition for key inputs is gradually influencing payment terms offered by raw material suppliers to equipment manufacturers. As a result, manufacturers with relatively stronger liquidity positions, who are able to accommodate advance payments or shorter credit cycles, may be better positioned compared to those seeking extended payment terms. This dynamic is expected to persist over the medium term, until the raw material supply chain expands sufficiently to support the higher T&D capacity addition targets.

8.9 Shunt Reactors

8.9.1 Overview

A shunt reactor is an essential component in modern electrical power systems, primarily used to absorb reactive power and regulate voltage on high-voltage transmission networks. Transformers transfer energy between circuits, while shunt reactors are designed to absorb excess reactive power generated by the capacitance of long transmission lines or underground cables, especially under light-load or no-load conditions. Without these devices, excess reactive power could lead to overvoltage conditions, stressing insulation and damaging equipment.

There are two main types of shunt reactors: fixed and variable. Fixed shunt reactors operate with a constant inductive load, while controlled or variable shunt reactors (CSRs) can adjust their inductance in real time based on system requirements. This dynamic control helps utilities maintain tighter voltage regulation and system flexibility, particularly as the grid becomes more complex with renewable energy sources and fluctuating demand patterns.

Key players in the shunt reactor manufacturing space include BHEL, Hitachi Energy India Ltd, CG Power & Industrial Solutions Ltd, Transformers & Rectifiers (India) Ltd, Kanohar Electricals, etc.

8.9.2 Functioning and usage

In a power grid, shunt reactors are connected in parallel with the system, meaning they are installed across the lines rather than in series. Their main function is to counterbalance the capacitive effect of long transmission lines by providing inductive reactance. This becomes especially important at high transmission voltages (220 kV, 400 kV, and above), where even a small imbalance in reactive power can lead to significant voltage instability. Shunt reactors are commonly placed at the ends of transmission lines, in substations, and in cable systems such as those used in offshore wind farms or metro rail networks.

In more advanced applications, variable or controlled shunt reactors are used. These can adjust their inductive output using on-load tap changers or power electronics, allowing dynamic voltage control based on real-time system demands. This feature is particularly useful in grids with high renewable energy penetration or fluctuating load profiles.

8.9.3 Usage of Shunt Reactors

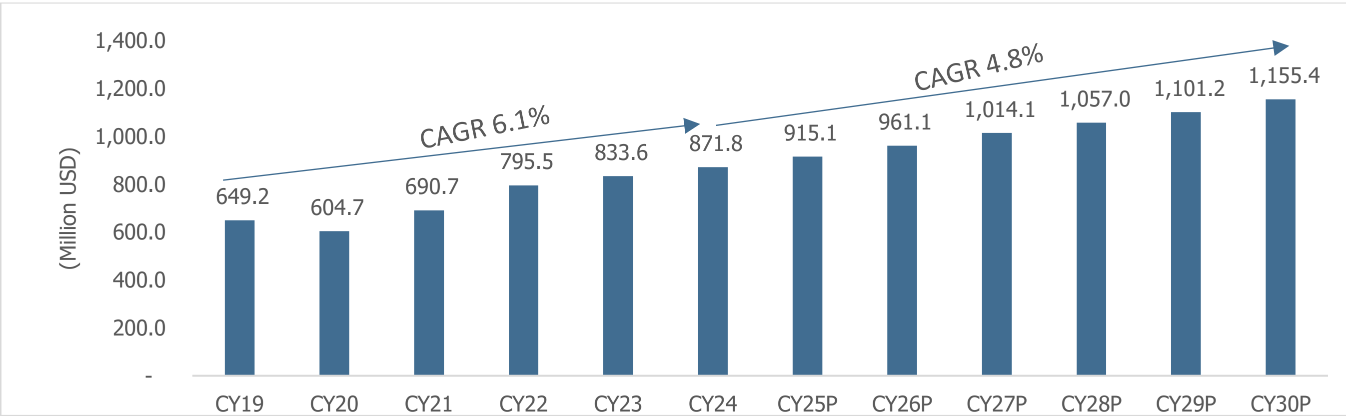
Shunt reactors are used at the ends of long high-voltage transmission lines to control line charging currents and maintain stable voltages during no-load or light-load conditions. In EHV/UHV substations, they regulate busbar voltage and prevent overvoltage during switching or load variations. They are also essential in underground and submarine cable systems such as offshore wind connections to manage reactive power and avoid voltage buildup.

In renewable projects like solar and wind farms, shunt reactors help stabilize voltage affected by intermittent generation and long-distance transmission. Industrial plants and rail networks use them to manage voltage fluctuations caused by large motors and traction loads. They also help suppress ferro-resonance and oscillations in specific system configurations, making them vital for modern grid stability and reactive power control.

8.9.4 Market size and outlook of shunt reactors

From CY19 to CY24, the shunt reactor market grew from USD 649.2 mn to USD 871.8 mn, reporting a CAGR of 6.1%. This growth can be attributed to the expanding power transmission infrastructure and the rising demand for reactive power compensation in India's electrical grid.

Chart 37: Market size and outlook of Shunt reactors

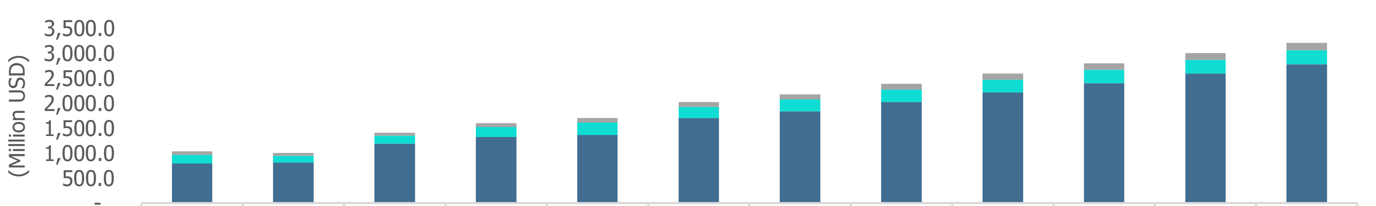


Source: MAIA Research, CareEdge Research
P: Projected

In future, the market is projected to continue growing at a slightly moderated CAGR of 4.8% from CY24 to CY30. The market size is expected to increase from USD 871.8 mn in CY24 to USD 1,155.4 mn in CY30. This indicates a steady demand for shunt reactors, supported by ongoing electrification, renewable integration, and grid stability efforts.

8.10 Trade dynamics of transformer market in India

Chart 38: India - transformer imports by key countries



	CY19	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
USA	72.9	55.6	61.2	76.7	89.0	98.0	101.3	112.0	120.3	128.5	136.8	145.1
Germany	175.2	131.7	160.3	202.8	248.6	224.7	239.1	250.1	258.6	267.2	275.7	284.2
China	791.2	814.9	1,189.6	1,322.2	1,363.0	1,703.6	1,835.9	2,026.7	2,214.8	2,403.0	2,591.2	2,779.4

China Germany USA

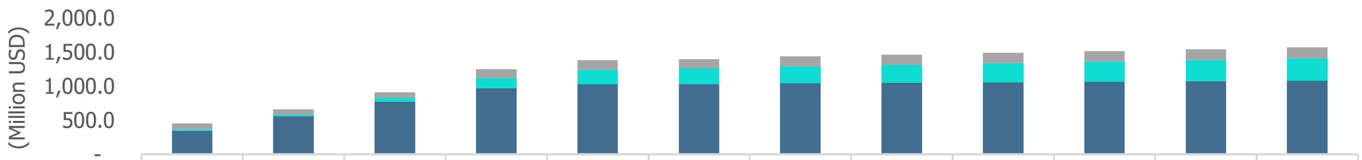
Source: MAIA Research, CareEdge Research
P: Projected

India's transformer imports from China, Germany, and the U.S. are rising steadily through 2030. China is the top exporter, consistently holding over 70% share due to its cost-effective manufacturing. Germany supplies high-efficiency equipment with stable growth, while the U.S. caters to niche, tech-oriented demand. Overall, the trend reflects India's growing infrastructure needs and ongoing reliance on imported transformer technology, even amid domestic manufacturing efforts.

Import trend: India has long relied on imports to meet some of its transformer needs, especially high-end technology products such as high voltage and ultra-high voltage, as well as some large-capacity power transformers. China is the main import source, and other major import sources include the United States and Germany.

Import drivers: Grid expansion and upgrade: National grid interconnection, urban grid transformation, and renewable energy grid connection projects have driven the demand for high-performance transformers; local production capacity and technology gap: Some special specifications, high voltage levels, or large-capacity transformers have insufficient local production capacity or incomplete technology; large-scale project demand: Specific large-scale power projects may directly specify or require the import of equipment of specific brands/technologies.

Chart 39: India - transformer exports by key countries



	CY19	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
Germany	83.9	75.1	80.4	125.7	137.4	130.5	145.1	145.3	149.1	153.0	156.8	160.6
UK	23.6	27.5	58.6	149.2	214.0	234.2	246.3	263.8	279.9	296.1	312.2	328.4
USA	343.9	558.9	771.6	971.6	1,028.3	1,029.1	1,043.3	1,048.6	1,056.1	1,063.6	1,071.1	1,078.6

Source: MAIA Research, CareEdge Research
P: Projected

India's transformer exports to the USA, UK, and Germany have grown significantly from 2019 and are projected to keep rising through 2030. The USA is the top destination, consistently accounting for the largest share each year. Exports to the UK and Germany also show steady gains, especially from 2021 onward. Overall, this trend reflects India's strengthening position in global transformer markets, driven by rising demand and competitive manufacturing.

Export trends: India's exports are mainly to Asia, Africa, the Middle East, and some European and American regions. Its export products are mainly medium and low voltage distribution transformers and small and medium-sized power transformers, with obvious cost-effectiveness.

Drivers of export growth: Improved local manufacturing capabilities: India has a mature transformer manufacturing industry chain and a large number of skilled workers, with strong cost competitiveness; "Make in India" strategic support: The government encourages exports and provides relevant policies and conveniences; Global demand growth: Developing countries (especially Africa, Southeast Asia, and the Middle East) have strong demand for power infrastructure construction and transformation; Cost advantage: Compared with European, American, Japanese, and Korean manufacturers, Indian products are more attractive in price.

8.11 Export opportunities

Africa, Southeast Asia, and South Asia are expanding their power grids on a large scale, and are in urgent need of medium and low voltage distribution transformers; Indian products have become the first choice due to their price advantages and applicability; developed regions such as Europe, America, and the Middle East have entered the power grid renewal cycle and need to replace inefficient transformers. There are replacement opportunities for India's cost-effective transformers.

India's transformer export market is experiencing notable growth, fuelled by increasing global demand for power infrastructure upgrades, renewable energy integration, and industrial electrification. This growth aligns with global trends where countries are investing heavily in grid modernization to handle cleaner energy sources and digitalized operations, making India a key supplier due to its cost-effective yet reliable transformer manufacturing capabilities.

Government initiatives have played a vital role in accelerating export potential. The Union Budget for FY2025–26 allocated Rs 9.15 lakh crore toward expanding transmission infrastructure across India. These measures not only stimulate domestic demand for transformers but also enhance production volumes and capabilities for export. Additionally, interest-free loans worth Rs 1.5 lakh crore to states for infrastructure development are expected to bolster high-voltage transformer usage and production, boosting India's international competitiveness.

8.12 Key drivers of Transformer market in India

Drivers	•RE Growth - drives demand for 400–765 kV and HVDC transformers •Transmission System Upgrades - HVDC and ISTS upgrades need large, HV transformers •100% rail electrification target - drives Scott-connected traction transformers •High-Speed Rail Projects - create long-term traction-transformer demand •Metro & Urban Rail Expansion - increases traction-transformer needs •Replacement of Aging Infrastructure - being replaced with efficient, smart transformers • Focus on Grid Reliability & Efficiency - Higher peak loads and distributed generation need OLTC- and sensor-enabled transformers •Strong Policy Support - GEC, NEP, NRP, Make in India
Challenges	•Import Dependence - Imported CRGO, copper raise costs •Price Pressure - Intense competition keeps margins thin •Overcapacity Issues - Low orders lead to underutilization •Payment Delays - DISCOM delays strain working capital •Clearance Bottlenecks - Land/environment approvals slow projects •High Entry Barriers - Capital- and tech-intensive industry

8.13 Entry Barriers in India's Transformer and Switchgear Market

India's power transmission and distribution sector operates under a structured framework designed to maintain grid stability and reduce operational risks. To participate in projects, manufacturers must meet several entry conditions, including vendor registration with utilities, obtaining technical certifications such as short-circuit testing, and complying with qualifying requirements specified in tenders. These measures act as filters to ensure that participating companies meet minimum technical and financial standards. While this process helps utilities manage risk and ensure reliable supply, it also limits the number of eligible participants and creates higher thresholds for new entrants.

The Technical Barrier - Short-Circuit Testing Certification

Short-circuit certification is a mandatory requirement for Extra High Voltage (EHV) transformers of 132 kV and above. It ensures that transformers can withstand severe mechanical and thermal stresses during grid faults, guaranteeing safety and operational reliability. Utilities such as PGCIL, NTPC, and state DISCOMs require certified short-circuit test reports in compliance with BIS, CEA, and IEC 60076-5 standards. Testing is conducted at accredited labs such as CPRI, ERDA, or NHPTL and involves significant costs and advanced design capabilities, which limits participation to a select group of manufacturers. Currently, only firms such as BHEL, Hitachi Energy India, Toshiba Transmission & Distribution Systems India, TRIL, and Kanohar Electricals have certified high-voltage transformers. Certification thus serves as a technical barrier.

The Administrative Barrier - Vendor Registration

Vendor registration is the first step for OEMs seeking to supply utilities or EPC contractors and serves as an administrative filter determining eligibility to bid. Each utility, such as PGCIL, NTPC, state transmission companies, and metro corporations, maintains its own list of approved vendors. The registration process typically involves submitting detailed technical documentation, undergoing factory inspections and quality audits, and providing evidence of past supplies. It can be time-consuming, often taking several months, and may require vendors to demonstrate prior experience with similar utilities, which can be challenging for new entrants.

The Composite Barrier - Qualifying Requirements (QRs)

Qualifying Requirements specified in tenders combine financial, technical, and operational criteria to determine bidder eligibility. Financial thresholds, such as minimum turnover, net worth, and liquidity, restrict participation to firms with sufficient capital. Tenders also often require proof of prior supply and successful operation of equipment of similar or higher rating, creating a path-dependency that favours experienced players. QRs frequently mandate type test and short-circuit test reports, linking administrative eligibility to technical achievement. Some tenders further specify prior supplies to government entities or the procuring utility, narrowing the competitive field.

Individually, each of these barriers ensures safety, reliability, and accountability in critical infrastructure. Together, they form a multi-layered barrier system: vendor registration determines who is on the eligible list, short-circuit certification verifies technical capability, and qualifying requirements decide who can actually bid and win projects. The combined effect sets a high threshold for market access, protecting incumbents, raising switching costs for utilities, slowing entry for new or mid-sized OEMs, and reinforcing the credibility of certified players with proven track records.

For existing companies, these barriers provide a competitive advantage by shielding them from new entrants. Emerging OEMs must make strategic investments in testing, certifications, and compliance over multiple years to overcome these barriers. For international buyers, certifications from Indian labs such as CPRI and ERDA enhance trust and facilitate exports, making certified Indian OEMs more competitive globally.

9 Short circuit testing certification

9.1 Overview

Short-circuit testing is an important procedure performed on power transformers to ensure that it can withstand high mechanical and thermal stresses caused by short-circuit currents. These tests simulate extreme fault conditions that a transformer might experience during actual operation, verifying its structural integrity and design reliability.
The test is typically conducted in a high-power laboratory, where controlled short-circuit currents (often several times the rated current) are passed through the transformer windings. The primary goals are to assess mechanical strength (ensuring windings do not deform or collapse under stress) and to confirm that the insulation system remains intact.
Successful short-circuit testing helps manufacturers guarantee product safety, comply with international standards and gain customer confidence especially for critical infrastructure applications such as power utilities and industrial installations.

9.2 Significance of Short circuit testing certification in India

Short circuit testing certification is crucial for transformer manufacturing companies in India as it ensures the safety and reliability of transformers under extreme fault conditions. During a short circuit, transformers face severe mechanical, thermal, and electrical stresses that can damage windings and insulation. Certification confirms that the transformer design can withstand such conditions without failure.

For manufacturers, certification is a mandatory requirement for participation in government and utility tenders. Organizations like Power Grid Corporation of India Limited (PGCIL), National Thermal Power Corporation (NTPC), and Distribution Companies (DISCOMs) require short circuit withstand certification, especially for Extra High Voltage (EHV) transformers of 132 kV and above. Compliance with Bureau of Indian Standards (BIS), Central Electricity Authority (CEA), and international norms such as International Electrotechnical Commission (IEC) 60076-5 is essential to meet these requirements.

Certification also enhances a company's credibility and competitiveness. Utilities and customers prefer certified transformers, as they represent reliability and long-term performance. It is equally important for exports since international buyers accept certifications from accredited Indian labs like the Central Power Research Institute (CPRI) and the Electrical Research and Development Association (ERDA).

In India, a few transformer manufacturers have obtained short circuit testing certification for high voltage transformers. These include **Bharat Heavy Electricals Limited (BHEL), Hitachi Energy India, Toshiba Transmission & Distribution Systems India (TTDI), Transformers and Rectifiers (India) Limited (TRIL),** and **Kanohar Electricals Limited**. The certification demonstrates that their high voltage transformers have been tested in accordance with the requirements of national and international standards such as those prescribed by the Bureau of Indian Standards (BIS) and the International Electrotechnical Commission (IEC). Possession of this certification enables these companies to supply transformers for projects undertaken by utilities, government agencies, and private sector entities where short circuit withstand capability is a prerequisite. It also allows participation in domestic and international tenders where compliance with short circuit testing requirements is mandatory.

9.3 Testing certification for transformer/Scott transformer

For Scott transformers, which are primarily used in India by railways for converting three-phase supply into two-phase supply, the certification process includes general transformer testing requirements along with additional traction-specific checks. These tests focus on voltage conversion accuracy to ensure balanced and stable transformation, thermal performance to confirm temperature limits under load and overload conditions, short circuit withstand capability, and impedance testing to verify load sharing between phases. Efficiency and loss measurements are also carried out to confirm compliance with energy performance requirements. Indian Railways prescribe their own technical specifications, making certification critical for manufacturers targeting this segment. Certification establishes that the transformer is fit for deployment in grid-connected systems and traction applications, making it a fundamental requirement for manufacturers to remain competitive in the industry.

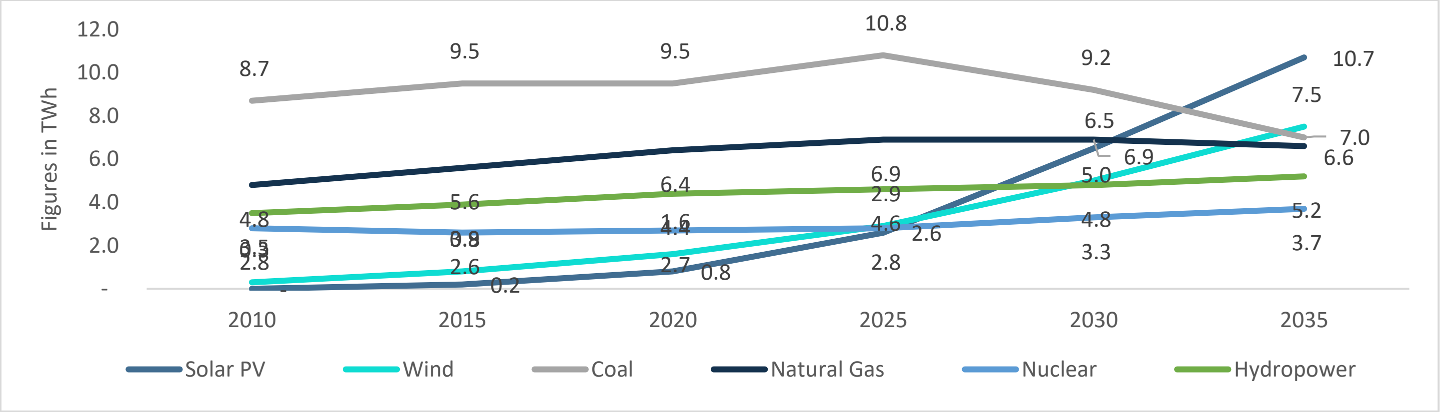
10 Global Power Transmission Sector

10.1 Overview of Global Power Generation

The global electricity generation trends from 2010 to 2035 under the "Stated Policies Scenario," implicates a significant shift towards renewable energy sources, especially solar PV, and wind. Solar PV generation is projected to grow rapidly, from 0-Terawatt hour (TWh) in 2010 to 10.7 TWh by 2035, reflecting the global push for cleaner energy and the decreasing cost of solar technology. Wind energy follows a similar trajectory, increasing from 0.3 TWh in 2010 to 7.5 TWh by 2035, with substantial growth especially in the 2020s. These shifts point to the increasing dominance of renewables in global electricity generation.

In contrast, traditional fossil fuels like coal and natural gas see a decline or stabilization in their contribution to electricity generation. Coal generation remains stable until 2025 but decreases to 7 TWh by 2035 due to stricter environmental regulations and the increasing competitiveness of renewables. Natural gas generation grows modestly before and slightly declining towards the end of the period. The slower growth of hydropower and nuclear reflects both the physical limits of their expansion and the excessive costs and regulatory challenges faced by nuclear energy.

Chart 40: Global Power Generation Mix



Source: IEA, CareEdge Research

Coal's decline is particularly notable, as it gives way to the expansion of renewables in the global energy mix. Although natural gas and nuclear energy maintain their roles, they are expected to play a secondary role in the energy transition, with renewables increasingly leading the way in meeting global energy needs.

10.2 Global Electricity Transmission Sector

Global electricity demand is expected to rise, driven by the expansion of wind, solar, natural gas-fired generation, and nuclear energy. The increasing adoption of electric vehicles (EVs) and growth in residential, commercial, and industrial activities further contribute to this trend.

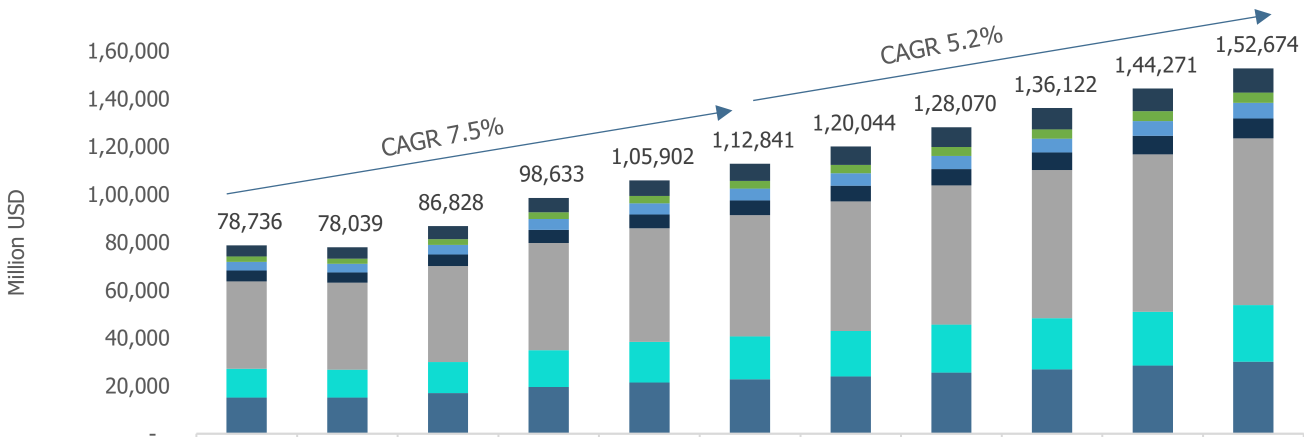
Transmission lines are high-voltage power lines that distribute electricity over a long distance from immense power plants to smaller power distribution lines for use at the local level. The increasing electricity demand in the world, especially the need to integrate renewable energy into the main grid line is projected to drive the transmission sector globally.

10.2.1 Global Electricity Transmission Sector by Value

The transmission sector has grown at a CAGR of 7.5% in CY19 at USD 78,736 mn to USD 1,12,841 mn in CY24. The largest contributor to the growth of transmission sector is from Asia Pacific and North America contributing roughly 65% on the market as of CY24.

The market size consists of the entire supply chain of the power transmission sector and is expected to grow at a CAGR of 5.2% from USD 1,12,841 mn in CY24 to USD 1,52,674 mn in CY29.

Chart 41: Global Electricity Transmission Sector by Value



	CY19	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P
Total	78,736	78,039	86,828	98,633	1,05,902	1,12,841	1,20,044	1,28,070	1,36,122	1,44,271	1,52,674
India	4,595	4,850	5,478	6,114	6,545	7,236	7,757	8,300	8,906	9,485	10,054
Africa	2,331	2,232	2,466	2,815	2,997	3,147	3,355	3,637	3,902	4,113	4,388
Middle East	3,583	3,486	3,979	4,474	4,702	4,984	5,243	5,491	5,806	6,196	6,541
Latin America	4,575	4,391	4,824	5,510	5,846	6,168	6,529	6,918	7,334	7,766	8,227
Asia Pacific	36,515	36,368	40,101	44,763	47,465	50,693	54,236	58,062	61,872	65,728	69,642
Europe	12,016	11,651	13,055	15,384	16,902	17,882	19,005	20,172	21,358	22,558	23,756
North America	15,121	15,061	16,925	19,573	21,445	22,732	23,919	25,490	26,944	28,426	30,066

North America, Europe, Asia Pacific, Latin America, Middle East, Africa, India, Total

Source: MAIA Research, CareEdge Research
P: Projected

The global transmission line market is undergoing transformative shift as the power generation sector adopts more sustainable and energy-efficient energy sources. Cross-border transmission lines and multilateral power trade, especially in ASEAN countries, are expected to attract investments, driving sector growth.

The expansion of renewable energy capacity has increased the need for interconnected transmission systems to balance electricity generation and demand through imports and exports, spurring the construction of higher-capacity interconnection lines.

China and the US lead in transmission length. Developed countries upgrade transmission lines with advanced technologies to ensure universal electricity access, boosting the sector. In developing countries, grid expansions to electrify underserved areas drive growth.

The T&D sector faces substantial demand in, both domestic and international markets, fuelled by renewable energy expansion and the need for large transmission lines, substations, and underground cabling.

10.2.2 Global Electricity Transmission Sector by Volume

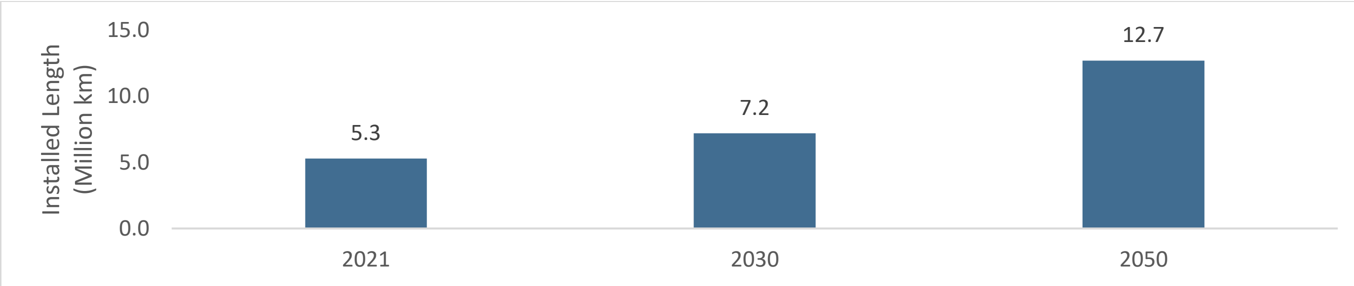
The global grid network is projected to more than double in length, reaching 166 mn km by 2050 under the APS scenario. Distribution lines will continue to account for over 90% of the total, connecting billions of consumers to meet daily needs. Transmission grids are expected to expand from 5.3 mn km in 2021 to 12.7 mn km by 2050. Grid development paths vary by region, shaped by economic changes and electrification trends. In advanced economies, grid length increases by 50% from 2021 to 2050, while emerging markets and developing economies (EMDEs) experience over 150% growth. By 2050, EMDEs will have nearly 120 mn km of grid lines, exceeding the global total installed in 2021 by more than 50%.

Table 22: Installed line length, transmission, and distribution, by Region (Mn km)

Region	Transmission			Distribution			Total		
	2021	2030	2050	2021	2030	2050	2021	2030	2050
United States	0.5	0.6	1	11.1	11.5	15.2	11.6	12.1	16.1
European Union	0.5	0.6	0.9	10.3	11	14	10.8	11.7	14.9
Japan	0.04	0.04	0.05	1.3	1.3	1.7	1.4	1.4	1.8
Other advanced economies	0.5	0.6	1	6.9	8	13.7	7.4	8.5	14.7
Southeast Asia	0.2	0.3	0.8	4.7	6.3	11.9	4.9	6.6	12.7
India	0.5	0.7	1.7	11.3	14	25.6	11.8	14.7	27.2
Africa	0.3	0.4	1.1	3.9	5	14	4.2	5.3	15
China	1.6	2.4	3.7	7.8	12.3	27.6	9.4	14.8	31.4
Other EMDEs	1.2	1.5	2.5	14.4	16.8	30	15.6	18.3	32.5
World	**5.3**	**7.2**	**12.7**	**71.7**	**86.1**	**153.7**	**77.1**	**93.4**	**166.4**

Source: IEA, CareEdge Research

Chart 42: Global Transmission Lined Additions

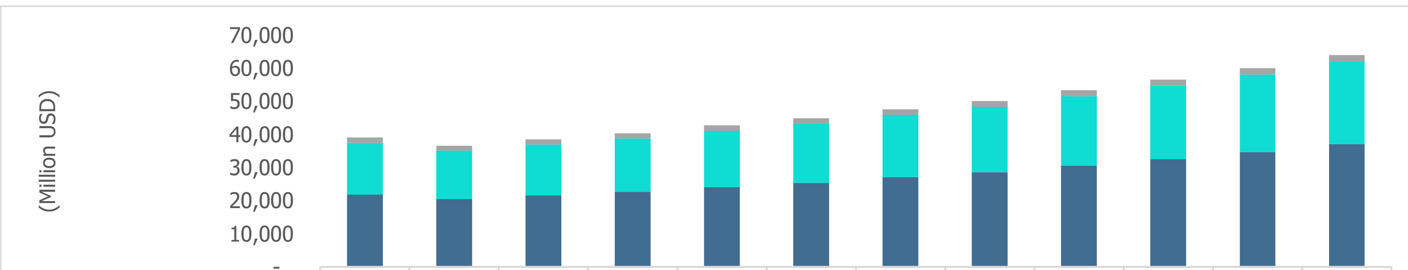


Source: IEA, CareEdge Research

10.3 Global transformer market – by type

In CY19, the total market size was USD 39,127 mn, where Power Transformers contributed USD 21,805 mn, Distribution Transformers USD 15,698 mn, and Others USD 1,624 mn. Over the next few years, the market remained stable with moderate growth. By CY22, the total market size reached about USD 40,377 mn, showing steady demand growth for both Power and Distribution Transformers.

Chart 43: Global transformer market



	CY19	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
Others	1,624	1,491	1,522	1,555	1,607	1,648	1,708	1,733	1,792	1,844	1,901	1,971
Distribution Transformer	15,698	14,655	15,388	16,082	16,974	17,786	18,823	19,752	21,000	22,182	23,486	24,989
Power Transformer	21,805	20,482	21,617	22,740	24,163	25,458	27,108	28,593	30,597	32,539	34,640	37,083

Source: Maia Research, CareEdge Research

From CY23 onwards, the market started to expand more strongly, reaching USD 41,744 mn in CY23 and further to USD 44,895 mn in CY24. This rise was mainly driven by increasing investments in power infrastructure, grid modernization, and renewable energy integration, which require more transformers for transmission and distribution networks.

The market is expected to grow from USD 46,519 mn in CY25 to USD 63,043 mn by CY30. Power Transformers are projected to grow the fastest, increasing from USD 25,458 mn in CY24 to USD 37,083 mn in CY30. Similarly, Distribution Transformers will also see notable growth from USD 17,786 mn in CY24 to USD 24,989 mn in CY30. The "Others" category remains relatively small but will gradually increase from USD 1,648 mn in CY24 to USD 1,971 mn in CY30.

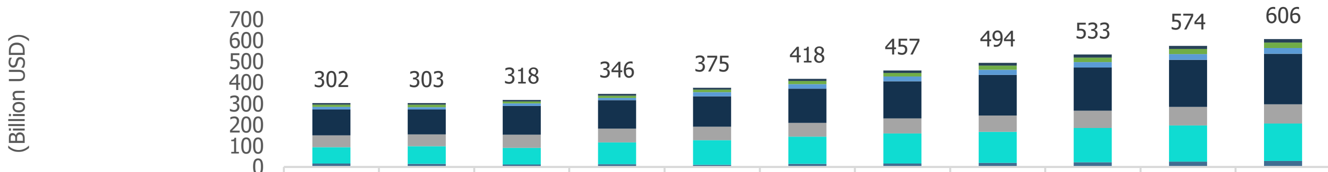
The transformer market has been steadily growing over time, with Power Transformers making up the largest share. This growth is mainly driven by rising electricity demand worldwide, greater use of renewable energy, urban development, and expanding infrastructure.

10.4 Grid Investments

The chart below covers global grid investments from 2019 to 2029. Over this period, significant growth in grid investment is observed, particularly in the Asia Pacific (excluding India), which consistently leads the investments with an estimated increase from USD 124 bn in CY19 to USD 162 bn in CY24 and is expected to reach to USD 239 bn by CY29. North America follows as the second-largest region, with investments rising from USD 77 bn in CY19 to USD 129 bn in CY24 with an anticipated investment to USD 177 bn by CY29, reflecting robust efforts in modernizing infrastructure and integrating renewable energy. Europe also shows steady growth, reaching USD 92 bn by CY29 as it continues to expand renewable energy and cross-border grid initiatives.

Regions like the Middle East, Latin America, and Africa, though starting with lower investment levels, demonstrate progressive growth over the decade. The Middle East sees an increase from USD 10 bn in CY19 to USD 15 bn in CY24 with rising to USD 25 bn by CY29, reflecting ongoing infrastructure expansion. Latin America shows investments rising notably from USD 12 bn in CY19 to USD 28 bn by CY29, driven by energy access improvements and grid expansions. Africa's investments grow modestly from USD 8 bn to USD 17 bn in CY29, showing gradual grid development. India, starting with USD 17 bn in CY19, reaches USD 14 bn in CY24 and expected to reach to USD 28 bn by CY29, aligning with its renewable energy goals and transmission network enhancements. The total global grid investment reaches USD 606 bn by CY29, up from USD 302 bn in CY19, indicating strong worldwide commitment to modernizing and expanding grid infrastructure to support energy transition and growing energy demand. Collective investments from CY19-CY24 globally have been USD 2,062 bn. Asia Pacific (excluding India) will contribute to the highest investments from CY24-CY29 contributing 38.8% of total investments followed by North America and Europe at 30.2% and 15.8% respectively.

Chart 44: Global Grid Investments across regions



	CY19	CY20	CY21	CY22	CY23	CY24	CY25E	CY26E	CY27E	CY28E	CY29E
Total	302	303	318	346	375	418	457	494	533	574	606
Africa	8	7	8	9	9	11	12	13	14	15	17
Middle East	10	13	9	11	12	15	17	20	22	24	25
Latin America	12	10	11	10	19	21	22	24	25	27	28
Asia Pacific(Except India)	124	118	137	136	145	162	176	192	206	224	239
Europe	55	57	62	65	63	66	71	77	82	88	92
North America	77	84	79	103	117	129	142	147	161	171	177
India	17	14	12	13	10	14	17	20	23	25	28

India North America Europe Asia Pacific(Except India) Latin America Middle East Africa Total

Source: MAIA Research, CareEdge Research

10.5 Global Growth Drivers

The Global transmission sector is experiencing significant transformation and expansion due to multiple growth drivers that vary by region but share common themes of modernization, sustainability, and connectivity. Below is a detailed explanation of these drivers:

- **Integration of Renewable Energy Sources**
  - Global shift to clean energy drives transmission demand.
  - Renewables' variability needs strong long-distance HVDC networks.
- **Grid Modernization and Upgrades**
  - Aging grids in developed regions need upgrades.

- Smart grids, FACTS improve reliability and flexibility.
- Climate-resilient infrastructure reduces weather-related outages.

- **Electrification Initiatives in Emerging Economies**
  - Expanding electricity access in Africa, South Asia, Latin America.
  - Electrification supports economic and social development goals.
  - PPPs help fund and execute transmission expansion.

- **Economic Growth and Urbanization**
  - Urbanization in Asia-Pacific increases power demand.
  - Industrial growth requires high-capacity transmission.
  - Large regional initiatives (e.g., BRI) boost grid investment.

- **Cross-Border and Regional Interconnections**
  - Grid interconnections enable energy trading and security.
  - Major multi-country projects link renewable hubs to demand centers.
  - Shared grids reduce need for excess generation capacity.

- **Technological Advancements**
  - HVDC and FACTS enhance efficiency and renewable integration.
  - Smart grid tech improves real-time control.
  - Digitalization enables predictive maintenance and reliability.

- **Sustainability and Decarbonization Goals**
  - Policies push for low-carbon, renewable-based grids.
  - Net-zero targets require expanded transmission.
  - Upgraded lines improve efficiency and reduce losses.

- **International Funding and Investments**
  - Global banks fund transmission in developing nations.
  - Private investments rising due to stable returns.
  - Public–private partnerships drive large project execution.

10.6 Advantages for Indian companies in global market

Cost Competitiveness and Growing Compliance with International Standards

Indian manufacturers benefit from lower labour and production costs compared to many developed countries. This enables them to offer transformers at competitive prices without compromising on quality, making Indian manufacturer attractive suppliers in global tenders. Many Indian transformer manufacturers have aligned their production processes with global quality and safety standards such as IEC (International Electrotechnical Commission), ANSI (American National Standards Institute), and ISO (International Organization for Standardization). This improves their credibility and acceptability in foreign markets.

Strategic Location and Logistics and Expanding Domestic Capacity

India's geographical location provides easy access to the Middle East, Africa, and Southeast Asian markets. With improvements in port infrastructure and logistics, Indian companies can efficiently serve international clients. India's transformer industry has significantly scaled up its manufacturing capacity to meet both domestic and international demand. This allows Indian firms to handle large export orders and supply utility-scale transformers.

11 Railway Electrification in India

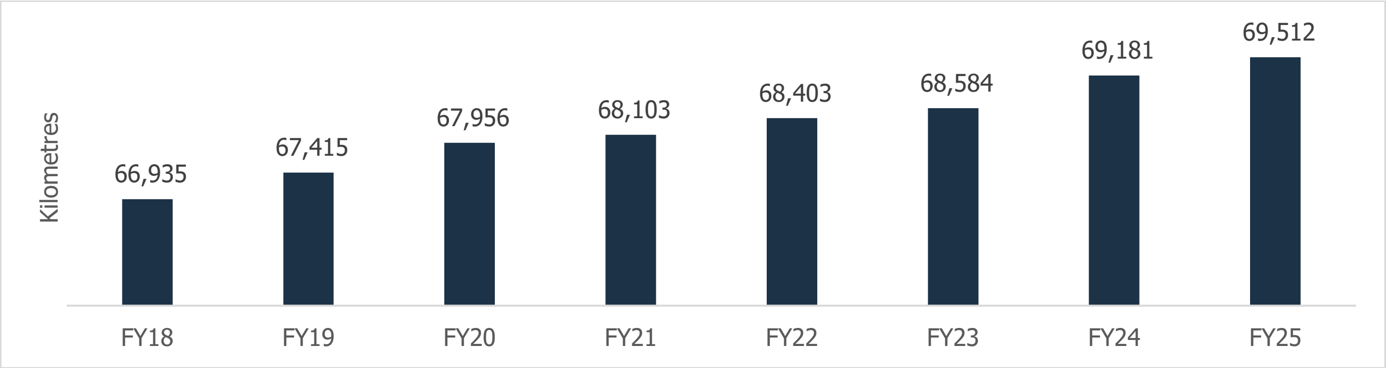
11.1 Overview

The Indian railway industry, led by Indian Railways (IR), is a vast and intricate network that plays a vital role in the nation's economy and social structure. Covering over 69,000 kilometres, it is one of the largest passenger rail systems globally, connecting remote areas to major cities and facilitating the transport of essential goods for various industries like agriculture, mining, and manufacturing. Managed under the Ministry of Railways, Indian Railways is organized into zones, each responsible for local operations, budgeting, and safety standards. This hierarchical structure allows for effective administration but can also lead to bureaucratic challenges that slow decision-making.

In recent years, there has been a shift toward increasing private participation in the railway sector, driven by policy changes. This move encourages private investments in infrastructure, station redevelopment, and the development of new passenger and freight corridors. While private involvement brings in much-needed capital and technological advancements, the transition is still in its initial stages. Indian Railways continues to maintain control over key operations, and balancing public and private interests is essential to ensure that services remain accessible to all passengers.

Indian Railways is the fourth-largest railway system in the world behind the US, Russia, and China. India has over 69,512 route km as of FY25. The Indian railway sector has seen multiple developments in the last decade such as expansion of metro rail network, introduction of high-speed trains and semi-high-speed trains, modernization of railway stations etc. Indian railways are moving towards large scale capacity expansion with technological advancement. For the next four to five years, India Railways has set out massive network expansion and decongestion targets.

Chart 45: Indian Railway Network



Source: Indian Rail Yearbook, CareEdge Research

Indian Railways also faces operational challenges and is adopting various technologies to enhance efficiency. Innovations such as digital ticketing, automated train control, and predictive maintenance systems are being implemented to streamline operations. However, integrating modern technologies into an extensive and aging infrastructure is complex. Additionally, Indian Railways is committed to sustainability, aiming to become a net-zero carbon emitter by 2030 through initiatives like electrifying the rail network and utilizing renewable energy sources. These efforts not only support environmental goals but also improve operational efficiency and reduce long-term costs, reinforcing Indian Railways' role as a crucial player in the country's transportation framework.

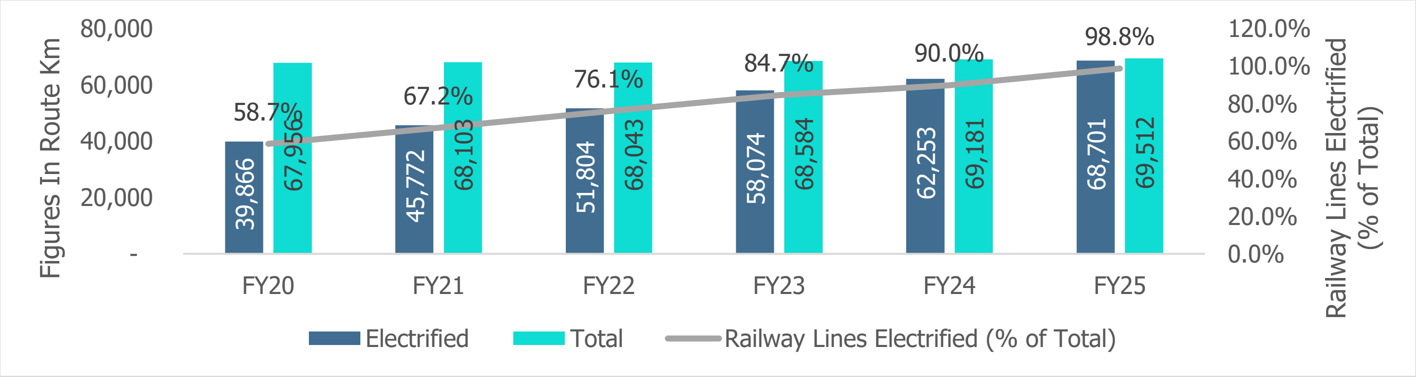
11.2 Railway electrification

Indian Railways is undergoing a significant transformation, driven by modernisation and infrastructure investments. It focuses on improving operational efficiency, safety, and passenger experience. As of FY25, over 98% of its routes are electrified, Indian Railways aims to achieve 100% electrification of its Broad-Gauge network by the 2025-26 financial year. It also aims to become a net-zero carbon emitter by CY30, sourcing 1,000 MW of solar and 200 MW of wind power.

As of September 2025, the Vande Bharat Express network has grown impressively, with 144 trains now operating across 20 states and 3 Union Territories. These semi-high-speed services continue to redefine intercity travel through improved comfort, faster journey times, and heightened reliability. The occupancy rate surged beyond expectations, touching 102.01% in FY2024-25 and 105.03% in the first quarter of FY2025–26, signalling exceptional passenger demand. Indian Railways has also introduced sleeper variants of Vande Bharat trains to extend premium services to overnight route, 10 are in production, with 50 more planned. The expansion of dedicated freight corridors is set to reduce transit times and costs. Over 1,300 stations are being redeveloped under the Amrit Bharat scheme to enhance infrastructure. Financially, Indian Railways' freight revenue increased to Rs 1,610.5 bn in FY24, reflecting significant growth over previous years, with a gross budgetary support of Rs 2,407 bn for FY 2023-24. These advancements highlight Indian Railways' commitment to becoming a more efficient, modern, and passenger-friendly network.

In recent years, there has been a concerted effort to modernize and redevelop the stations under initiatives such as Station Redevelopment Programme, Public-Private Partnership (PPP) Model, Smart Railway Stations Project, Amrit Bharat Station Scheme and Railway Station Development Fund (RSDF), which aims to improve infrastructure and amenities at stations.

Chart 46: Trend in railway electrification in India



Source: Indian Railways Annual Report, CareEdge Research

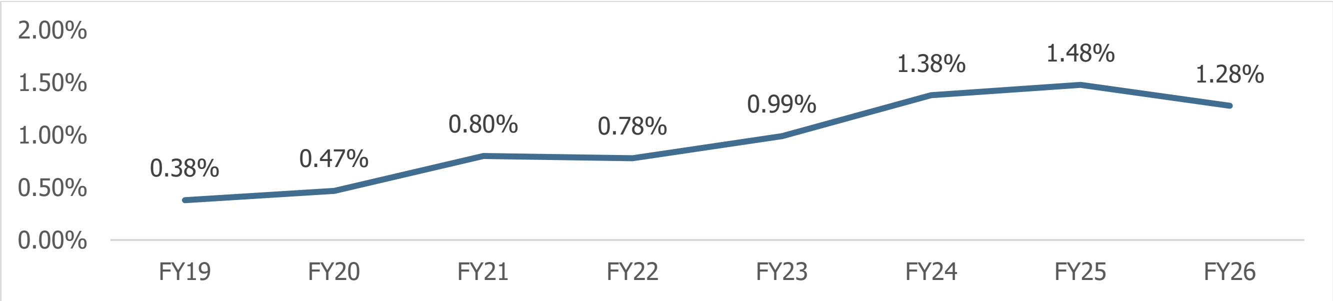
The expansion of railway networks, coupled with the accelerated pace of electrification, is driving significant demand for specialized transformer solutions. This development is creating new opportunities for transformer manufacturers, as the sector requires efficient and reliable transformers to support traction systems, power supply, and overall grid stability in railway operations.

11.3 Need of investment in railway infrastructure

Budgetary Outlay towards Indian Railways

The Union Budget 2025-26 allocated Rs 2.62 lakh crore to the Ministry of Railways, focusing on infrastructure development, safety, and modernization. Key highlights include provisions for track expansion, electrification, rolling stock procurement, and station upgrades. Additionally, Rs 1.16 lakh crore has been dedicated to safety initiatives, with a target of achieving 100% electrification by March 2026. The allocation for rolling stock, including locomotives, freight wagons, and passenger coaches, has decreased year-over-year to Rs 4,55,302 mn in the Union Budget for FY25-26 from Rs 4,62,517 mn in the revised budget for FY24-25. The projects like track doubling, new lines, track renewable, gauge conversion etc. have also seen significant growth in budget allocation over FY18 to FY25. The budget also emphasizes the introduction of 200 new Vande Bharat trains to enhance passenger experience and connectivity.

Chart 47: Budget allocation towards railways as a percentage of GDP

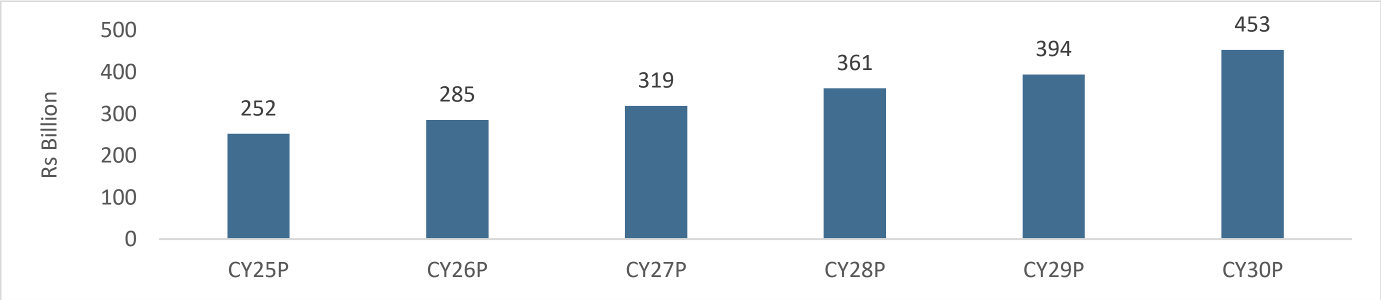


Source: Union Budget 2025-26, MOSPI, CareEdge Research
Note: GDP is considered at constant prices

11.3.1 High Speed Railways and Semi-High-Speed Railways

High-speed railways in India represent a significant leap forward in the country's transportation infrastructure, offering faster, more efficient, and comfortable travel options between major cities. These trains in India are designed to travel at speeds ranging from 250 to 350 km/h, drastically reducing travel times compared to conventional trains. The projected investment in High-Speed Railways is around Rs 2,282 bn from CY24-CY30.

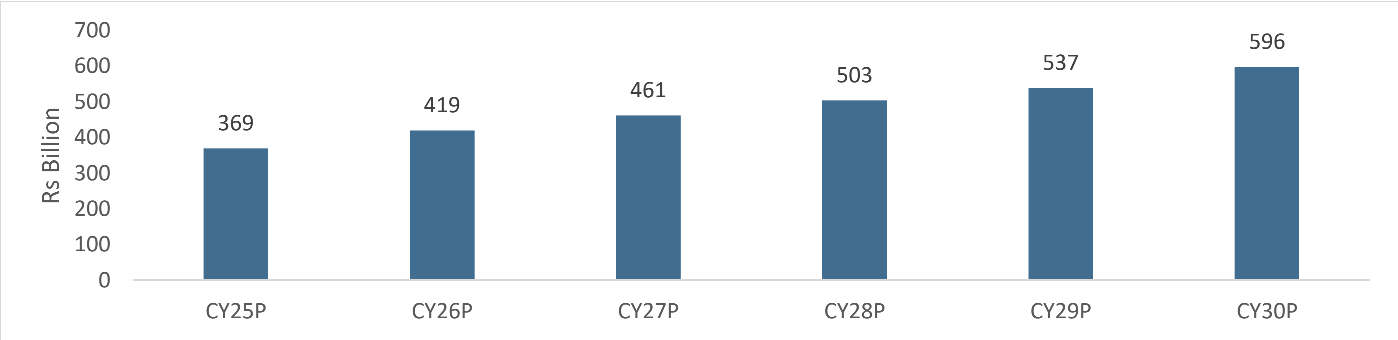
Chart 48: Projected Investments in High-Speed Railways



Source: Maia Research

Semi-high-speed railways in India represent a significant advancement in the country's railway infrastructure, bridging the gap between conventional rail services and full high-speed rail systems. Designed to operate at speeds ranging from 160 to 200 km/h, semi-high-speed trains aim to enhance travel efficiency and reduce journey times on key routes, making rail travel a more competitive alternative to air and road transport. The projected investments in Semi -High Speed Railways is around RS 3,213 bn from CY24-CY30. The projected investments in semi-high-speed railways are estimated at Rs 3,213 bn from CY24 to CY30, with India aiming to develop a 7,000 km high-speed rail network supporting speeds of 250 km per hour by 2047.

Chart 49: Projected Investments in Semi High- Speed Railways

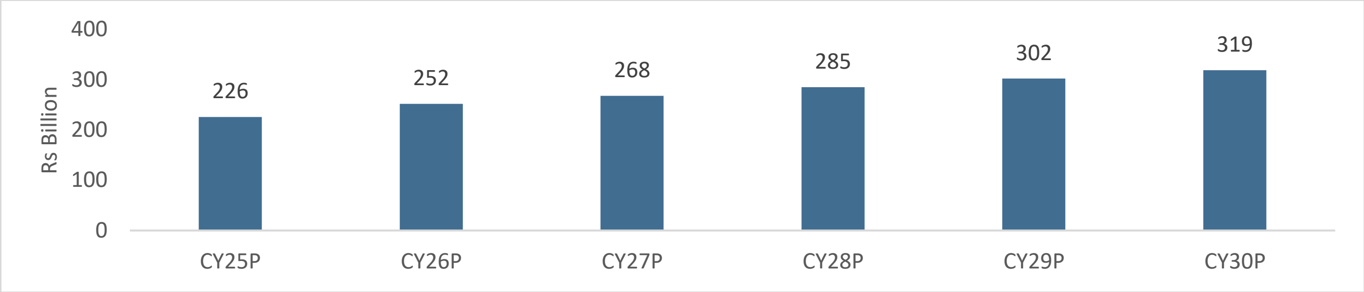


Source: Maia Research

11.4 Development of Metro Rails Infrastructure in India

The Metro Rail system in India has become a crucial component of urban transportation, offering a fast, efficient, and environmentally friendly alternative to road transport in many of the country's largest cities. The introduction and expansion of metro networks across India have been driven by the need to reduce traffic congestion, lower pollution levels, and provide reliable public transportation to rapidly growing urban population. The expansion of metro rail systems in India is transforming urban mobility, making cities more accessible, reducing environmental impact, and contributing to the overall quality of urban life. As more cities adopt and expand metro networks, the benefits of this modern, efficient, and sustainable mode of transport are set to grow. There is a lot of opportunity for players doing ballastless tracks and the same as all station tracks and majority metro tracks are ballastless. The projected investments in Metro Rail is around Rs 1,862 Bn from CY24-CY30.

Chart 50: Projected Investments in Indian Metro Rail



Source: CareEdge Research, Maia Research

As on August 2024, three major Metro Rail projects have been approved by the Union Cabinet-

- Bengaluru Metro Project: 44 km expansion comprising two corridors
- Thane Metro Project: 29 km network aimed at reducing congestion on the roads of Thane
- Pune Metro Project: A 5.5 km route to further improve urban mobility in the city

In addition to these major metros, tier-2 cities like Surat, Indore, Bhopal, and Patna are launching their first metro systems, embracing models like MetroLite and MetroNeo to balance costs and urban density. Cities such as Nagpur, Pune, Agra, Kanpur, and Thane are actively building extensions or new standalone corridors. Over 970 km of metro lines are under construction nationwide, illustrating the government's commitment to sustainable transit.

Several new projects have received approval, including in Bhubaneswar, Coimbatore, Madurai, Jammu, and Gorakhpur. Meanwhile, proposals are being explored in cities like Amritsar, Ludhiana, Chandigarh, Ranchi, Hubli, Gwalior, Dehradun, and Mangalore, showcasing the growing ambition to provide metro connectivity across the country.

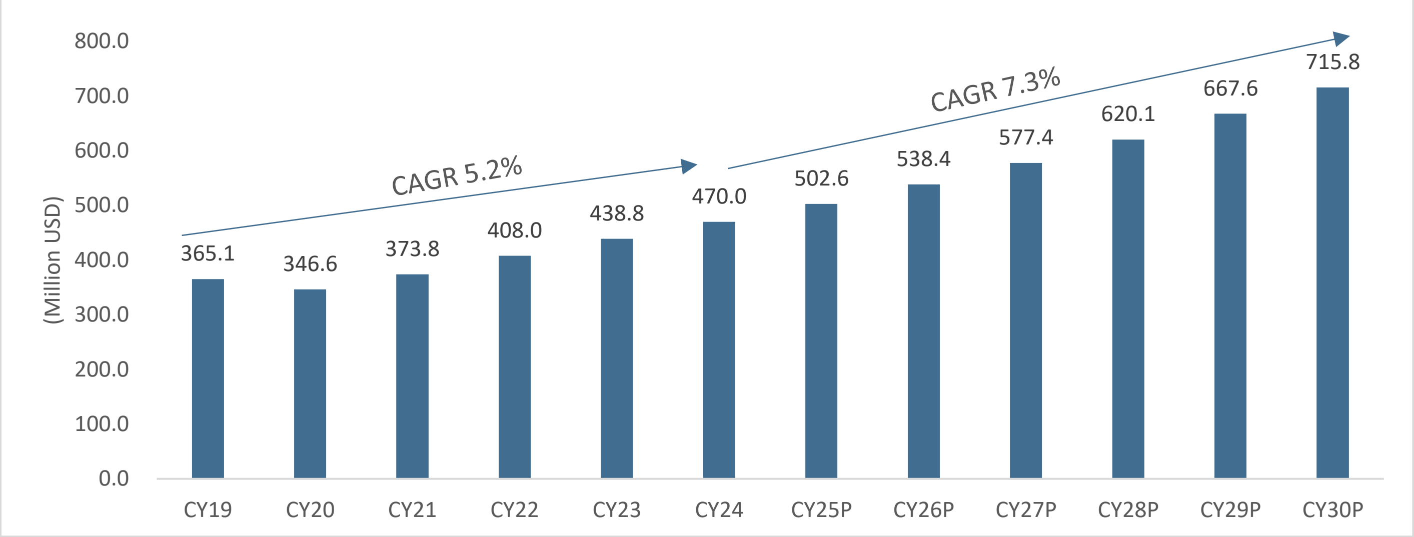
11.5 Railway/metro transmission EPC market in India

Railway Transmission EPC (Engineering, Procurement, and Construction) refers to projects involving the design, procurement, construction, and commissioning of electrical transmission infrastructure for Indian Railways or related railway electrification and power supply systems. These projects are critical for electrifying routes and ensuring reliable power delivery to locomotives and rail infrastructure.

11.5.1 Railway transmission EPC market in India

India's railway transmission EPC market was USD 365.1 mn in CY19, slightly dipped in CY20 due to pandemic-related disruptions (USD 346.6 mn), but recovered and grew steadily thereafter. By CY24, the market reached USD 470 mn, registering CAGR of 5.2% from CY19 to CY24. This reflects moderate but consistent investments in electrification, transmission upgrades, and grid interlinking of railway networks.

Chart 51: Railway transmission EPC market in India



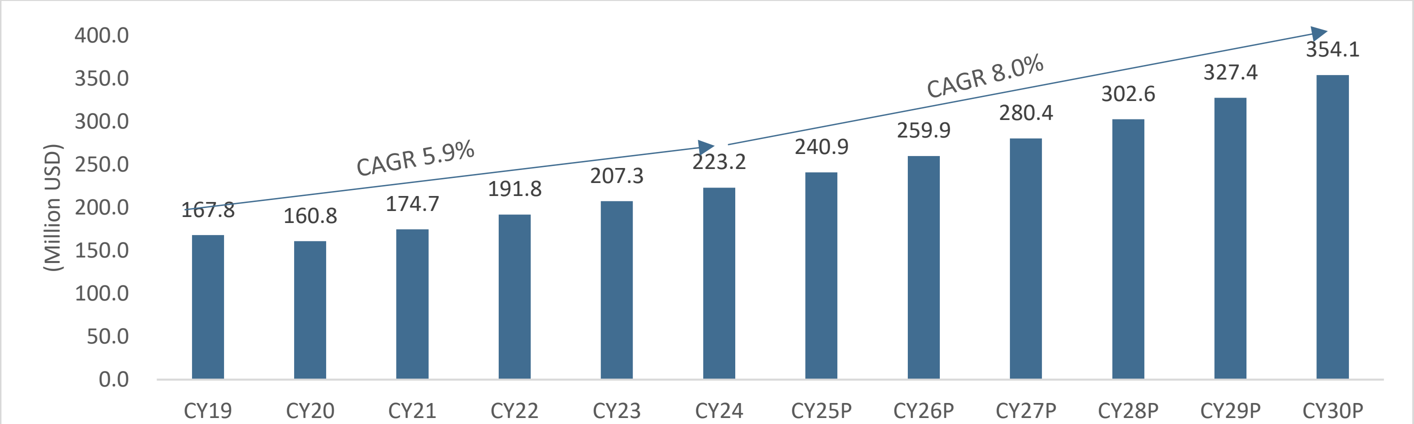
Source: Maia Research, CareEdge Research

From CY24 onward, the market is projected to accelerate, reaching USD 715.8 mn by CY30P, with an in increased CAGR of 7.3% over CY24 to CY30P. This sharper growth implies increased capital allocation for railway infrastructure modernization, such as 100% electrification targets, high-speed corridors, and new transmission nodes to support freight and passenger movement.

11.5.2 Metro transmission EPC market in India

In CY19, the market size was USD 167.8 mn and experienced a slight dip in CY20 to USD 160.8 mn. From CY21 onward, the market recovered steadily, reaching USD 223.2 mn in CY24, growing at a CAGR of 5.9% during this period. This reflects moderate growth spurred by expanding metro networks and demand for reliable electricity supply systems in urban transit.

Chart 52: Metro transmission EPC market in India



Source: Maia Research, CareEdge Research

From CY24 to CY30P, the market is projected to accelerate rapidly, with a CAGR of 8.0%, reaching USD 354.1 mn by CY30P. This stronger momentum suggests increased investment in metro electrification, substation upgrades, and grid extensions to support rising ridership, new lines in Tier-2 cities, and advanced technologies.

11.6 Key drivers

Reduction in dependence on imported fossil fuels

- The electrification of Indian Railways is driven by a combination of economic, environmental, operational, and strategic factors. One of the primary drivers is the need to reduce dependence on imported fossil fuels, especially diesel, which has historically accounted for a significant share of railway traction. By shifting to electric traction, the railways can significantly lower fuel costs and reduce exposure to global oil price volatility.

Cost efficiency and operational savings

- Electric locomotives offer better energy efficiency, require less maintenance, and have lower operating costs compared to diesel engines. This makes electrification a more viable long-term investment. Additionally, electrified routes allow for higher speeds and improved haulage capacity, enabling faster and more reliable train services for both passengers and freight.

Environmental sustainability and emissions reduction

Environmental considerations are also central to the electrification push. Electric trains produce zero tailpipe emissions, helping reduce greenhouse gas emissions and air pollution, especially in urban and densely populated regions. This aligns with India's commitment to sustainability and the goals outlined in its Intended Nationally Determined Contributions (INDCs) under the Paris Agreement.

Government targets and policy support

- From a strategic standpoint, the government has set a target to achieve 100% electrification of broad-gauge routes by 2030, as part of its larger vision of achieving a net-zero carbon railway network. Schemes like "Mission Electrification" and support from agencies like the Ministry of Railways and the Railway Energy Management Company (REMCL) are helping accelerate this transition.

Self-reliance through domestic manufacturing

- The availability of domestic manufacturing capabilities for electrification components, such as transformers, switchgear, and overhead equipment, ensures smoother project execution and reduces costs. All these factors collectively make electrification a central pillar of Indian Railways' modernization and sustainability roadmap.

12 Indian Substation and Transmission Line EPC

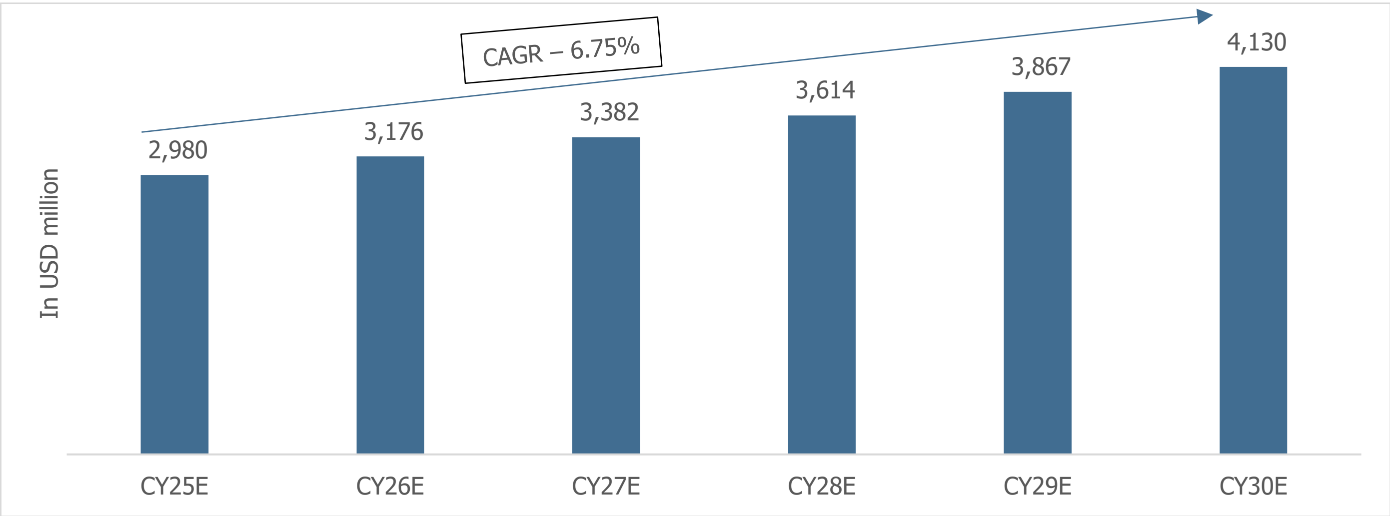
12.1 Overview

Transmission and Substation EPC refers to the engineering, procurement, and construction services involved in building high-voltage power infrastructure, including transmission lines and substations. These companies offer end-to-end solution from system design, analysis, construction management and inspection of energy structures, high voltage transmission lines and equipment sourcing to installation, testing, and commissioning. These services are critical for expanding and modernizing India's power grid, as demand grows for reliable electricity across urban and rural regions.

These firms handle projects up to 400kV and beyond, incorporating advanced technologies like SCADA systems, GIS substations, and smart grid solutions. Some also specialize in turnkey execution, while others may focus on specific segments such as tower erection, conductor stringing, or substation automation.

In the National Electricity Plan of FY22 to FY32 the Government of India has approved a Rs 9.15 lakh crore plan to expand central and state transmission systems to meet a projected peak demand of 458 GW by 2032. Key targets include increasing transmission lines from 4.91 lakh Ckm in FY24 to 6.48 lakh Ckm in FY32, boosting transformation capacity from 1,290 GVA to 2,342 GVA during the same period, adding 33.25 GW of HVDC capacity, and enhancing inter-regional transfer capacity from 119 GW to 168 GW. The plan focuses on 220 kV and above networks and supports renewable energy and green hydrogen integration.

Chart 53: Market size of transmission EPC in India



Source: MAIA, CareEdge Research
Note: E stands for Estimates

The transmission EPC market is expected to grow at CAGR of 6.75% from FY25 to FY30, the growth is attributable to factors like National Railway Electrification Policy, which aims to electrify 100% of broad-gauge routes across the country and increased investments in grid upgrades.

12.2 Eligibility criteria for tenders

The eligibility criteria for Transformer EPC tenders can vary depending on the issuing authority, region, and specific project requirements. However, some common eligibility requirements are.

General Criteria

- The Bidder should be either a body incorporated in India under the Companies Act, 1956 or 2013 including any amendment thereto.
- The EPC contractor should be able to provide end-to end solutions
- The Bidder (either individually or as a consortium or any of the participating members of the Consortium) shall not have been debarred by EMPLOYER/ Owner/ or any other ministries and / or any other Government Department, Agencies or CPSUs from future bidding due to "poor performance" or "corrupt and fraudulent practices" or any other reason in the past.
- The Bidder should not be under any liquidation court receivership or similar proceedings on the due date of submission of bid.

Technical Criteria

- The bidder must have successfully completed EPC works for substations of equal or higher voltage class (e.g., 220 kV, 400 kV, 765 kV, GIS/AIS) in the last 5–7 years.
- The transformer manufacturer must have designed, tested, and supplied transformers of required voltage class, with proven satisfactory operation for at least 2 years.
- The project should have been commissioned prior to the Techno-Commercial Bid Opening date. The bidder is required to submit a list of such projects, indicating their grid-connected status, along with relevant supporting documentation, such as the commissioning certificate and work order/contract/agreement from the client or owner.

Financial Capacity

- The bidder must have an annual turnover of 2 to 3 times of the estimated annual contract value over the last 3 years.
- The bidder must have a net worth equal to or greater than 100% of paid-up capital of the value calculated at a specified rate per unit of the capacity offered in the bid.
- In case of more than one Price Bid submitted by the Bidder, the financial eligibility criteria must be fulfilled by such Bidder for the sum total of the capacities being offered by it in its Price Bid.

12.3 Key drivers for transmission EPC market

Growth Drivers	
Digital economy and Data Centre	Data centre capacity is expected to reach approximately 2.4 GW by FY28, rapid development and investments are seen in this sector, this has led to a demand opportunity in the value chain for transformer EPC sector
Energy transition initiatives	Large-scale renewable energy additions, industrial growth, growth in metro systems, railway electrification, expansion of EV charging networks, and grid modernisation efforts are creating opportunities in the sector
Higher investments	Higher capital allocation towards grid infrastructure, acts as a catalyst, as per NEP during FY22 to FY27 India plans to expand the transmission network by over 114,000 Ckms and enhance transformation capacity by approximately 776,000 MVA. In the subsequent period FY27 to FY32 addition of over 76,000 Ckms of transmission line and 497855 MVA capacity is expected.
BESS and Transmission system integration	Battery Energy Storage System (BESS), for renewable energy integrated into transmission infrastructure, are expected to reach 47 GW by 2030. The rising RE share in the energy mix has given rise for grid-balancing solutions and accelerated renewable deployment these creates growth potential for transmission EPC players.

12.4 Rail and Metro Rail - Transmission EPC opportunity Analysis

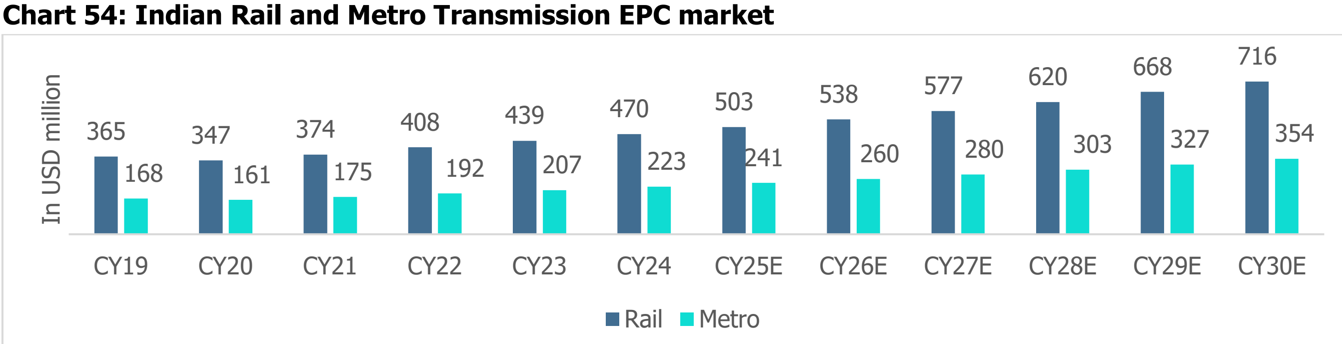
The Indian transmission line and substation EPC market has shown consistent growth in investment value over the past decade.

In 2019, the total value of transmission line projects across rail and metro stood at USD 533 mn, comprising USD 365 mn from rail and USD 168 mn from metro projects. In 2024, the share of Rail EPC market size increased to USD 470 mn and Metro EPC to USD 223 mn a CAGR of 5.2% for rail and 5.9% for metro.

By 2025, the total market value has reached USD 743 mn of this rail segment stands at USD 503 mn and metro stands at USD 241 mn. The market is expected to reach USD 1

070 mn by 2030, with rail accounting for USD 716 mn and metro contributing USD 354 mn a CAGR of approximately 6.7% over the 2019–2030 period.

Chart 54: Indian Rail and Metro Transmission EPC market



Source: MAIA, CareEdge Research

Note: E stands for Estimates

This growth outlook for the rail and metro segment is a combination of infrastructure expansion, increased investment and advanced transmission technologies.

India is making effort to achieve 100% railway electrification target by FY26, which requires addition of thousands of kilometres of electrified lines. Each kilometre length demands 2–3 traction substations, with core equipment such as 132 kV/25 kV main transformers and rectifiers. Another important factor is the renovation of older lines, for example the Kolkata Suburban Line, this also involves substantial substation expansion.

Plans for expansion of metro networks in major cities with Delhi, Mumbai, and Bangalore at the core, large-scale projects like the Mumbai Metro Phase III (33.5 km) require 58 traction power supply systems, each equipped with a 33 kV/750 V rectifier transformer. The tunnel environment in metro projects necessitates moisture-proof and compact designs (width under 2.5 meters), driving up demand for epoxy resin cast transformers.

The Mumbai–Ahmedabad high-speed railway, developing with Japanese technology, has introduced a 110 kV/25 kV special traction transformer for the first time, designed for compatibility with both 50 Hz and 60 Hz grids. This project serves as a benchmark for the development of future high-speed rail corridors.

The outlook for India's substation and transmission line EPC segment remains robust, ensuring a healthy pipeline of opportunities across rail, metro, and high-speed rail projects over the next decade.

12.5 Key benefits of having Transformer/components manufacturing and providing EPC services

Benefits	Description
Smooth management of Projects	When working on a turnkey basis, EPC companies handle every aspect of the project, eliminating the need for the project owner to coordinate with various parties.
Quality Assurance	EPC companies hire skilled engineers and technicians to carry out projects. They focus on delivering high-quality construction while reducing malfunctions, ultimately enhancing long-term performance.
Cost Efficiency	The EPC contractors have their own suppliers and procurement methods for easy procurement at competitive prices. With efficient designing of systems and cost-effective procurement, EPC companies can help achieve optimal construction costs for the project.
Timely Completion	Manufacturing transmission projects consists of several stages. EPC companies are hired to finish the project on schedule, and a skilled EPC company guarantees its prompt commissioning. Delays in completion usually result in penalties outlined in the EPC contract.

12.6 Recent trends in tenders in transmission (Equipment, EPC) sector

Table 23: State-wise tender allocation

States	Central Government	State Government	Others	Grand Total
Andhra Pradesh	52	1		53
Arunachal Pradesh	7	2		9
Assam	2	9		11
Bihar	5	33		38
Chhattisgarh	7			7
Delhi	10	1		11
Gujarat	45	22	1	68
Haryana	41	8	1	50
Himachal Pradesh	1	10		11
Jammu & Kashmir	20	16		36
Jharkhand	5	2		7
Karnataka	22	21		43
Kerala		1		1
Ladakh		1		1
Madhya Pradesh	19	9		28
Maharashtra	20	17	3	40
Mizoram		1		1
Multi States	14			14
Odisha	5	4		9
Punjab	1	14		15
Rajasthan	4	49		53
Sikkim	2	1		3
Tamil Nadu	10	10		20
Telangana	8			8
Tripura		1		1
Unallocated	3			3
Uttar Pradesh	23	24		47
Uttarakhand	2	4		6
West Bengal	2	6		8
Grand Total	**330**	**267**	**5**	**602**

Source: Projects Today, CareEdge Research
Note: Tenders included from Sept'24 to Aug'25

A substantial majority of transmission EPC tenders in India continue to be awarded by central and state government entities. These include ministries, public sector undertakings (PSUs), and state transmission utilities, these are allotted through platforms like the Central Public Procurement Portal and state-level e-tendering systems. This government-led tendering landscape ensures consistent project flow and reinforces the strategic role of public investment in expanding and modernizing the national grid infrastructure.

13 Switchgear Market in India

13.1 Overview

Switchgear is a system of electrical components, including circuit breakers, fuses, isolators, and relays which are designed to control, protect, and isolate electrical circuits. It plays a critical role in ensuring the safety and reliability of power systems by managing electricity flow and interrupting fault currents. When equipment requires maintenance or if there is a fault like a short circuit, switchgear allows safe isolation without disrupting the entire network.

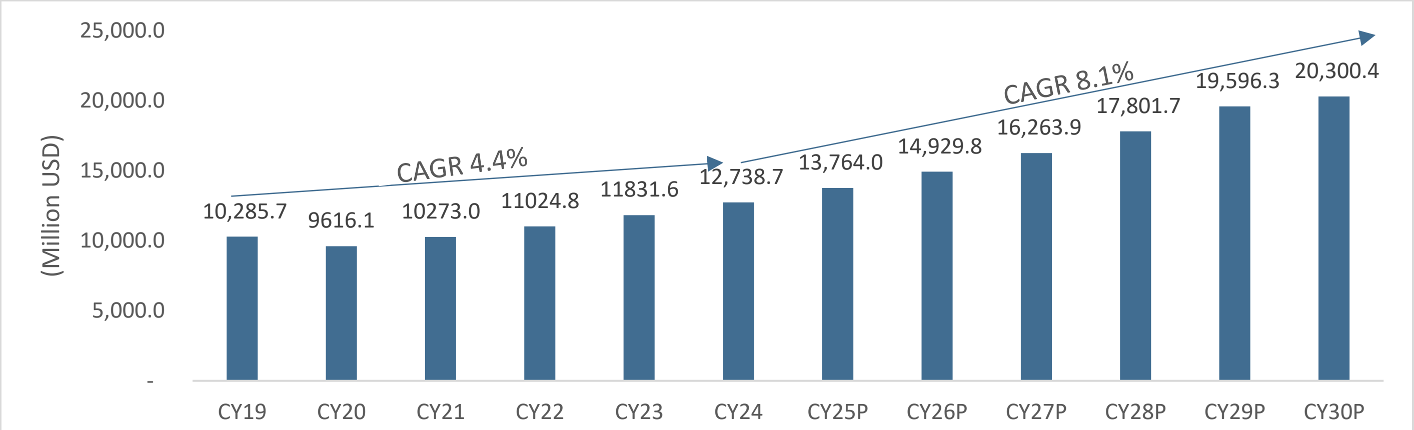
Switchgear fulfils three key functions. It protects the system by identifying faults or overloads and promptly disconnecting the affected section to prevent damage. It controls the flow of electricity, ensuring efficient distribution across a facility or grid. It also isolates specific equipment, enabling engineers to carry out maintenance safely without interrupting the operation of other systems.

Industries across sectors deploy switchgear to ensure safe and efficient operations. Utilities and distribution companies (DISCOMs) use it for grid control and protection during faults. Large industrial plants rely on robust switchgear systems to manage energy loads and protect expensive machinery. Infrastructure projects—including airports, metro networks, and data centres—rely on switchgear for dependable power management. As the grid increasingly integrates renewable sources such as solar and wind, switchgear ensures the safe handling and distribution of electricity within hybrid energy systems.

13.1.1 Switchgear market size in India

Switchgear market size was USD 10,285.7 mn in CY19, in CY20 it declined slightly due to economic disruptions such as the COVID-19 pandemic and then resumes a steady upward trajectory.

Chart 55: Total Switchgear market size in India



Source: EMIS, CareEdge Research
P: Projected

By CY24, the market reached USD 12,738.7 mn, reflecting a CAGR of 4.4% during this period. From CY24 onwards, the market is expected to grow with a projected CAGR of 8.1%, culminating in a value of USD 20,300.4 mn by CY30.

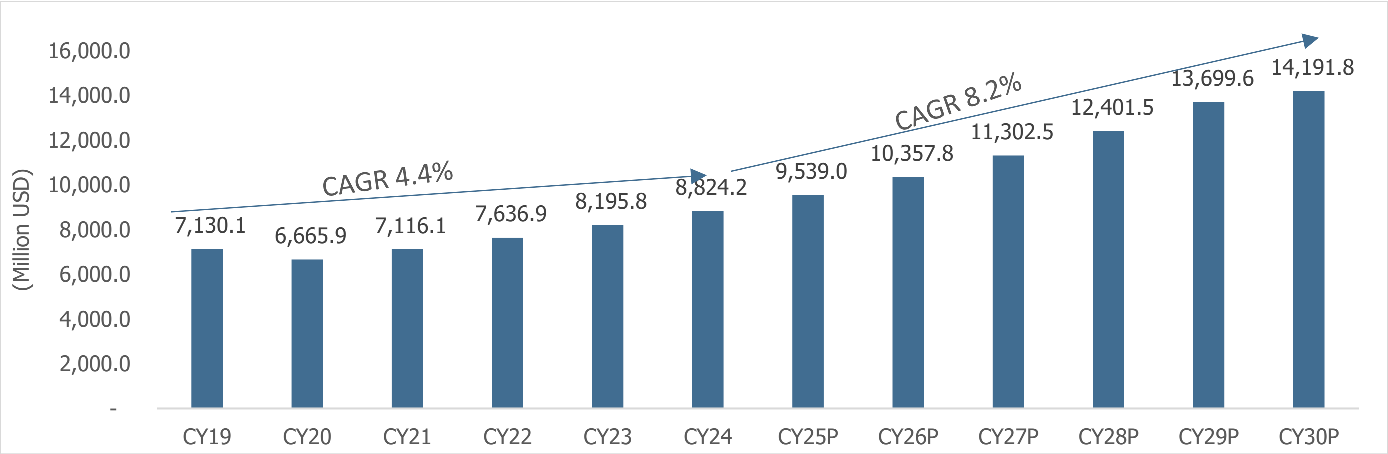
13.2 Market size and outlook by type

There are mainly two types of Switchgear based on insulation technology. 1) Air-Insulated Switchgear (AIS) is cost-effective and ideal for outdoor installations with sufficient space. 2) Gas-Insulated Switchgear (GIS), on the other hand, is compact and suitable for urban environments or tight spaces due to its high dielectric strength.

13.2.1 Air-insulated switchgear

Air-Insulated Switchgear (AIS) is a type of electrical switchgear where air is used as the primary insulating medium to separate and protect electrical components such as circuit breakers, busbars, and disconnectors. Commonly used in medium- and high-voltage applications, AIS is typically installed outdoors or in substations and is known for its reliability, ease of maintenance, and lower cost compared to gas-insulated switchgear (GIS).

Chart 56: Market size and outlook of Air insulated switchgear



Source: EMIS, CareEdge Research
P: Projected

The market size for air insulated switchgear in India has shown consistent growth from USD 7,130.1 mn in CY19 to USD 8,824.2 mn in CY24, with a CAGR of 4.4%. Despite a temporary dip in CY20 the sector rebounded and continued an upward trajectory.

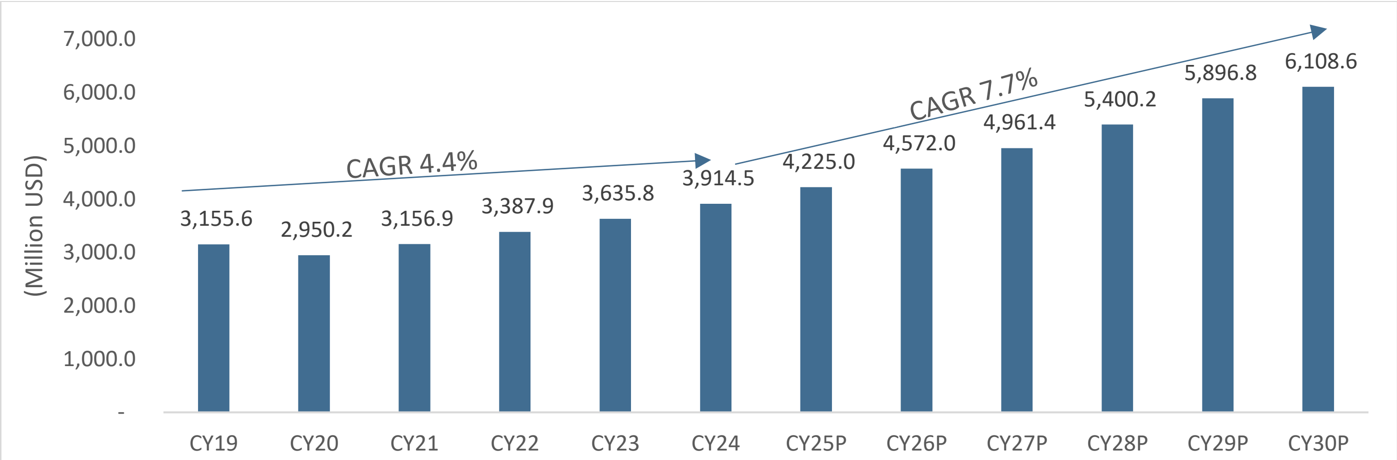
Projections from CY24 to CY30 suggest a significant acceleration in growth, with the market expected to reach USD 14,191.8 mn by CY30, supported by a robust CAGR of 8.2%. This increase is anticipated to come from increased investment in smart grids, rising demand for industrial safety systems, and modernization across utilities and infrastructure segments. Overall, the market is poised for significant expansion, nearly doubling in size between CY19 and CY30.

13.2.2 Gas insulated switchgear

Gas-Insulated Switchgear (GIS) is a compact, high-voltage switchgear in which all live components are enclosed in a sealed metal enclosure filled with insulating gas, usually sulphur hexafluoride (SF_6). It offers high reliability, safety, and space efficiency, making it ideal for use in urban areas, industrial facilities, and environments with space constraints or harsh conditions.

Gas-Insulated Switchgear (GIS) is widely used in **urban substations** where land availability is limited, as its compact design requires significantly less space compared to conventional switchgear. It is also applied in **industrial plants**, **underground power stations**, and **high-rise buildings**, where safety and reliability are critical. GIS plays an important role in **renewable energy integration**, such as wind and solar farms, by ensuring efficient and stable power transmission. Additionally, it is preferred in **harsh environments** like coastal areas, deserts, or regions with high pollution, as it provides robust protection against external conditions.

Chart 57: Market size and outlook of Gas insulated switchgear



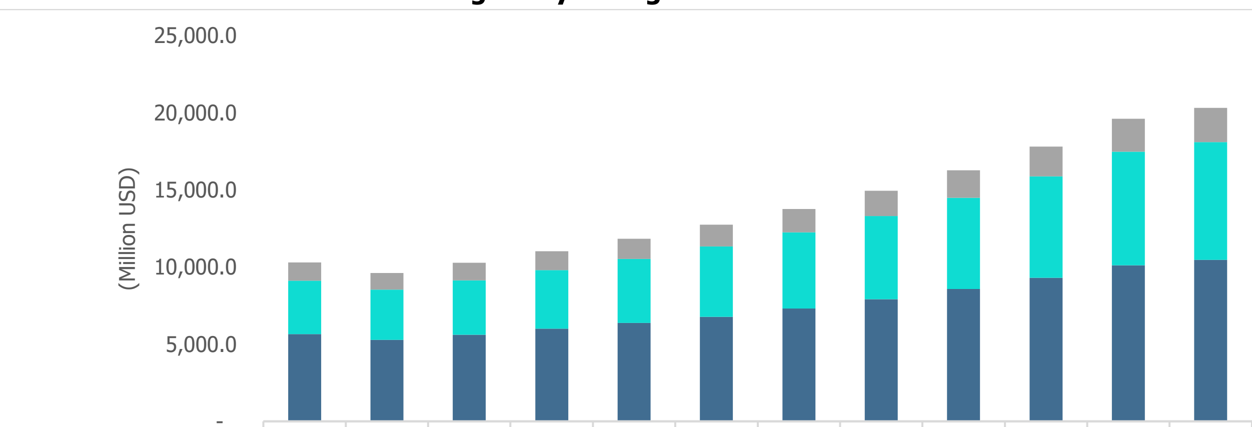
Source: EMIS, CareEdge Research
P: Projected

The market size for Gas insulated switchgear in India has shown consistent growth from USD 3,155.6 mn in CY19 to USD 3,914.5 mn in CY24, with a CAGR of 4.4%. Despite a temporary dip in CY20 the sector rebounded and continued an upward trajectory. Projections from CY24 to CY30 suggest a significant growth, with the market expected to reach USD 6,108.6 mn by CY30, supported by a robust CAGR of 7.7%.

13.3 Market Segmentation by voltage

The switchgear market in India is categorised into Low Voltage (LV), Medium Voltage (MV), and High Voltage (HV) categories, with LV consistently holding the largest market share throughout the period from CY19 to CY30. In CY19, the market size was USD 5,647.3 mn for LV, followed by USD 3,475.0 mn for MV and USD 1,163.4 mn for HV. A slight dip in CY20 likely due to pandemic-related disruptions is followed by steady recovery and growth.

Chart 58: Market size and outlook of Switchgear by voltage



	CY19	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
High voltage (HV) switchgear	1,163.4	1,080.5	1,147.8	1,226.5	1,312.9	1,412.8	1,516.1	1,635.1	1,773.4	1,936.1	2,130.0	2,206.5
Medium voltage (MV) switchgear	3,475.0	3,260.9	3,506.4	3,801.0	4,138.6	4,545.2	4,928.4	5,378.9	5,915.5	6,564.4	7,363.5	7,628.1
Low voltage (LV) switchgear	5,647.3	5,274.7	5,618.8	5,997.3	6,380.1	6,780.7	7,319.5	7,915.8	8,575.0	9,301.2	10,102.8	10,465.8

Low voltage (LV) switchgear　Medium voltage (MV) switchgear　High voltage (HV) switchgear

Source: EMIS, CareEdge Research
P: Projected

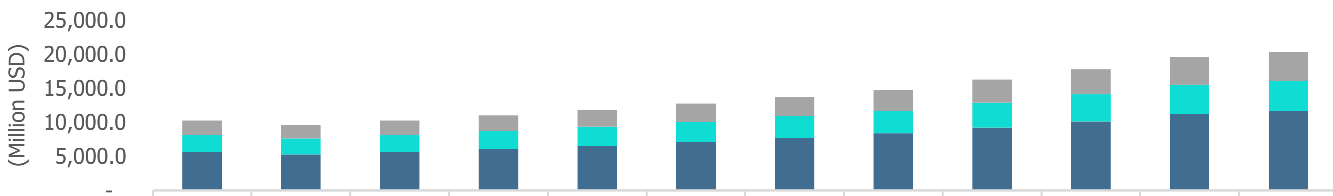
Projected figures for CY30 indicate a substantial increase across all segments, with LV forecasted to hit USD 10,465.8 mn, MV USD 7,628.1 mn, and HV USD 2,206.5 mn. This upward trajectory is driven by rising demand for urban electrification, infrastructure modernization, and smart grid deployments, with LV and MV switchgear dominating due to their widespread application in commercial buildings, manufacturing, and power distribution networks. The LV, MV, and HV segments are projected to grow at a CAGR of 7.5%, 9.0%, and 7.7% respectively from CY24 to CY30.

13.4 Market size and outlook by usage

Market size and outlook of Switchgear by usage

Use of Switchgear in commercial segment consistently holding the largest market share throughout the period from CY19 to CY30. In CY19, the market size was USD 5,682.7 mn for commercial segment, followed by USD 2,481.6 mn for industrial segment and USD 2,121.4 mn for residential segment.

Chart 59: Market size and outlook of Switchgear by usage



	CY19	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
Residential	2,121.4	1,983.3	2,131.6	2,287.6	2,455.0	2,643.2	2,855.9	3,097.8	3,374.6	3,693.7	4,076.1	4,222.6
Industrial	2,481.6	2,341.6	2,493.3	2,648.7	2,813.8	2,996.3	3,198.9	3,224.7	3,677.5	3,962.0	4,292.0	4,446.2
Commercial	5,682.7	5,291.2	5,648.1	6,088.5	6,562.8	7,099.2	7,709.2	8,407.2	9,211.8	10,146.0	11,227.9	11,631.3

Commercial Industrial Residential

Source: EMIS, CareEdge Research
P: Projected

Estimated figures for CY30 indicate a significant increase across all segments, with commercial segment forecasted to hit USD 11,631 mn, industrial segment USD 4,446.2 mn, and residential USD 4,222.6 mn. The commercial segment, industrial segment, and residential segments are projected to grow at a CAGR of 8.6%, 6.8%, and 8.1% respectively from CY24 to CY30.

13.5 Switchgear market drivers

Growth Driver	Brief Explanation
Rapid industrialization & infra growth	Manufacturing, steel, mining, O&G, and data centres need reliable power and protection → boosts MV/HV switchgear; infra projects (metros, airports, smart cities) drive LV/MV demand.
Rising renewable energy capacity	Solar/wind expansion requires switchgear for grid integration, protection, and evacuation; large parks & hybrid projects rely on MV/HV switchgear.
T&D network expansion & modernization	Investments to reduce losses and upgrade grid (Green Energy Corridor, Smart Grid Mission) increase demand for traditional and digital switchgear.
Urbanization & real estate growth	Residential, commercial, and smart city projects use LV switchgear for safe and efficient power distribution; digital/smart switchgear adoption rising.
Growing power demand & electrification	Higher electricity demand, rural electrification, and new capacity additions drive switchgear needs in T&D, substations, and power plants.

13.6 Switchgear market challenges

High cost of GIS and digital switchgear

Gas-insulated switchgear (GIS) and digital switchgear offer superior performance but come at a significantly higher cost compared to traditional air-insulated switchgear (AIS). Many Indian utilities and builders, especially in tier-2 and tier-3 cities, hesitate to adopt them due to tight budgets and lower awareness of long-term benefits.

Import dependency for vacuum interrupters and relays

India lacks large-scale domestic manufacturing of critical components like vacuum interrupters, protection relays, and digital control modules. These are mostly imported from China, Germany, and Japan, exposing the market to delays, price fluctuations, and geopolitical risks.

Inconsistent BIS and safety compliance in unorganized sector

The unorganized sector in India often supplies low-cost switchgear that does not comply with BIS (Bureau of Indian Standards) or international IEC standards. This leads to safety hazards, frequent failures, and reputational risk for developers using such products.

Delays in government tenders and approvals

Switchgear procurement in large infrastructure and utility projects often faces delays due to complex tendering processes, bureaucratic red tape, and slow approval cycles. These issues impact order inflows for manufacturers and cause delays in project execution.

Low penetration of skilled service technicians and environmental concerns over SF_6 usage

There is a shortage of trained technicians for installation and servicing of modern switchgear, especially in remote and semi-urban areas. This results in frequent faults, improper maintenance, and increased operational costs for users. Most GIS systems use SF_6 gas, which has a very high global warming potential (GWP). With rising regulatory focus on emissions, manufacturers are under pressure to find eco-friendly alternatives, which increases R&D costs and limits product availability.

13.7 Government Policies and Regulations

The Electrical Equipment (Quality Control) Order, first issued in 2020 and amended in 2023 by the Ministry of Heavy Industries, plays a pivotal role in standardizing switchgear quality across India. It mandates that eight categories of low-voltage switchgear and control gear such as circuit breakers, switches, and disconnectors must comply with BIS (Bureau of Indian Standards) certification under the Scheme-X of the BIS Conformity Assessment Regulations, 2018. While products manufactured solely for export are exempt, all items intended for domestic sale, distribution, or exhibition must meet certification requirements.

Safety regulations under the Central Electricity Authority (CEA) Guidelines, rooted in the Electricity Act, 2003, offer another layer of oversight. These rules outline critical installation and accessibility requirements for switchgear within electrical systems. Whether in substations, industrial plants, or residential zones, switchgear must be strategically located and installed to reduce the risk of faults and electrical hazards, thereby upholding public and occupational safety standards.

The **Indian Standard** IS:3072-1975 adds further guidance by addressing both indoor and outdoor switchgear systems, covering AC and DC applications. It specifies best practices for equipment selection, installation, and maintenance, making it essential for engineers and installers aiming for reliability and longevity in power systems. Despite its age, this standard remains foundational to India's switchgear deployment strategy.

Electricity Act, 2003, together with the associated Tariff Policy, encourages upgrades in grid technology and distribution efficiency. While not switchgear-specific, these regulations indirectly boost demand for smart and automated switchgear solutions. As utilities and DISCOMs invest in modernization, there is greater scope for deploying IoT-enabled switchgear with enhanced diagnostic and fault isolation capabilities.

13.8 Technological advancement in India

India's power sector is undergoing notable technological advancements, particularly in switchgear systems. These developments focus on improving operational efficiency, strengthening safety standards, and supporting the integration of digital and sustainable solutions. Highlighted below are some of the advanced technologies in switchgear.

SF_6 Gas-Insulated Switchgear (GIS)	SF_6-based switchgear is widely used in India for high-voltage applications due to its superior insulation and arc-quenching properties. It allows for compact and space-saving installations, making it ideal for urban substations, underground setups, and critical facilities like airports or industrial plants. However, SF_6 is a potent greenhouse gas, and concerns about its environmental impact have led to the exploration of alternatives. Indian manufacturers are now gradually transitioning toward eco-friendly gases like g^3 or AirPlus and vacuum technologies.
Digital and Smart Switchgear	Digital switchgear uses embedded sensors, communication systems, and intelligent protection relays to enable real-time monitoring, diagnostics, and control. This facilitates predictive maintenance, energy management, and fault detection. In India, smart switchgear is being adopted in commercial buildings, renewable energy projects, and industrial plants.
Vacuum Interruption Technology	Vacuum circuit breakers (VCBs) are increasingly replacing traditional SF_6 or oil-based systems in medium-voltage applications due to their safety, reliability, and zero environmental impact. VCBs use a vacuum as the arc-extinguishing medium, offering long operational life and minimal maintenance. In Utilities and industries are actively deploying VCBs as part of their grid modernization and equipment replacement programs.
Solid Insulated Switchgear (SIS)	Solid Insulated Switchgear is a gas-free alternative that uses solid dielectric material for insulation. It is safe, environmentally friendly, and compact, making it suitable for space-constrained areas such as metro stations and residential complexes. With growing awareness about sustainability, SIS is seeing rising adoption in India's infrastructure projects and renewable power applications.
IoT and Cloud-Enabled Systems	Switchgear systems are now being equipped with IoT devices that allow real-time data collection, remote access, and cloud-based analysis. These technologies enhance asset management by enabling predictive maintenance, optimizing load distribution, and reducing energy waste. Power distribution companies and industrial consumers are increasingly adopting IoT enabled switchgear for digital grid operations.

Collectively, these innovations reflect a decisive move towards intelligent, environmentally responsible, and future-ready power infrastructure in India

14 Threats and challenges to the product offered by the issuer company

Skilled Workforce Gap	A shortage of skilled technicians and engineers, particularly in areas such as winding, core assembly, CNC machining, and precision manufacturing, affects operational efficiency in transformer production. This gap limits the company's ability to scale up manufacturing capacity or consistently maintain high-quality standards required for large utility and industrial projects.
Compliance Hurdles	The transformer manufacturing sector faces increasingly stringent quality, safety, and environmental regulations, including energy efficiency norms, IEC/IS standards, and eco-friendly oil usage requirements. Meeting these standards can be resource-intensive, and delays in certification or testing can restrict market access and postpone project deliveries.
Import Dependence	Heavy reliance on imported raw materials and critical components such as high-grade electrical steel, copper, insulation materials, and advanced tap changers exposes the company to currency volatility, global shipping delays, and supply disruptions. This dependency can increase input costs and threaten production continuity, particularly during geopolitical or trade-related uncertainties.
Margin Pressure	Intense competition from both established multinational manufacturers and low-cost regional players, coupled with rising raw material prices and high customer price sensitivity, continues to put downward pressure on profit margins. This financial strain can limit the company's ability to invest in new technologies, manufacturing automation, and capacity expansion.
R&D Gap	Limited in-house research and development capabilities restrict the ability to design advanced, high-efficiency, or customized transformers tailored to emerging market needs. These are few disadvantages against global competitors that actively invest in innovative designs, smart transformer technology, and digital monitoring solutions.

15 Company Profiling

(Unless the context otherwise requires, in this section, references to "the Company" and "it" refers to Kanohar Electricals Limited and its Subsidiary and an entity under the control of Kanohar Electricals Limited i.e., the AOP, on a consolidated basis.)

Kanohar Electricals Limited is a manufacturer of power transformers, Traction transformers, Scott connected transformer, shunt reactors and high voltage gas insulated switchgear. It manufactures transformers in the range of 400 kV and above, 220–400 kV and 220 kV and below". The company's manufacturing facilities are located in Meerut in Uttar Pradesh. It also undertakes EPC projects for substations and power distribution systems and works on transmission lines.

The company offers comprehensive energy solutions through two primary segments: Manufacturing and EPC (Engineering, Procurement, and Construction). Most of the revenue comes from the Manufacturing segment, which includes Transformers and Gas Insulated Switchgear. Transformers are tailored for industries like Power Transmission, Railways, Renewables, and Distribution, with five distinct types of special application transformers designed with customized technical specifications to meet diverse energy demands. The company has a technical collaboration with Chung-Hsin Electric and Machinery Manufacturing Corp. (CHEM Taiwan), a global player in GIS SF6 technology, since September 2017, whereunder it manufactures and supplies up to 252 Kv Gas Insulated Switchgear (GIS), enhancing the company's technical capabilities. The EPC segment contributes a limited portion of the revenue and focuses on turnkey execution of Sub-Stations and Transmission Lines. The company manufacture transformers across various capacities ranging from < 132 kV to > 400 kV. The company has obtained the short circuit test certification for 500 MVA 400 kV power transformers and 100 MVA, 200 kV and 1000 MVA 132 kV Scott-connected transformers in Fiscal 2024. In particular, as on September 30, 2025, Kanohar is one of five companies in India to have the short circuit test certification for 500 MVA 400 kV transformers that are used in the power transmission industry. Such successful lab testing has positioned it to be among a select group of transformer manufacturers equipped to be eligible and qualify to bid for certain key orders. This is observed from an increase in the sales 500MVA of 400 kV power transformers in FY25 and the recent Rs 5,686.69 mn order for 500 MVA 400 kV power transformers from India's largest electricity transmission company Power Grid Corporation of India Limited (POWERGRID) in June 2025. It is also one of four manufacturers in India who are certified by Research Designs and Standards Organisation (RDSO), the research and development wing of Indian Railways, to manufacture 100 MVA 132 kV Scott transformers. Also, it is one of two Indian manufacturers certified to manufacture 100 MVA 220 kV Scott transformers, both of which cater to the demand for rail network electrification from the Indian Railways.

Kanohar Electricals is one of the leading domestic players in transformer manufacturing in terms of revenue in FY25 and cater to industries such as power transmission, railways, renewable energy, and power distribution. The Company caters to high-growth industries such as power transmission, railways, renewable energy, and power distribution. In power generation and renewable energy, rising demand for reliable and sustainable infrastructure is driving strong expansion. In railways, the government's focus on electrification, modernization, and high-speed corridors is boosting the need for advanced transformers and related equipment. By serving these sectors, the Company may be well-positioned to benefit from sustained growth opportunities and long-term industry tailwinds. Scott-connected transformers, high-voltage power transformers up to 500 MVA, 400 kV, trackside transformers, and 100 MVA, 220 kV Scott transformers have high entry barriers due to large capital investment, advanced technology, and mandatory testing certifications. A key challenge for new entrants in India's transformer manufacturing industry is the high entry barrier, driven by its capital-intensive nature, long facility setup timelines, and the requirement for advanced technical expertise. Some of its key competitors across transformer business verticals include, among others, Bharat Heavy Electricals Limited, CG Power and Industrial Solutions Limited, Hitachi Energy Limited and Schneider Electric Infrastructure Limited.

The company manufactures nearly all types of transformers, but a major share of its revenue comes from power transformers, particularly in the high-voltage segment. In India, many players operate in the transformer industry, but limited number are manufacturing transformers above 400 kV. As a result, competition in the high-voltage transformer space remains limited. The growth of power transmission, railways, renewable energy, and power distribution in India is driving demand for transformers, particularly in the high-voltage category. Power generation, renewable integration, and railway electrification are key growth areas, creating steady requirements for power, traction, and Scott transformers. Also, a significant portion of the revenue comes from government entities, which generally reduces the risk of default, as such contracts are typically backed by approved budgets and structured payment mechanisms.

Business segments and Key Customers

Power transformer – Power transmission

In Power Transmission, the focus is on Power Transformers that efficiently step up or step-down voltage levels across long distances, minimizing energy losses. Key customers include PGCIL, GETCO Gujarat, Rajasthan Transco, MAHATRANSCO, and JKPTCL. This segment benefits from lower payment risks, strong financials, structured tariffs, and pre-financed projects with strict payment mechanisms, supported by robust governance.

Traction and Scott transformer – Railway

In the Railways segment, the company provides Traction and Scott Transformers, which supply power to electric trains and convert three-phase power into two-phase for railway electrification. Customers such as the Central Organisation for Railway Electrification and Blue Star rely on these products for government-backed electrification projects. The market is characterized by steady demand, long-term contracts, and standardized specifications that reduce customization costs.

Shunt reactors – Renewable energy

For the Renewable sector, Shunt Reactors are offered to stabilize voltage, compensate for reactive power, and enhance grid efficiency in wind and solar transmission systems. Major clients include TATA Projects, Vestas, and Suzlon. This segment is driven by rapid growth, favourable government policies, and the need for grid stability amid fluctuating renewable energy supply. s

Distribution

In the Distribution segment, Distribution Transformers are used to step down high-voltage electricity for safe delivery to homes, businesses, and industries. Customers such as NPCL, BPC, and Kuhlman Electric benefit from solutions that support urban and rural electrification. The market sees consistent demand due to infrastructure growth, industrial expansion, and recurring replacement needs, with regulated tariffs ensuring predictable cash flows.

Advantages of the high growth sectors that company cater to:

S. No.	Sector	Advantages
1.	Power transmission	(a) Lower payment risk with transmission utilities; (b) Structured tariffs; (c) Low exposure to consumer defaults; (d) Pre-approved projects and set payment mechanisms; and
2.	Railways	(a) Government backed electrification projects; (b) Steady demand from expanding railway networks; (c) Long term contracts which ensure revenue stability; and (d) Standardized specifications reduce customization costs.

3.	Renewable energy	(a) Rapid growth in renewable energy; (b) Government incentives and policies driving demand; (c) Critical for grid stability in solar and wind power projects; and (d) Ensures efficient power flow in fluctuating renewable energy supply.

16 Operational Parameters

		Kanohar Electricals Ltd			Hitachi energy India Ltd		
Operating Metrics	**Unit**	**FY23**	**FY24**	**FY25**	**FY23**	**FY24**	**FY25**
Annual Installed Capacity	MVA	15,000 MVA	15,000 MVA	19,200 MVA	NA	NA	NA
Order book	Rs in million	5,223.75	5,958.48	8,614.72	70,709.00	72,295.00	192,459.00

		Bharat Heavy Electricals Ltd.			Schneider Electric Infrastructure Ltd		
Operating Metrics	**Unit**	**FY23**	**FY24**	**FY25**	**FY23**	**FY24**	**FY25**
Annual Installed Capacity	MVA	NA	NA	NA	NA	NA	NA
Order book	Rs in million	913,360.00	1,315,980.00	1,963,280.00	10,735.00	12,260.00	12,530.00

		CG Power & Industrial solutions Ltd.			Transformers & Rectifiers India Ltd.			GE Vernova T&D India Ltd.		
Operating Metrics	**Unit**	**FY23**	**FY24**	**FY25**	**FY23**	**FY24**	**FY25**	**FY23**	**FY24**	**FY25**
Annual Installed Capacity	MVA	NA	NA	NA	NA	37,200	40,200	NA	18,000 to 20,000	NA
Order book	Rs in million	44,580.00	64,110.00	106,310.00	s 14,990.00	25,817.00	51,320.00	37,000.00	62,700.00	126,575.00

Note: (TRIL Production capacity for FY24) as per company's QIP document disclosure dates 13 June 2024

Note: Peers such as Hitachi Energy India, BHEL, Schneider Electric, CG Power and GE Vernova offer broad range of equipment and solutions for the power transmission & distribution segment, including transformers and GIS

17 Peer analysis

17.1 Kanohar Electricals Ltd

Kanohar Electricals Limited established in 1981, is a manufacturer of Power Transformers and Gas Insulated Switchgear as per IEC, ANSI, BS and various other standards. It offers up to 500MVA, 500kv transformers. The company is focused on serving quality-conscious customers across diverse sectors: TD Utilities, Power Generation, EPC Contractors, Railways and Industry.

Kanohar Electricals Ltd	FY23	FY24	FY25	H126
Revenue from Operations	3,037.68	2,766.90	4,506.12	1,655.78
Y-o-y Revenue growth	-	-8.91%	62.86%	NA
Total Income	3,069.72	2,811.21	4,572.96	1,706.25
Gross Margin %	23.60%	28.80%	32.51%	43.16%
EBITDA	283.59	310.72	933.92	427.29
EBITDA Margin	9.34%	11.23%	20.73%	25.81%
Profit After Tax	168.09	177.55	651.18	306.71
Profit After Tax Margin	5.48%	6.32%	14.24%	17.98%
ROE	11.06%	10.49%	30.92%	11.86%
ROCE	20.83%	16.69%	47.71%	19.64%
Debt/ Equity	0.15	0.24	0.13	0.15
Debt/ EBITDA	0.83	1.35	0.35	0.97
Net Fixed Asset Turnover Ratio	11.93	11.37	16.76	5.48
Net Working Capital Days	64	124	113	197

Source: Audited Financial Statements

Note: The H1FY26 figures for Debt/EBITDA, net fixed asset turnover, ROE and ROCE are not annualised. Accordingly, these H1FY26 metrics are not directly comparable with the corresponding FY figures of prior periods.

17.2 Hitachi Energy Ltd

Hitachi Energy India Ltd formerly known as ABB Power Products and Systems India Ltd. was created in 2019 as a Joint Venture between Hitachi and ABB's Power Grids. It serves utility, industry, and infrastructure customers with solutions and services across the value chain. The company is engaged in the business relating to products, projects, and services for Power technology. It manufactures and supplies systems, equipment, devices, and accessories products such as disconnectors, cable accessories, electric motors, semiconductors, transformers, and others. The company also provides project and service engineering, installation, commissioning, and support services.

Hitachi energy India Ltd	FY23	FY24	FY25	H126
Revenue from Operations	44,685.10	52,374.90	63,849.30	33,114.50
Y-o-y Revenue growth	-8.51%	17.21%	21.91%	NA
Total Income	44,836.50	52,467.80	64,421.00	34,356.30
Gross Margin %	39.33%	38.54%	42.12%	47.54%
EBITDA	2,359.30	3,489.70	5,958.10	4,632.50
EBITDA Margin	5.28%	6.66%	9.33%	13.99%
Profit After Tax	939.00	1,637.80	3,839.80	3,959.60
Profit After Tax Margin	2.09%	3.12%	5.96%	11.53%
ROE	8.00%	12.72%	13.78%	9.00%

ROCE	12.47%	19.12%	56.40%	248.80%
Debt/ Equity	0.23	0.11	0.00	-
Debt/ EBITDA	1.17	0.43	0.00	-
Net Fixed Asset Turnover Ratio	7.68	8.64	10.73	5.65
Net Working Capital Days	13	15	3	18

Source: Audited Financial Statements
Note: The H1FY26 figures for Debt/EBITDA, net fixed asset turnover, ROE and ROCE are not annualised. Accordingly, these H1FY26 metrics are not directly comparable with the corresponding FY figures of prior periods.

17.3 Bharat Heavy Electricals Ltd.

Bharat Heavy Electricals Ltd (BHEL) is manufacturer of power plant equipment and an engineering company based in India. It provides products and services across various sectors, including power, transportation, energy, oil and gas, defence, and other industries. The company operates through three primary segments: Power (which generates the majority of its revenue), Industry, and International Operations. BHEL's product range includes heavy industrial equipment and components such as turbines, valves, pumps, boilers, and insulators.

Bharat Heavy Electricals Ltd.	FY23	FY24	FY25	H126
Revenue from Operations	2,33,649.40	2,38,927.80	2,83,394.80	1,29,987.10
Y-o-y Revenue growth	10.15%	2.26%	18.61%	NA
Total Income	2,38,535.70	2,44,390.50	2,88,047.90	1,33,444.80
Gross Margin %	30.23%	29.66%	33.50%	29.99%
EBITDA	9,527.30	6,126.00	12,415.70	437.90
EBITDA Margin	4.08%	2.56%	4.38%	0.34%
Profit After Tax	6,541.20	2,822.20	5,339.00	-806.10
Profit After Tax Margin	2.74%	1.15%	1.85%	-0.60%
ROE	2.71%	1.16%	2.17%	-0.33%
ROCE	3.11%	1.45%	3.66%	-0.40%
Debt/ Equity	0.22	0.36	0.36	0.44
Debt/ EBITDA	5.65	14.38	7.08	245.45
Net Fixed Asset Turnover Ratio	9.85	9.71	10.55	4.58
Net Working Capital Days	1	13	59	127

Source: Audited Financial Statements
Note: The H1FY26 figures for Debt/EBITDA, net fixed asset turnover, ROE and ROCE are not annualised. Accordingly, these H1FY26 metrics are not directly comparable with the corresponding FY figures of prior periods.

17.4 Schneider Electric Infrastructure Ltd

Schneider Electric Infrastructure Ltd is an India-based company that is engaged in businesses related to products and systems for electricity distribution. It has a single primary business segment which is products and systems for electricity distribution. The company's products and services include transformers, substations, switchgear, automation systems and products, installation services, switchboard modernization services, and others. Schneider Electric Infrastructure generates almost all of its sales from the domestic Indian market. The majority stake in the company is owned by Indian private company Energy Grid Automation Transformers and Switchgears India Private Limited.

Schneider Electric Infrastructure Ltd	FY23	FY24	FY25	H126
Revenue from Operations	17,771.90	22,066.80	26,367.10	12,717.70
Y-o-y Revenue growth	16.13%	24.17%	19.49%	NA
Total Income	17,893.90	22,159.80	26,612.80	12,805.10
Gross Margin %	32.00%	36.65%	38.16%	38.56%
EBITDA	1,677.10	2,957.50	3,827.70	1,531.40
EBITDA Margin	9.44%	13.40%	14.52%	12.04%
Profit After Tax	1,236.30	1,720.30	2,678.90	935.60
Profit After Tax Margin	6.91%	7.76%	10.07%	7.31%
ROE	132.08%	76.93%	62.44%	15.34%
ROCE	25.87%	41.58%	51.37%	18.02%
Debt/ Equity	3.48	1.40	0.76	0.66
Debt/ EBITDA	3.13	1.40	1.12	2.82
Net Fixed Asset Turnover Ratio	7.65	9.03	10.32	4.94
Net Working Capital Days	39	54	56	64

Source: Audited Financial Statements

Note: The H1FY26 figures for Debt/EBITDA, net fixed asset turnover, ROE and ROCE are not annualised. Accordingly, these H1FY26 metrics are not directly comparable with the corresponding FY figures of prior periods.

17.5 CG Power & Industrial solutions Ltd.

CG Power & Industrial Solutions Ltd is an India based company engaged in providing products, services, and solutions to utilities, industries, and consumers for the management and application of sustainable electrical energy. It has two business segments. Power Systems segment includes products and services from ultra-high-voltage, high voltage, medium voltage and low voltage like transformer, switchgear, and turnkey projects whereas the Industrial Systems segment include rotating machines of power and ratings, automated AC, DC, and variable frequency drives and control systems like electric motors, alternators, drives, traction electronics, and SCADA. It operates in India and internationally.

CG Power & Industrial solutions Ltd.	FY23	FY24	FY25	H126
Revenue from Operations	69,725.40	80,459.80	99,086.60	58,008.40
Y-o-y Revenue growth	27.15%	15.40%	23.15%	NA
Total Income	70,403.00	81,522.40	1,00,708.30	58,924.30
Gross Margin %	30.36%	30.99%	30.10%	30.66%
EBITDA	9,933.20	11,280.70	13,047.30	7,606.90
EBITDA Margin	14.25%	14.02%	13.17%	13.11%
Profit After Tax	7,963.30	8,711.20	9,729.80	5,513.10
Profit After Tax Margin	11.31%	10.69%	9.66%	9.36%
ROE	56.98%	36.22%	27.58%	9.51%
ROCE	91.97%	63.56%	48.26%	13.49%
Debt/ Equity	0.00	0.00	0.00	0.00
Debt/ EBITDA	0.00	0.00	0.00	-
Net Fixed Asset Turnover Ratio	8.54	9.96	11.09	5.46
Net Working Capital Days	9	18	27	34

Source: Audited Financial Statements

Note: The H1FY26 figures for Debt/EBITDA, net fixed asset turnover, ROE and ROCE are not annualised. Accordingly, these H1FY26 metrics are not directly comparable with the corresponding FY figures of prior periods.

17.6 Transformers & Rectifiers India Ltd.

Transformers & Rectifiers (India) Ltd incorporated in 1994, is a holding company that manufactures a range of transformers, switchgears and rectifiers. The firm's products are Transformer including Power Transformer, Distribution Transformer, Furnace Transformer, Rectifier Transformer, Speciality Transformer, and Reactors, Switch gear including Instrument Transformer and Condenser Bushing.

Transformers & Rectifiers India Ltd.	FY23	FY24	FY25	H126
Revenue from Operations	13,959.70	12,946.76	20,193.82	9,893.60
Y-o-y Revenue growth	20.16%	-7.26%	55.98%	NA
Total Income	14,046.57	13,004.92	20,510.85	10,235.90
Gross Margin %	23.14%	28.41%	31.44%	33.42%
EBITDA	1,208.76	1,341.09	3,274.53	1,397.10
EBITDA Margin	8.66%	10.36%	16.22%	14.12%
Profit After Tax	423.45	470.05	2,164.35	1,048.10
Profit After Tax Margin	3.01%	3.61%	10.55%	10.24%
ROE	11.08%	9.75%	23.59%	7.94%
ROCE	14.30%	14.59%	27.63%	8.62%
Debt/ Equity	0.82	0.45	0.22	0.27
Debt/ EBITDA	2.73	1.91	0.86	2.62
Net Fixed Asset Turnover Ratio	9.05	9.13	10.95	4.30
Net Working Capital Days	128	169	106	139

Source: Audited Financial Statements

Note: The H1FY26 figures for Debt/EBITDA, net fixed asset turnover, ROE and ROCE are not annualised. Accordingly, these H1FY26 metrics are not directly comparable with the corresponding FY figures of prior periods.

17.7 GE Vernova T&D India Ltd.

GE Vernova, established in 1957, is in the electric power industry, with products and services that generate, transfer, orchestrate, convert, and store electricity. They design, manufacture, deliver, and service technologies to create a more reliable, secure, and sustainable electric power system, enabling electrification and decarbonization. The company also has high-voltage direct current transmission (HVDC) products, power transformers, switchgear, and grid automation related products and services.

GE Vernova T&D India Ltd.	FY23	FY24	FY25	H126
Revenue from Operations	27,732.20	31,679.10	42,923.00	28,685.90
Y-o-y Revenue growth	-9.55%	14.23%	35.49%	NA
Total Income	28,071.50	31,904.60	43,548.90	29,035.20
Gross Margin %	28.97%	34.41%	40.44%	45.85%
EBITDA	1,015.90	3,189.70	8,187.00	7,840.60

EBITDA Margin	3.66%	10.07%	19.07%	27.33%
Profit After Tax	-14.90	1,810.50	6,083.30	5,906.80
Profit After Tax Margin	-0.05%	5.67%	13.97%	20.34%
ROE	-0.14%	15.64%	40.34%	30.61%
ROCE	3.84%	22.83%	64.03%	60.96%
Debt/ Equity	0.20	0.00	0.00	-
Debt/ EBITDA	2.16	0.00	0.00	-
Net Fixed Asset Turnover Ratio	7.38	8.83	12.36	8.19
Net Working Capital Days	121	110	80	63

Source: Audited Financial Statements

Note: The H1FY26 figures for Debt/EBITDA, net fixed asset turnover, ROE and ROCE are not annualised. Accordingly, these H1FY26 metrics are not directly comparable with the corresponding FY figures of prior periods.

Parameters	
Revenue from Operations	Revenue from Operations
Y-o-y Revenue growth	Current year Revenue from operation / Previous year Revenue from operation -1
COGS	Cost of Material Consumed + Construction Expense + Purchase of Stock in Trade + Changes in inventories of finished goods, stock-in-trade and work-in-progress
Gross Profit	Revenue from Operations - COGS
Total Income	Revenue from Operations + Other Income
Gross Margin %	Gross Profit / Revenue from operations
EBITDA	Profit Before Tax + Finance Cost+ Depreciation and Amortization Expense - Other Income
EBITDA Margin	EBITDA/ Revenue from operations
Profit Before Tax	EBIT - Finance Cost + Other Income
Profit After Tax	Profit Before Tax - Tax expense - Exceptional Items
Profit After Tax Margin	Profit after Tax/ Total Revenue
ROE	PAT/ Average Total Equity (including Non-controlling interest)
ROCE	EBIT/Average Capital Employed,
Debt/ Equity	Total Debt/ Total Equity (including Non-controlling interest)
Debt/ EBITDA	Total Debt/ EBITDA
Net Fixed Asset Turnover Ratio	Revenue from Operations /((Current Year Net Fixed Asset + Previous Year Net Fixed Asset)/2)
Debtor Days	(Average Debtors/ Revenue from operations)*365
Creditor Days	(Average Creditors/ Cost of Goods Sold)*365
Inventory Days	(Average Inventory/Cost of Goods Sold)*365
Net Working Capital Days	Debtor Days + Inventory Days - Creditor Days
Capital Employed	Total equity (Including Non-controlling interest) + Total Debt - Cash and Cash Equivalent - Bank balances other than cash and cash equivalents

Note: EBIT excludes Other Income

2024 – Days taken as 366

PBT calculated before exceptional items

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About:

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