Market Intelligence
& Analytics

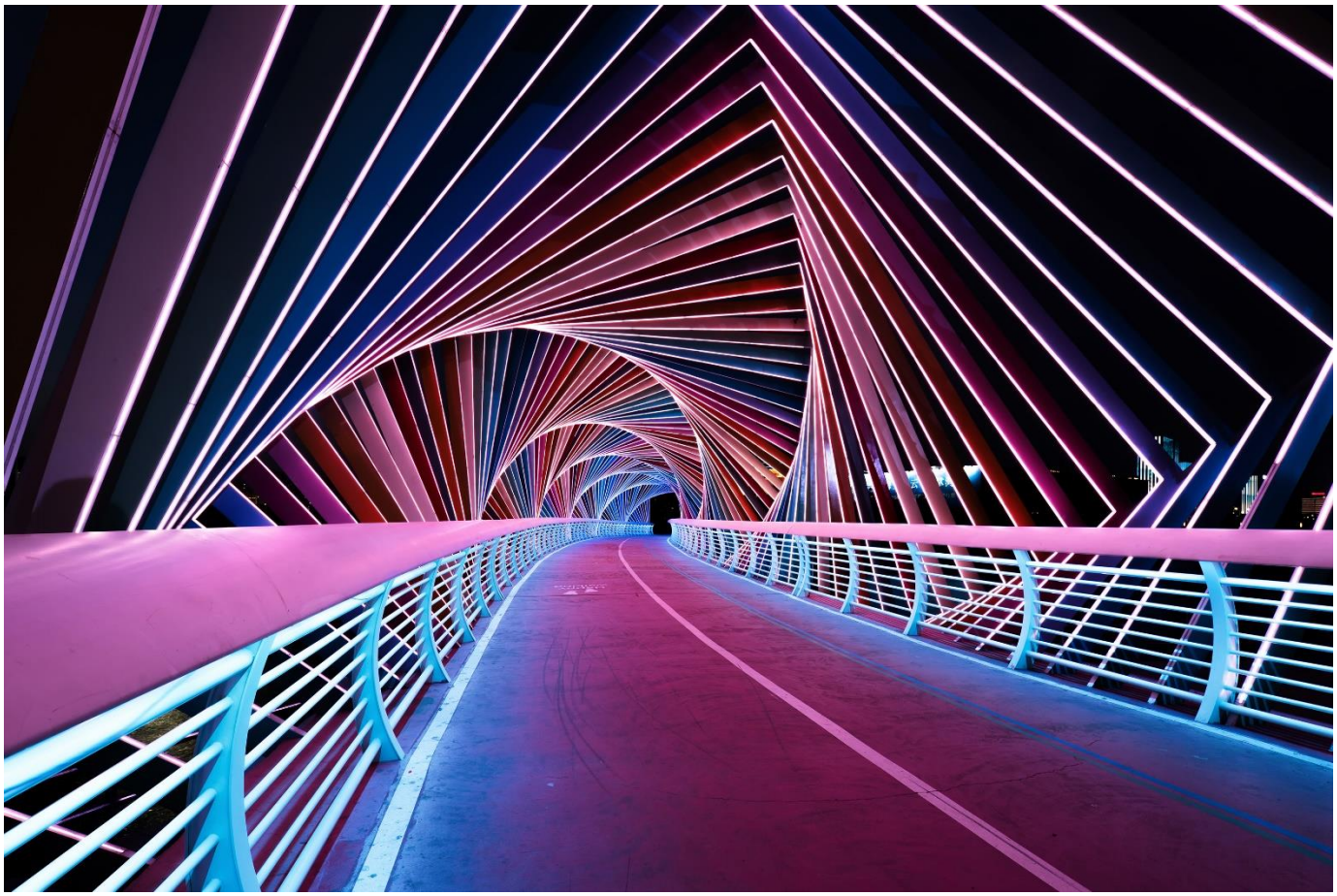
CRISIL
An S&P Global Company

Industry Assessment: Power, Civil Construction, and Poles & Lighting

Transrail Lighting Ltd.

Final report

January 2024



Consulting

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1 Overview of India's macroeconomy

1.1 Economic indicators

As per data released by the National Statistical Office (NSO) in May 2023, India's gross domestic product (GDP) at constant (fiscal 2012) prices was estimated at Rs 160.06 lakh crore in fiscal 2023 vis-à-vis the first revised estimate for fiscal 2022 of Rs 149.26 lakh crore, which translated into a growth of 7.2%. This was slower than the 9.1% growth in fiscal 2022. However, India has overtaken the United Kingdom's economy in terms of size, making it the fifth biggest. In fact, India's GDP growth is estimated to be the highest amongst the top 10 economies.

Table 1:GDP trajectory (% change)

At basic prices	FY18	FY19	FY20	FY21	FY22	FY23E	At market prices	FY18	FY19	FY20	FY21	FY22	FY23E
							GDP	6.8%	6.5%	3.9%	-5.8%	9.1%	7.2%
Agriculture	6.6%	2.1%	5.5%	3.3%	3.5%	4.0%	Private consumption	6.2%	7.1%	5.2%	-6.0%	11.1%	7.5%
Industry	5.9%	5.3%	-1.4%	-3.3%	14.8%	10.0%	Govt. consumption	11.9%	6.7%	3.4%	3.6%	6.6%	0.1%
Manufacturing	7.5%	5.4%	-2.9%	-0.6%	11.1%	1.3%	Fixed investment	7.8%	11.2%	1.6%	-10.4%	14.6%	11.4%
Mining and quarrying	-5.6%	-0.8%	-1.5%	-8.6%	7.1%	4.6%	Exports	4.6%	11.9%	-3.4%	-9.2%	29.3%	13.6%
Services	6.3%	7.2%	6.3%	-7.8%	9.7%	7.2%	Imports	17.4%	8.8%	-0.8%	-13.8%	21.8%	17.1%

E: Estimated
Source: NSO, CEIC, CRISIL Consulting

Trumping Expectations

GDP grew 7.6% on-year in the second quarter compared with 7.8% in the previous quarter. Gross value added (GVA) grew 7.4% compared with 7.8% the previous quarter. Growth was the strongest for industry (13.2%), followed by services (5.8%) and agriculture and allied (1.2%). Within industry, growth improved across segments, with strongest growth in manufacturing (13.9%) and construction (13.3%). In the services sector, growth was highest for public administration, defence and other services (7.6%), followed by financial, real estate and professional services (6.0%), and trade, hotels, transport and communication (THTC; 4.3%). Among demand segments, growth was strongest for government consumption expenditure (12.4%), followed by fixed investment (11.0%). Exports took a positive turn (4.3%). However, private consumption saw the slowest growth (3.1%). Nominal GDP grew 9.1% compared with 8% the previous quarter.

Growth surpassed forecasts in the second quarter, driven by strong government spending and a sharp rise in manufacturing and construction growth. Globally, too, growth beat expectations in major economies such United States (US) and China, contributing to better export earnings for India. However, private consumption was tepid, possibly reflecting hit to agriculture and rural demand.

However, CRISIL Consulting expects growth to slow in the second half of this fiscal, driven by the impact of (1) tightening financial conditions on global growth and exports, (2) weak rains and reservoir levels on domestic agriculture and (3) transmission of the Reserve Bank of India's (RBI) rate hikes to bank lending rates.

Table 2: Industrial segments see strongest growth

Particulars	Demand Side		Particulars	Supply Side	
	Q1 FY24	Q2 FY24		Q1 FY24	Q2 FY24
GDP	7.8%	7.6%	GVA	7.8%	7.4%
GFCE	-0.7%	12.4%	Manufacturing	4.7%	13.9%
PFCE	6.0%	3.1%	Public Administration	7.9%	7.6%
GFCF	8.0%	11.0%	Agri	3.5%	1.2%
Imports	10.1%	16.7%	Mining	5.8%	10.0%
Exports	-7.7%	4.3%	Financial Services	12.2%	6.0%
			Electricity	2.9%	10.1%
			Construction	7.9%	13.3%
			THTC	9.2%	4.3%

Note: GFCE: Government final consumption expenditure, PFCE: Private final consumption expenditure; GFCF: Gross fixed capital formation; GVA: Gross value added; THTC refers to trade, hotels, transport, and communication services; financial services+ refers to financial, real estate and professional services; public ad+ refers to public administration, defence and other services

Source: NSO, CEIC, CRISIL Consulting

Manufacturing and construction lead growth

Among major producing sectors, manufacturing saw the highest growth at 13.9% on-year in the second quarter, a major push from 4.7% in the previous quarter. Resilient domestic demand supported growth, while goods exports were less of a drag relative to the previous quarter. Industrial goods (metals, machinery, infrastructure and construction goods) along with some consumer goods (automobiles and pharmaceuticals) saw highest growth this quarter. Lower input costs on-year (non-food wholesale price index-based inflation averaged -3% in the second quarter) also supported manufacturing GVA.Construction GVA grew (13.3% vs 7.9%) was supported by government capital expenditure (capex) in infrastructure

Services growth slowed (5.8% vs 10.3%) on a high base of the second quarter last year (9.4%).

- Growth in THTC slowed (4.3% in Q2 versus 9.2% in Q1) as the sector caught up with pre-pandemic levels
- Financial, real estate and professional services slowed to 6% from 12.2%. Financial services performed well with strong credit demand. However, services exports growth moderated 4.6%, on average, in the second quarter, compared with 6.0% the previous quarter
- Public administration, defence and other services grew 7.6% vs 7.9%

Agriculture and allied GVA slowed (1.2% vs 3.5%), reflecting monsoon's hit to agricultural output. Kharif output is estimated to be 4.6% lower than last year, based on the government's first advance estimates

Strong government spending keeps domestic demand resilient

Strong government support for consumption and investment: Government final consumption expenditure (GFCE) rose sharply to 12.4% in the second quarter compared with -0.7% in the previous quarter.

Fixed investment, measured by gross fixed capital formation (GFCF), improved (11.0% vs 8.0%). Its share in GDP rose to a fresh decadal high of 35.3%. Government remains the primary driver of GFCF growth this year. Centre's capex grew 26.4% on-year in the second quarter, while states, which contribute more to government spending, grew stronger at 39.4%. Faster growth could also indicate pickup in private sector investment.

Easing external headwinds: Export growth improved to 4.3% in the second quarter from -7.7%. Improving global growth, especially in the US and China alleviated export distress. However, import growth remained strong at 16.7%, following 10.1% growth in the previous quarter, reflecting stronger domestic demand.

Net exports (exports-imports) continued to drag India's GDP growth, but lesser in the second quarter relative to the previous quarter.

Tepid private consumption: Private final consumption expenditure (PFCE) slowed to 3.1% on-year compared with 6% the previous quarter. Rural demand seems to be weaker, based on rising demand for work under National Rural Employment Guarantee Act (NREGA), and lower growth in sales of tractors, two-wheelers and FMCG goods production in the second quarter relative to the previous quarter. Uneven monsoon and stubbornly high food inflation may have hit sentiment in rural areas. Delayed festive season may have also postponed consumption.

However, urban demand may have stayed robust, going by improvement seen in passenger vehicle sales, consumer durables and air passenger traffic. Healthy services sector activity augurs well for urban demand, as it accounts for 61.5% of urban employment[2] . Consumer confidence is on an uptrend, based on the RBI's survey. Retail credit growth remained strong at 18.3%, reflecting modest impact of rate hikes so far.

India, like the US and China, has outperformed growth expectations in July-September 2023. S&P Global revised up its global GDP growth forecast by 20 basis points to 3.3% for 2023 (calendar year), driven by India and China. Expectations of a slowdown due to rising interest rates have been pushed further.

However, downside risks remain on account of the following factors:

Signs of global slowdown: Despite growth being strong in the US so far, S&P has begun to see signs of moderation ahead and a tightening of financial conditions. Growth has already stalled in the eurozone. China continues to face challenges from weak consumer confidence and struggling property sector. Overall, S&P Global expects global growth to slow to 2.8% in 2024. This will weigh on India's export demand in the remainder of this fiscal.

Transmission of the RBI's rate hikes: As the RBI noted in its October monetary policy, bank lending and deposit rates have not increased to the same extent as the repo rate in the current rate hike cycle. It has taken measures to speed up transmission of rate hikes, such as open market sales to reduce excess liquidity, and regulatory measures to temper credit growth (increasing risk weights for unsecured consumer credit and non-bank financial companies). Bank lending rates are already above average seen in the 5 years preceding the pandemic, and further rise in borrowing costs could moderate domestic demand.

Vulnerable rural demand: Rural demand remains vulnerable to weak agricultural output, erratic weather and El Niño this year. While an uneven monsoon hit kharif output, the upcoming rabi crop faces risks from lower groundwater levels. As on November 30, the reservoirs were at only 80% of last year's level. The impact of other rural activities (work demand under NREGA, livestock and fishing) will also have a bearing on rural demand.

Geopolitical risks: Escalation in geopolitical tensions can impact India through spike in crude prices. CRISIL Consulting expects crude prices to range $80-85 per barrel this fiscal.

Government capex is expected to remain a key support to the investment cycle this year. Private investment is also showing signs of pick-up, with rising capacity utilisation in manufacturing.

Downside risks are expected to moderate GDP growth in the second half. Despite this, India will end up outperforming other large economies this fiscal. Overall, CRISIL Consulting expects India's real GDP to grow 6.4% this fiscal, compared with 7.2% last year.

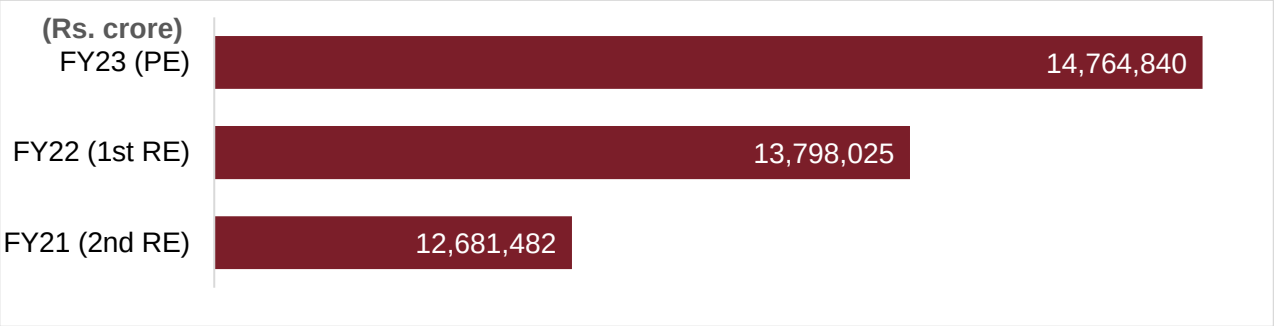
1.2 GVA performance

Real GVA, i.e., GVA at constant (fiscal 2012) basic prices, is estimated to have increased 7% in fiscal 2023.

In fiscal 2022, real GVA had risen 8.8% as against a contraction of 4.2% in fiscal 2021. Growth in the primary sector (comprising agriculture, forestry, fishing, and mining and quarrying), secondary sector (comprising manufacturing, electricity, gas, water supply and other utility services, and construction), and tertiary sector (services) were estimated as 3.9%, 12.0% and 8.8% in fiscal 2022 as against 2.4%, -0.2% and -8.2%, respectively, in fiscal 2021.

The growth in real GVA in fiscal 2022 was on account of growth in mining and quarrying, manufacturing, electricity, gas, water supply and other utility services, construction, trade, repair, hotels and restaurants, transport, storage and communication and services related to broadcasting, and other services. However, agriculture, forestry and fishing, financial services, real estate, ownership of dwelling and professional services, and public administration and defence saw modest growth.

Figure 1: GVA at basic prices



RE: Revised estimates; PE: Provisional estimates

Source: Ministry of Statistics and Programme Implementation, CRISIL Consulting

1.3 India's GDP recovered with subsiding of the pandemic

In the past 10 years (during fiscal 2014 to 2023), India's GDP at constant (fiscal 2012) prices grew at a compounded growth of ~5.6% (CAGR).

After the robust growth in fiscal 2023, a slowdown is inevitable this fiscal because of rising borrowing costs. External demand is expected to weaken with interest rates in the major advanced economies hitting the highest in more than a decade. The rates are expected to peak in the fiscal, hitting both global and domestic demand. S&P Global expects the United States GDP growth to slow to 0.7% in 2023 from 2.1% in 2022 and that of eurozone to 0.3% from 3.5%. These economies account for 33% of the goods exports from India.

While domestic interest rates are rising slower than in advanced nations, bank lending rates have reached the pre-pandemic five-year average. This is expected to moderate domestic demand, particularly in interest-sensitive industries such as housing and automobiles. However, domestic demand this fiscal looks promising due to declining commodity costs and decelerating inflation. CRISIL Consulting expects further support from the government's continuing infrastructure spend.

The key swing factor is monsoon, which has a significant bearing on rural demand. While the India Metrological Department has forecast a normal monsoon, regional and temporal distribution will have a bearing on agricultural output. Downside risks from an expected El Niño remain. Overall, CRISIL Consulting expects India's real GDP to grow 6% in fiscal 2024, compared with 7.2% past fiscal. Nominal growth will see a sharper slowdown to 10.6% from 16.1%, with falling inflation (particularly wholesale) narrowing the gap between real and nominal GDP.

Table 3: CRISIL's key projections

	FY18	FY19	FY20	FY21	FY22	FY23E	FY24P
GDP growth (%)	6.8%	6.5%	3.9%	-5.8%	9.1%	7.2%	6.4%
CPI (%, average)	3.6%	3.4%	4.8%	6.2%	5.5%	6.8%	5.5%
CAD/GDP (%)	1.8%	2.1%	0.9%	-0.9%	1.2%	2.5%	1.8%
FAD/GDP (%)	3.5%	3.4%	4.6%	9.2%	6.7%	6.4%#	5.9%*
Exchange rate (Rs/$ March-end)	65.0	69.5	74.4	72.8	76.2	82.0	83.0

	FY18	FY19	FY20	FY21	FY22	FY23E	FY24P
10-year G-sec yield (%, March-end)	7.6%	7.5%	6.2%	6.2%	6.8%	7.5%	7.0%

Revised estimate, *Budget estimate

E: Estimated; P: Projected; CPI: Consumer Price Index-linked; CAD: Current account deficit; G-sec: Government security; FAD: Fiscal account deficit

Source: CSO, RBI, CRISIL estimates

1.4 Overview of other demographic factors

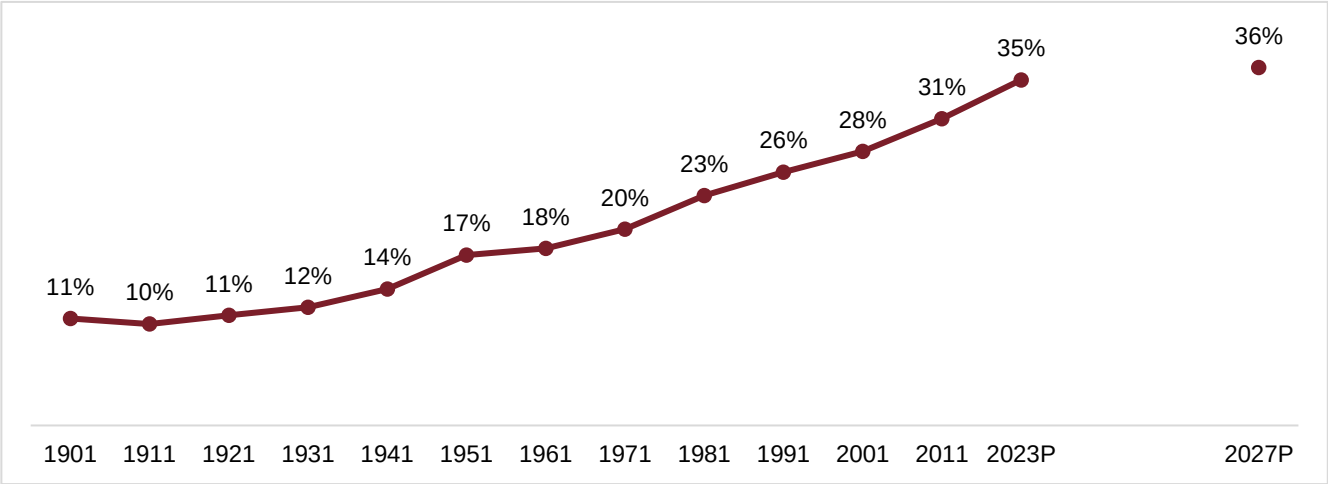
1.4.1 Urbanisation

Urbanisation is one of the big growth drivers, as it leads to rapid infrastructure development, job creation, development of modern consumer services, and mobilisation of savings.

To be sure, the share of the urban population in India in overall population, which stood at ~31% in 2011, has been consistently rising over the years, and is expected to reach 36% by 2027, spurring increasing consumer demand.

Indeed, urban consumption in India has shown signs of improvement. And given India's favourable demographics, along with rising disposable income, the trend is likely to continue and drive the country's economic growth.

Figure 2: Urban population as a % of total population of India



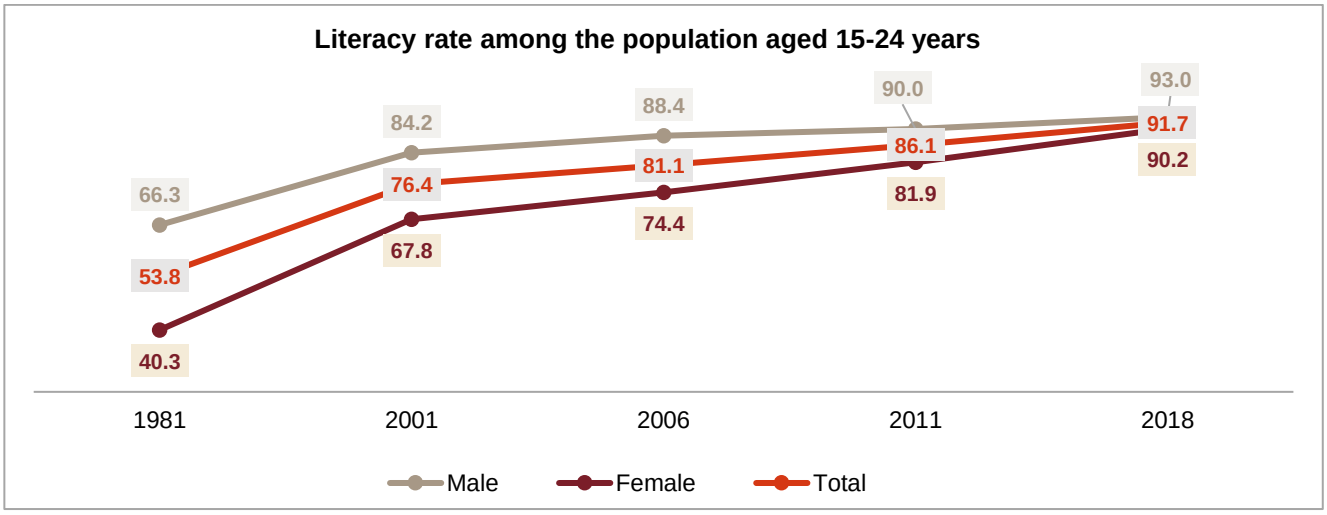
P: Projected

Source: Census 2011, Report of The Technical Group on Population Projections by Ministry of Health & Family Welfare (July 2020), CRISIL Consulting

1.4.2 Literacy

Literacy rate reflects the socio-economic progress of a country. India has experienced continuous growth in youth literacy rate (aged 15-24 years), which rose from ~54% in 1981 to ~90% in 2015. However, the pace of growth has decelerated since 2006. This is because the growth in male literacy rate is slowing; the literacy rate for the female population, though, has continued to rise.

Figure 3: Youth literacy rate of India



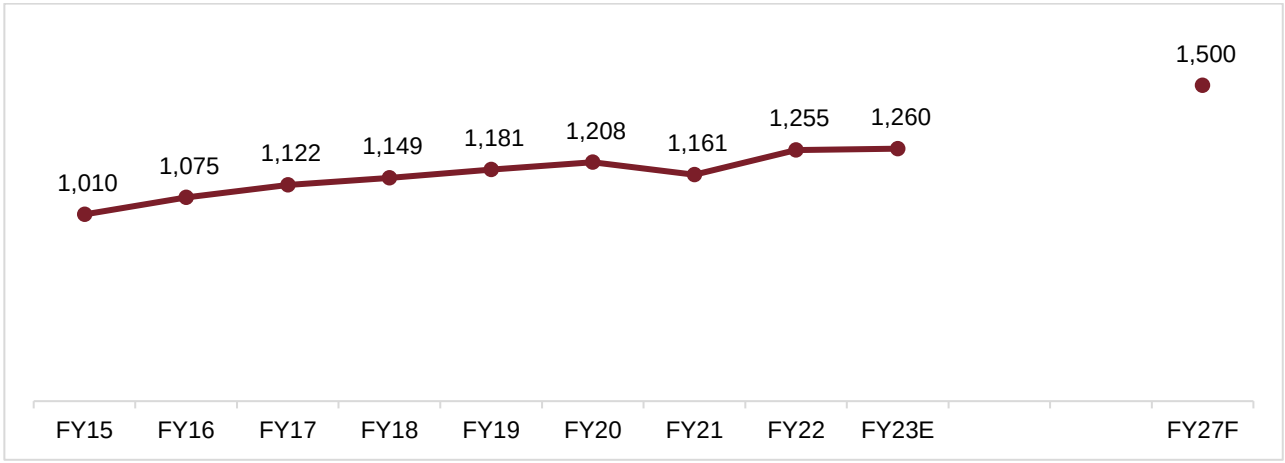
Source: United Nations Educational, Scientific and Cultural Organization, CRISIL Consulting

1.4.3 Per capita power consumption

Electricity consumption per person rose to 1,161 kWh in fiscal 2021 from 1,075 kWh in fiscal 2016 at a CAGR of 1.6%, primarily because of strengthening of the transmission and distribution (T&D) network as well as large capacity additions. Post successive on-year growth in consumption, demand declined in fiscal 2021, particularly from high-consuming industrial and commercial categories on account of weak economic activity following outbreak of the COVID-19 pandemic. In fiscal 2022, though, per capita consumption rebounded to 1,255 kWh on the back of recovery in power demand, with a similar trend estimated in fiscal 2023.

Between fiscals 2022 and 2027, India's per capita electricity consumption is expected to grow at ~4% CAGR. Per capita consumption is expected to gradually improve in the long term as well, as power demand picks up on the back of improvement in access to electricity, in terms of quality and reliability, on account of intensive rural electrification and reduction in cost of power supply, resulting in realisation of latent demand from the residential segment. Consequently, CRISIL Consulting expects per capita electricity consumption to reach 1,500-1,550 kWh by fiscal 2027.

Figure 4: Per capita electricity consumption



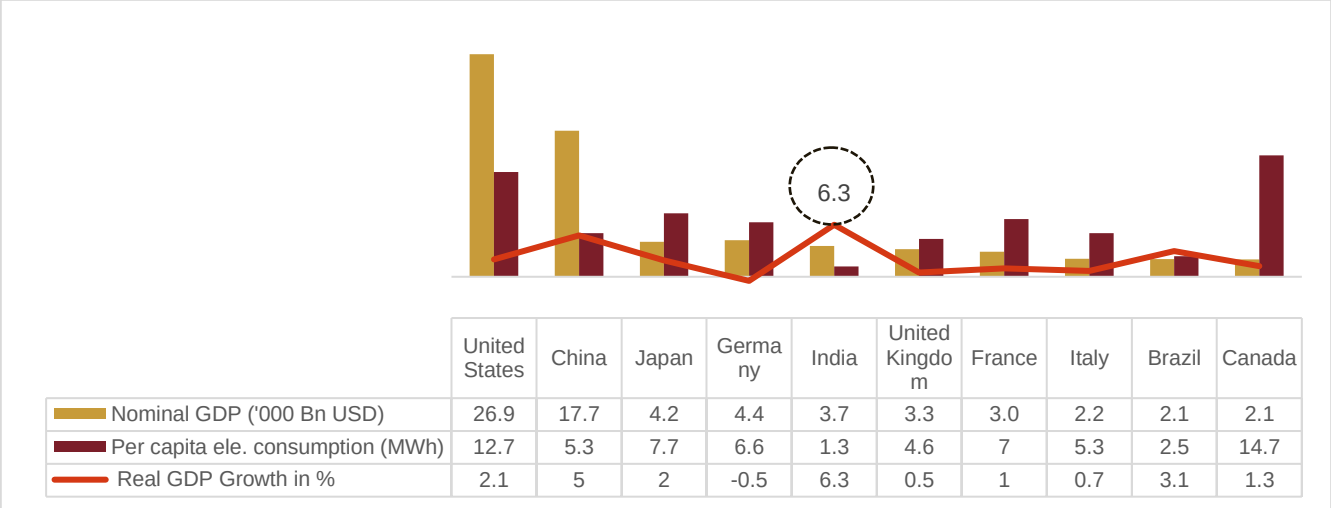
E: Estimated; F: Forecast

Source: Central Electricity Authority of India (CEA), CRISIL Consulting

1.5 Outlook on GDP of major economies

India is projected to be the fifth largest economy in the world in 2023, according to the International Monetary Fund's (IMF) World Economic Outlook (October 2023). As per the said Report, India's GDP growth is estimated to grow at 6.3% in 2023, highest amongst the top 10 economies.

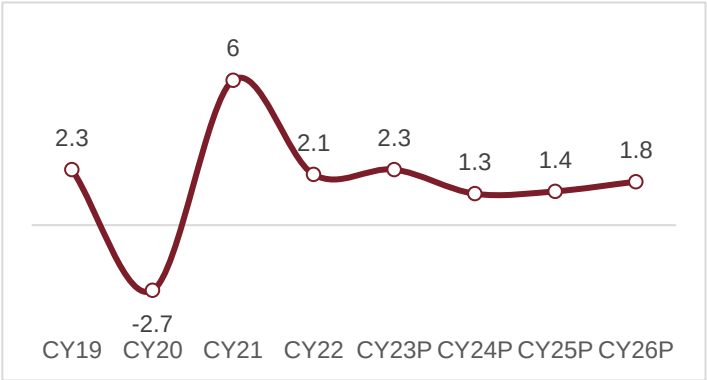
Figure 5: India's economy ranked 5th in the World

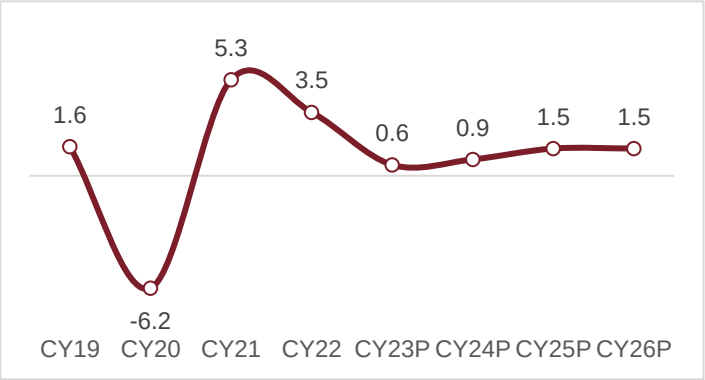
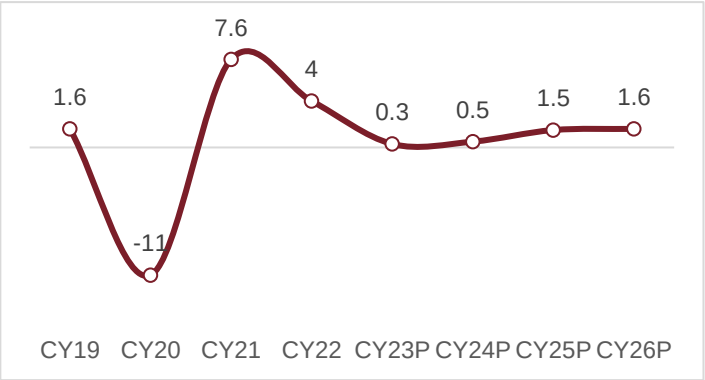
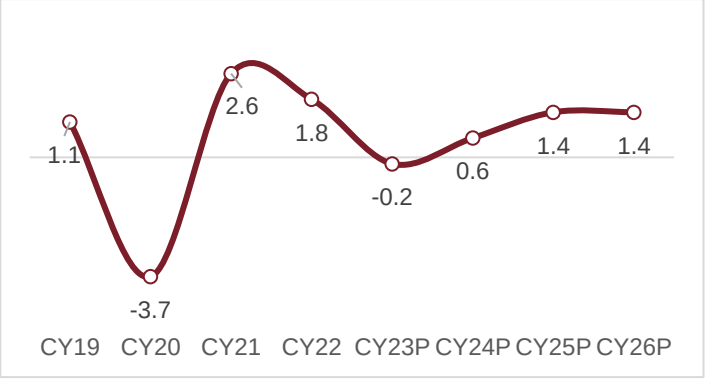


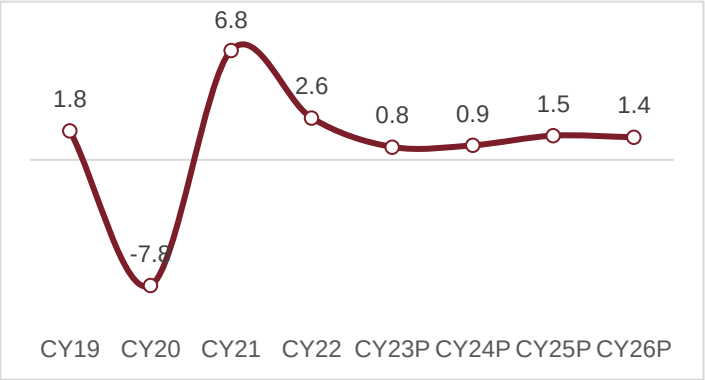
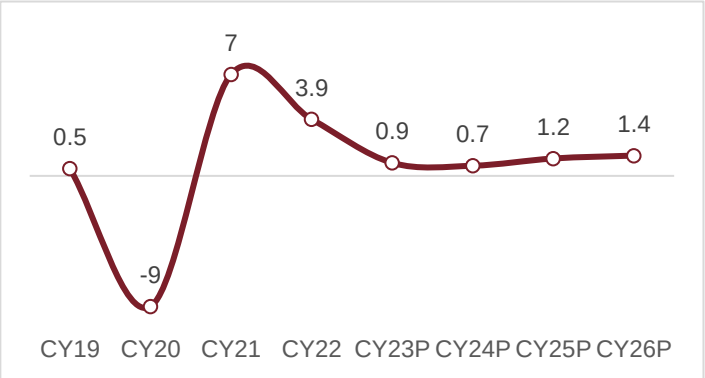
	United States	China	Japan	Germany	India	United Kingdom	France	Italy	Brazil	Canada
Nominal GDP ('000 Bn USD)	26.9	17.7	4.2	4.4	3.7	3.3	3.0	2.2	2.1	2.1
Per capita ele. consumption (MWh)	12.7	5.3	7.7	6.6	1.3	4.6	7	5.3	2.5	14.7
Real GDP Growth in %	2.1	5	2	-0.5	6.3	0.5	1	0.7	3.1	1.3

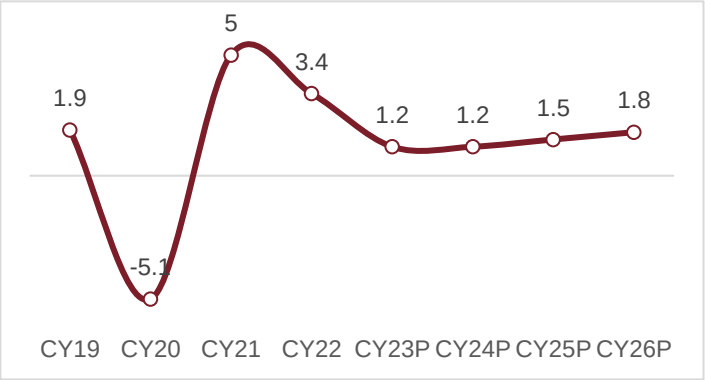
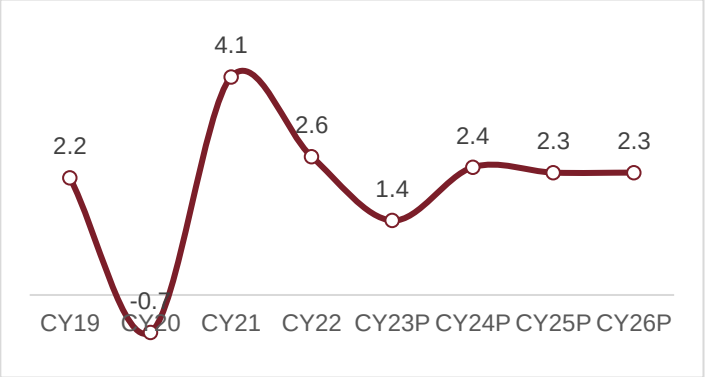
Source: World Economic Outlook Database (October 2023) by IMF; IEA, CEA, CRISIL Consulting

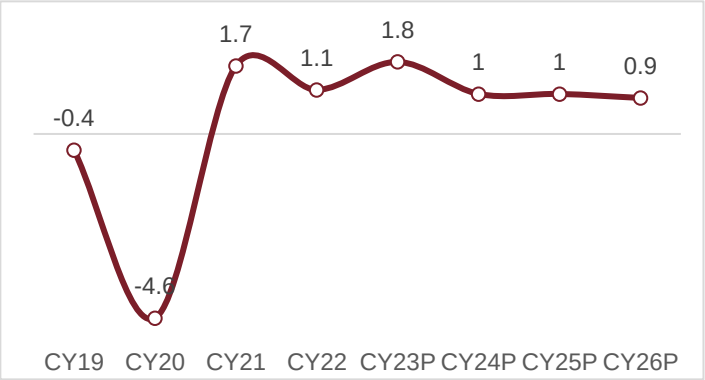
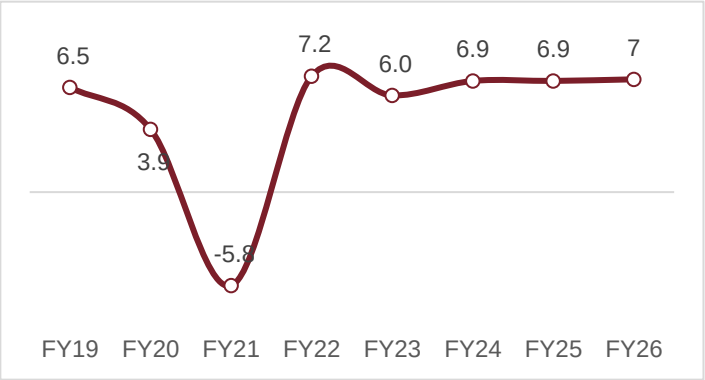
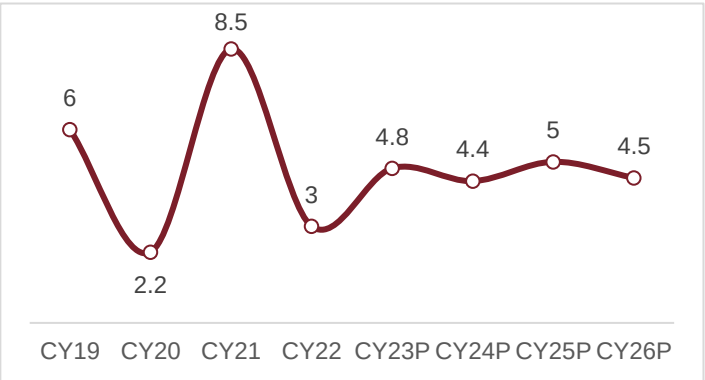
Table 4: Real GDP growth forecast of major economies (figures in %)

USA	Real gross domestic product (GDP) growth in the US slowed in the second quarter of 2023. It grew by an annualized 2.1%, down from a revised 2.2% in the first quarter. Consumer spending, federal government spending and exports were the growth-curbing factors. S&P Global expects US GDP to grow 2.3% in 2023 and 1.3% in 2024. Inflation remained unchanged at 3.7% in September. Energy prices declined 0.5% on year in September, compared with a fall of 3.6% in August. However, inflation in food (3.7% vs 4.3%) and shelter (7.2% vs 7.3%) cooled compared with the previous month. Core inflation, which excludes food and energy, eased to 4.1% from 4.3% in the previous month, the lowest print in the past 2 years.	

Eurozone	S&P Global expects the eurozone to grow 0.6% in 2023. S&P Global's HCOB manufacturing Purchasing Managers' Index (PMI) eased nominally in September to 43.4 from 43.5 in August. The PMI remaining below 50 indicates manufacturing activity contracted in September, the fifteenth straight month of contraction. While services PMI rose compared with the previous month to 48.7 it remained in the contraction zone.	
UK	Quarterly GDP growth in the UK was confirmed at 0.2% in the second quarter of 2023 while GDP growth for the first quarter was revised up to 0.3%. The production sector, which expanded 1.2% aided by falling input cost pressures on manufacturers, boosted second-quarter growth. S&P Global expects the UK economy to grow 0.3% in 2023. Looking at the latest available monthly data, the UK's GDP expanded 0.2% on-month in August after a 0.6% contraction in July. The growth was led by output expanding 0.4% in the services sector. However, output in consumer-facing services fell 0.6%, remaining below pre-pandemic levels. Production (-0.7%) and construction (-0.5%) output contracted in August. S&P Global expects annual growth in the UK at 0.3% in 2023.	
Germany	Germany's real GDP grew 1.8% in 2022 as rising demand, particularly in services, helped partially negate the effects of high inflation. However, in the third quarter of 2022, investment and private consumption could not reach pre-pandemic levels, leading to decrease of 0.2% in real GDP in the fourth quarter of 2022. Despite some resurgence in the economy,	

	Germany is expected to see a mild contraction in the first quarter of 2023 due to higher energy prices. Additionally, because of lack of foreign demand, export is also expected to slow down.	
France	France's real GDP grew 2.6% in 2022 against a backdrop of subsiding of challenges heaped by the pandemic. However, the economy slowed down in the second half of 2022 owing to accelerated energy and commodity prices, along with supply chain disruptions. Nevertheless, expected cooling of inflation will assist in a gradual recovery in the second half of 2023, with growing momentum in domestic demand and international trade, supported by rising private consumption. Consequently, Germany's real GDP is projected to grow at a moderate 0.8% in 2023.	
Italy	Italy's real GDP rose 3.9% in 2022, largely driven by domestic demand. However, higher energy prices put the brakes in the second half, slowing down private consumption and investments. In 2023, economic activity is expected to progress at a tepid pace on account of lower household consumption, and expiry of tax rebates on transport fuels and government support measures to boost household income. That said, the economy is expected to revive in the second half with improvement in consumer spending and acceleration in public investment projects, which is part of the government's recovery and resilience plan. Hence, GDP is expected to still grow, albeit at a modest, ~0.9% in real terms in 2023.	

Canada	Canada's economic growth stalled in the second quarter after a strong rebound in the first quarter suggesting the economy is losing steam. Part of the weakness in the second quarter can be attributed to transitory factors including the federal government workers strike in April and wildlife related disruptions in mining sector output. Household spending appeared to be declining particularly the durable goods offsetting the highest spending on semi durable and non-durable goods. In addition, services spending which had been resilient previously slowed in the second quarter. As a result, S&P global revised down its full year 2023 forecast for Canada to 1.2% given a mild contraction in the second quarter.	
South Korea	Excellent healthcare management and supportive policies helped South Korea's economy rebound rapidly in 2022 from the fallout of the COVID-19 pandemic. However, the country's real GDP, which rose 2.6% in 2022, is forecast to grow a slower 1.4% in 2023. In fact, South Korea's economic output shrank 0.4% in the fourth quarter of 2022 from the previous quarter, owing to contraction in manufacturing and exports amid a global economic slowdown. For 2023, private consumption and investment will continue to face challenges on account of weakening disposable income and a sluggish housing market. Inflation and higher interest rates will likely check private consumption, and lower global demand will impact exports.	

Japan	S&P Global expects Japan to grow at 1.8% in 2023. The au Jibun Bank Manufacturing PMI inched down to 48.5 in September from 48.6 in August, the fourth straight month of contraction. Input prices rose due to rising global crude oil prices. Services PMI, on the other hand, remained in the expansionary zone at 53.8, although it eased compared with the previous month.	
India	Year-on-year GDP growth picked up in the second quarter in both developed and emerging Asian economies. India led again, with GDP growing 4.2% quarter on quarter to a level 7.8% up on a year ago. Notwithstanding the strong expansion in India in the June quarter, S&P Global maintained forecast for fiscal 2024 (ending March 2024), given the slowing world economy, the delayed effect of rate hikes etc.	
China	Growth in China slowed to 4.9% on-year in the third quarter of 2023 from 6.3% in the previous quarter. However, this was due to a supportive base in the second quarter since several major Chinese cities were under lockdown in the second quarter of the previous year. On-quarter growth accelerated to a seasonally adjusted 1.3% from 0.8% in the second quarter. S&P Global expects China to grow 4.8% in 2023. The National Bureau of Statistics manufacturing PMI rose to 50.2 in September from 49.7 in August. This is the first time the manufacturing PMI has risen above neutral 50. The non-manufacturing PMI also rose, to 51.7 from 51 in August.	

P: Projected

S&P Global Economic Outlook (Q4 2023); September 27, 2023, CRISIL Consulting

1.6 Outlook on inflation, interest rates, balance of payment, and currency

1.6.1 Inflation

CPI inflation cooled to 5% in September from 6.8% in August and its 7.4% peak in July. The elevated inflation since July — and also the relief in September — were led by volatility in vegetable inflation, which rose to 37.4% in July and fell to 3.4% in September. Some softness in milk inflation and continued deflation in edible oils also aided the decline in headline inflation. There was comfort from non-food inflation components, which have stayed benign so far, supported by a high base of 6.2% in September 2022 and lower raw material costs.

First, not all the components of food inflation provided comfort. Inflation in pulses surged to 16.4% and in cereals, was uncomfortably high at ~11%, reflecting adverse impact from weather shocks. Further, inflation in pulses, eggs, meat and fish rose to 8.3% in September from 6.8% in August, a low of 0.8% in March. Second, rising oil prices — fueled by the Middle East conflict — can pressure, or at least limit, the easing in non-food inflation components, which played a crucial role in lowering headline inflation. Government intervention (such as the recent cuts in liquefied petroleum gas (LPG) prices), however, can cushion the impact.

Inflation for the September quarter rose to 6.4% — as predicted by the RBI — from 4.6% in the June quarter. For the December quarter, CRISIL Consulting expects food inflation to soften, helped by the kharif harvest entering the market and government intervention in food prices. However, inflation in pulses and cereals could see limited respite; further, oil could play spoilsport if the Middle East conflict escalates.

Food inflation plummets, led by vegetables

Food inflation eased to 6.6% from 9.9% a month prior, led by vegetables and cereals. Vegetable inflation, the main driver of food inflation over the past few months, nosedived to 3.4% from 26.1%. Inflation in tomato prices, which was in triple digits in July and August, turned negative in September at -21.5%, and in potatoes, carrots, leafy vegetables, brinjal, and cauliflower, decelerated. In contrast, in onions, it accelerated to 35.8% from 23.3%. Inflation in cereals eased to 10.9% from 11.9% as inflation eased in both rice (11.9% vs 12.5%) and wheat (7.9% vs 9.3%) from non-PDS sources. Inflation in proteins hardened to 8.3% from 6.8% and rose across major categories, including pulses (16.4% vs 13%) — led by higher inflation in arhar (37.3% vs 32.3%) and moong (11.2% vs 9.3%) — meat and fish (4.1% vs 3.7%), and eggs (6.4% vs 4.3%). Inflation in milk eased to 6.9% from 7.8%. Inflation in spices remained high, easing nominally to 23.1% from 23.2%.

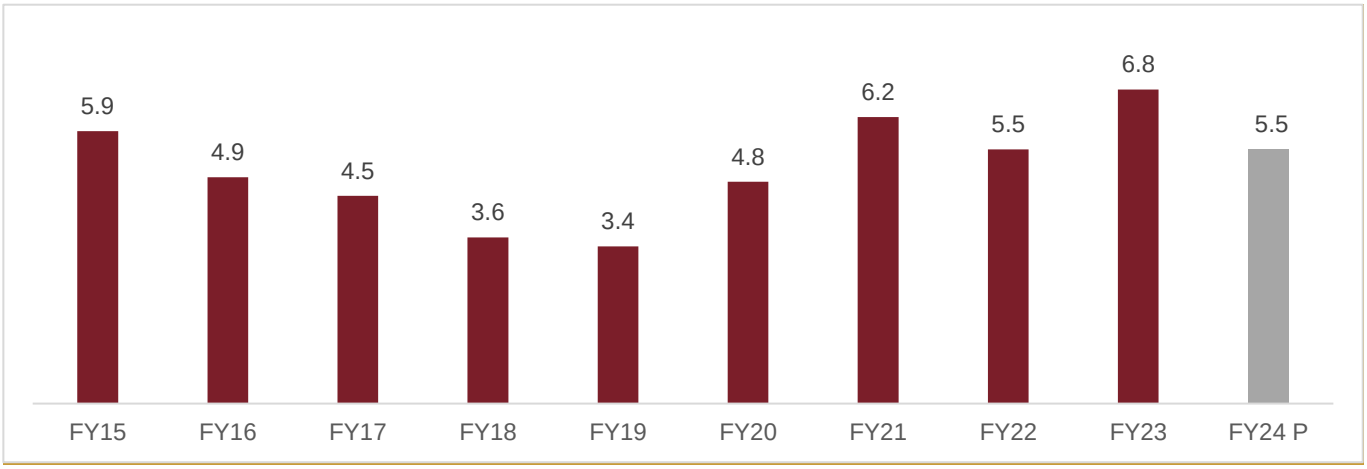
Fuel inflation turns negative

Despite the rise in international crude oil prices, domestic fuel inflation (CPI fuel and light) eased sharply in September, moving into the deflation zone, to -0.1% in September from 4.3% in August. The moderation in fuel inflation was backed by a sharp fall in LPG inflation (-12.7 vs 4.2%), due to the central government cutting LPG prices by Rs.200 per cylinder effective August 30. Electricity inflation, which has emerged as a major pressure point for fuel inflation this fiscal, also cooled in September to 11.2% from 13.5% the previous month. Inflation hardened in kerosene from both PDS (-17.3% vs -25.1%) and non-PDS sources (19.1% vs 17.3%).

Core inflation eases

Core inflation (CPI excluding food and beverages, and fuel and light) cooled to 4.5% from 4.9% in August. Inflation in essential categories such as health (5.9% vs 6.2%), education (5.3% vs 5.5%) and housing (4% vs 4.4%) eased compared with July. Inflation also eased in the transport and communication category (2.3% vs 2.5%) and clothing and footwear (4.6% vs 5.2%). Inflation in the personal care and effects category hardened to 8.5% from 8.1% as inflation accelerated in gold (17.6% vs 15.1%) and silver (24.7% vs 20.8%).

Figure 6: CPI inflation (%, y-o-y)



P: Projected

Source: NSO, CEIC, CRISIL Consulting

CRISIL Consulting expects the RBI to look through the September quarter hump but stay vigilant since headline inflation remains much above its Monetary Policy Committee's (MPC's) 4% target and risks are on the upside due to oil prices.

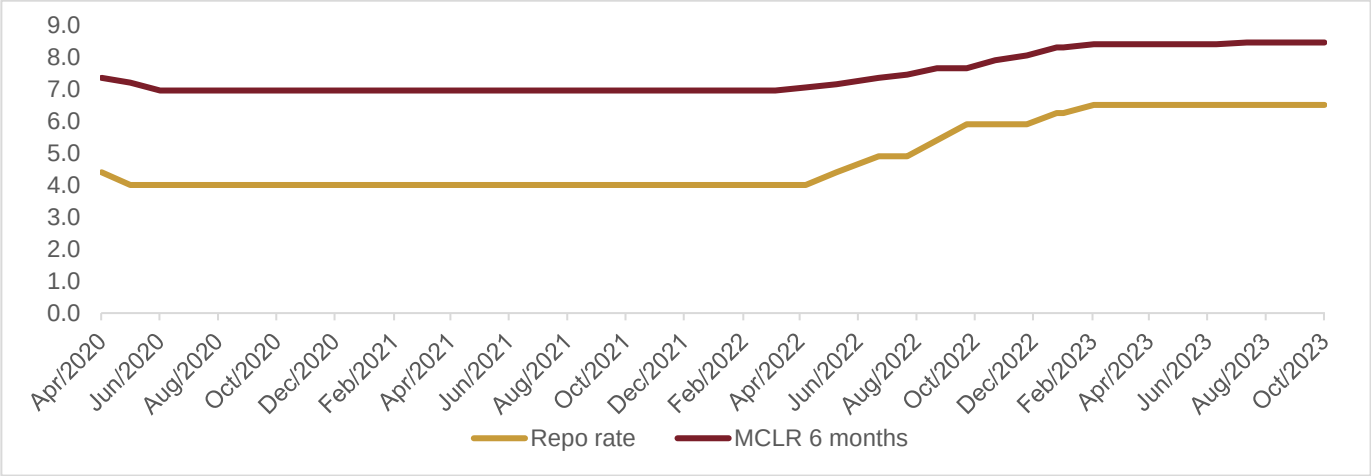
Uneven distribution of rainfall during the monsoon season, rising crude oil prices and tight global food supplies pose upside risks to inflation this fiscal. However, easing input cost pressures for manufacturers and moderating domestic demand are expected to ease core inflation. In the base case, CRISIL Consulting expects inflation to average 5.5% and MPC to maintain the policy rate and stance.

1.6.2 Interest rates

The MPC of the RBI kept the repo rate unchanged for the fourth straight time at its latest meeting. The MPC remained cautious on inflation, which is facing supply-side risks from elevated food prices. It also highlighted the need to be vigilant on volatility in the global financial markets. Resilient domestic growth and incomplete transmission of past rate hikes compelled the MPC to retain its 'withdrawal of accommodation' stance as well.

The MPC voted unanimously to keep policy rates unchanged. The repo rate remains at 6.50%, standing deposit facility at 6.25%, and marginal standing facility at 6.75%. The committee also voted with a 5-1 majority to keep the 'withdrawal of accommodation' stance. The MPC sees food items such as cereals, pulses and spices remaining under pressure. The prices of spices are also expected to be elevated on demand-supply mismatch. The impact of uneven monsoon is a risk for kharif production, especially for pulses and oilseeds, wherein sowing was lower on-year. Rabi production, too, faces risk from low reservoir levels. On the global front, food supplies face headwinds from the ongoing El Niño, with India dependent on palm oil supplies from Indonesia and Malaysia. However, non-food inflation is expected to cool, as lower commodity prices on-year reduce pressure on manufacturers to hike retail prices. Overall, the MPC maintained a forecast of CPI-based inflation at 5.4% this fiscal.

Figure 7: Trend in interest rates (%)



Source: RBI, SBI, CRISIL Consulting

The MPC is understandably staying on the sidelines as it awaits signals on inflation from noisy food prices. While monetary policy cannot control supply-side shocks to food inflation, it needs to watch out for risks from persistently elevated food prices, which can generalise inflation pressures. Food, which comprises 39% of the CPI basket, has a significant bearing on the purchasing power and inflation expectations of consumers in India. The impact of monsoon on kharif production will be watched closely, amid double-digit inflation in cereals and pulses.

Further, rising crude oil prices are a risk to inflation expectations. While global slowdown in the second half this year is likely to soften crude oil prices, supply disruptions will be monitorable. In India, the government's crude oil price management and passthrough by oil marketing companies to consumers will influence inflation.

Global slowdown will moderately hit India's GDP through falling growth in exports. Domestic interest rates have risen to a lesser extent vs. advanced economies. The RBI's rate hikes since April 2022 have not significantly affected domestic demand so far, as credit offtake remains at decadal highs. CRISIL Consulting expects domestic demand to be mildly impacted by lagged transmission of rate hikes in the second half of this fiscal.

1.6.3 Debt

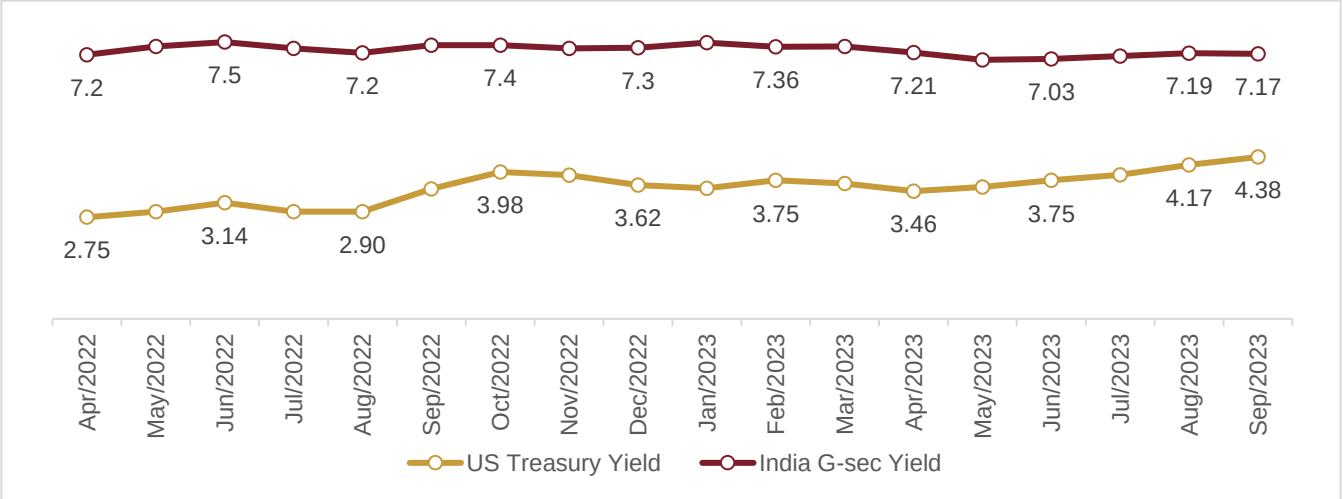
Upside pressure on the 10-year government bond yield continued in September. The benchmark G-sec (7.18% GS2033) yield averaged 7.17% during the month, almost unchanged from 7.19% in August. However, on end-month basis, the yield was up at 7.21% from 7.17%.

The domestic G-sec yield tracked higher United States Treasury yields and a sharp rise in crude prices, thus coming under pressure. Moreover, it was volatile through the month, with some favourable events pushing yields down on occasion. The domestic 10-year G-sec yield firmed up in the first week of September, approaching the 7.20%-mark, moving with the rise in the US Treasury yield and oil prices. Both Saudi Arabia and Russia extended their voluntary oil supply cut till the year-end, leading to a spike in crude. Brent spot went above $90/barrel for the first time since November 2022. It averaged $94/bbl in September 2023, up from $86.2/bbl in August 2023

Subsequently, India's inflation data revealed retail or CPI inflation had cooled to 6.8% in August from 7.4% in July. The softening had a sobering effect on domestic yields, which were pulled down to a low 7.10% and thereafter remained stable for a while around 7.15%. Even the exuberance resulting from the announcement that Indian government bonds would be included in the JP Morgan GBI-EM from June 2024 could not help keeping domestic bond yields low for long. They were pushed up after the US Federal Reserve's dot plot indicated higher interest rates for longer, because of which US treasury yields shot up. As a result, the domestic 10-year G-sec yield reached a high of 7.24% on September 28, before ending the month at 7.21% on September 29.

Amid the rising US Treasury yield, foreign portfolio investment (FPI) inflows to the Indian debt market dwindled. Net inflow fell sharply to $114 million in September, from $934 million in August. Liquidity was in deficit, with the RBI net injecting Rs 0.2 billion under the liquidity adjustment facility in September, as opposed to an average net absorption of Rs 1.4 billion in the previous three months. This was also unfavorable for bond yields, more so at the short end but also at the long end to some extent.

Figure 8: Yield remained under pressure in September as well



Source: RBI, US Department of the Treasury, CRISIL Consulting

Meanwhile, the RBI released the calendar for issuance of dated Government of India securities between October 1, 2023, and March 31, 2024. The amount declared, at Rs 655,000 crore, was as per the budgeted estimate. The central bank said a new 50-year dated security would be introduced to cater to demand in the Ultra Long space.

In the US, the 10-year Treasury yield increased sharply, rising for the fifth consecutive month on average to 4.38% in September, from 4.17% in August. This rise was on the back of the Fed indicating higher rates for longer in its September policy review even as it held rates steady. In fact, the 10-year US Treasury yield ended September at 4.6%, the highest level since October 2007.

The gap between the two benchmarks narrowed sharply to a multi-month low (and fell below the 3% mark) of 2.79% in September from 3.02% in August and 3.73% in September last year. The convergence means foreign capital flows could potentially move away from India (for that matter any emerging market) and into the US markets.

Yields are expected to ease by fiscal-end following the pause in rate hikes, lower inflation and fiscal consolidation moves. CRISIL Consulting expects the CPI-based inflation to be lower this fiscal, averaging 5.5% compared with 6.7% in fiscal 2023. Brent crude is expected to average $80-85 per barrel this fiscal, compared with $95 per barrel in the previous year since global growth will likely slow. That said, there is an upside to this call since oil prices have firmed up sharply in the past few weeks on account of supply cuts and the Middle East conflict.

With the Union Budget 2023-24 giving a thrust to fiscal consolidation and boosting growth via capex, the government's gross borrowing is expected to rise at a slower pace (8.4%) than nominal gross domestic product (GDP) growth (10.5%). In line with this, the budget aims to reduce fiscal deficit to 5.9% of GDP this fiscal

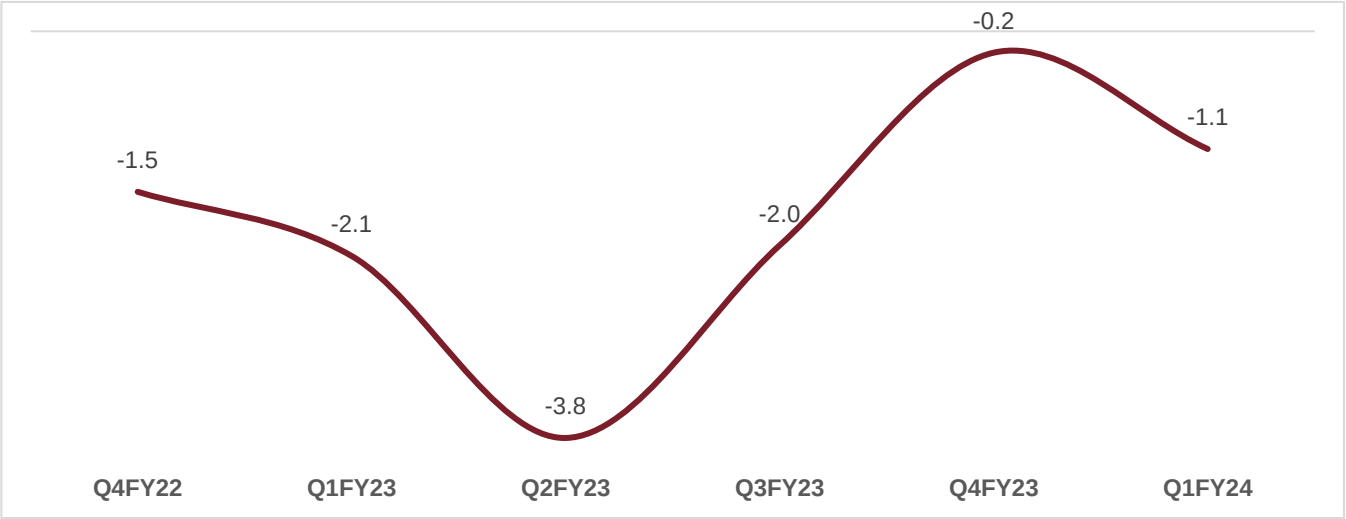
Inclusion of Indian government bonds in the JP Morgan emerging market index from June 2024 should also gradually help soften domestic yields. Given all this, CRISIL Consulting expects the 10-year G-sec yield to settle at ~7.0% by March 2024, compared with 7.4% in March 2023.

1.6.4 Balance of payment

India's current-account deficit (CAD) rose to 1.1% of GDP in Q1 FY24 from 0.2% of GDP previous quarter. Rise in merchandise trade deficit and softening in services trade surplus were largely behind it. Financial flows were more than sufficient to finance the CAD. While India's CAD narrowed on-year, it rose sequentially in the first quarter of this fiscal, thanks to a rise in merchandise-trade deficit and lower surplus in services trade. Secondary income surplus, largely reflecting remittances, declined as well. Financial flows also went up significantly and were more than sufficient to fund CAD, leading to an accretion in foreign exchange reserves. The uptick in financial flows was largely a result of surge in foreign portfolio investments (FPI), and other investments (largely banking capital), even as foreign direct investment (FDI) softened a bit. While the CAD remains manageable, the current uptick in oil prices means some upside pressure going ahead.

India's CAD rose to $9.2 billion (1.1% of GDP) in the first quarter (Apr-Jun) of fiscal 2024, from $1.3 billion (0.2% of GDP) in the fourth quarter of fiscal 2023. That said, CAD was down from $17.9 billion (2.1% of GDP) in the first quarter of fiscal 2023.The sequential rise in CAD was a result of a) rise in goods trade deficit to $56.6 billion from $52.6 billion in the fourth quarter as exports declined at a greater pace than imports with the latter reflecting resilience in the domestic economic activity, b) fall in services trade surplus to $35.1 billion from $39.1 billion, largely on account of the deficit in travel services as Indians spent abroad more than vice versa during the quarter, and c) secondary income surplus, which largely reflects personal transfers (which includes worker remittances) from abroad, came down to $22.9 billion from $24.8 billion. Decline in personal transfers remains monitorable, especially amidst slowing global growth as this is an important component that compensates a part of the deficit in the merchandise trade thereby keeping CAD in check.

Figure 9: CAD went up in the first quarter (% of GDP)



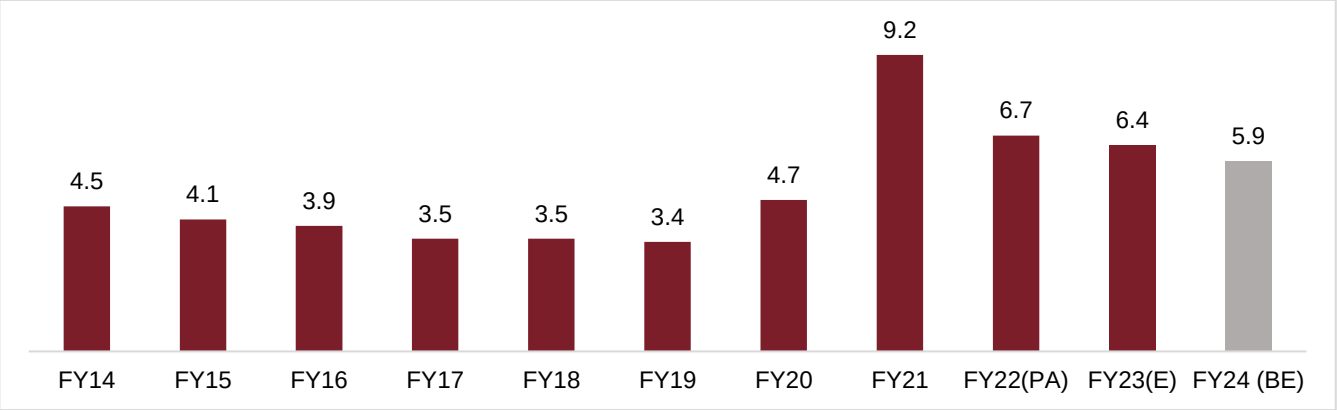
Source: RBI, CRISIL Consulting

The decline in services trade surplus during the first quarter seems to have got corrected in the second quarter and is likely to remain healthy going ahead. However, decline in personal transfers will need monitoring, especially as global growth is expected to slow down. The recent uptick in oil prices will also weigh on merchandise trade deficit. Brent spot has already crossed $95/bbl from an average $86.2/bbl in August. Together, these have put an upside to our CAD call of 1.8% of GDP for this fiscal. At the same time, given weakening global growth and tighter monetary policies in advanced economies, financial flows are expected to be volatile. CAD should be manageable and its financing is unlikely to be a major concern if there are no major setbacks on oil and remittances.

1.6.5 Fiscal deficit

Owing to the pandemic, India's fiscal deficit was pushed way above average over the past few years. However, timely interventions and prudent responses led to a decline in fiscal deficit. During fiscal 2021, the deficit reached 9.2% of GDP largely owing to the pandemic. However, the deficit moderated to ~6.7% of GDP in fiscal 2022 and was budgeted to reach 6.4% of GDP in fiscal 2023, which is still much higher than its historical range of 4-4.5%. This is in line with the path envisaged by the government of India (GoI) with careful fiscal management supported by buoyant revenue collection over the past two years.

Figure 10: Fiscal deficit (% of GDP)



E: Estimates, PA: Provisional Actuals; BE: Budget Estimates

Source: Economic Survey 2022-23; CRISIL Consulting

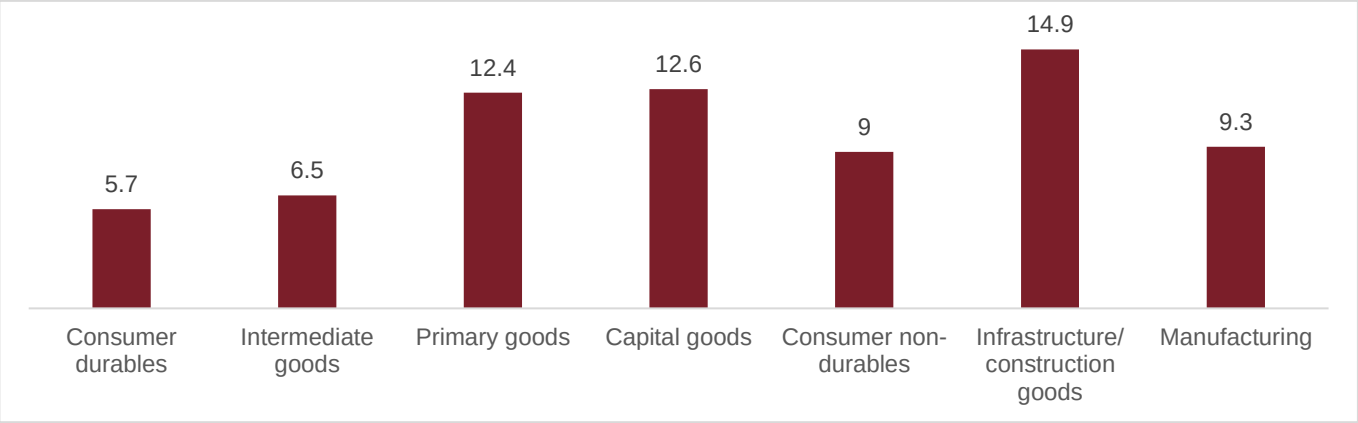
Union Budget 2023-24 provided a positive surprise for the G-sec market. Announcements of fiscal consolidation and growth push via capex are expected to see the government's gross borrowing increase at a slower pace (8.4%) vis-à-vis nominal GDP growth (10.5%). Accordingly, the budget has targeted to reduce the Centre's fiscal deficit to 5.9% of GDP in fiscal 2024.

1.6.6 Index of industrial production

IIP rose 10.3% on-year in August compared with 6.0% the previous month and -0.7% a year ago. All major sectors recorded improvement: mining rose 12.3% in August (vs 10.7% the previous month), manufacturing 9.3% (vs 5.0%) and electricity 15.3% (vs 8.0%). Within manufacturing, infrastructure and construction goods once again saw the strongest growth — 14.9% (vs 12.4%). It was followed by capital goods (12.6%), primary goods (12.4%) intermediate goods (6.5%) and consumer durables (5.7%). Sequentially, IIP grew 1.4% on a seasonally adjusted basis. Electricity saw the strongest sequential growth, followed by mining and manufacturing. Overall, IIP growth has been higher in the second quarter so far (8.2% in July-August), compared with 4.7% in the first quarter.

IIP growth in infrastructure and construction goods was the strongest, rising 14.9% on-year in August from 12.4% the previous month. Government capex remained strong — 29.9% higher on-year for the Centre and 27.6% for 16 major states.

Figure 11: Industrial goods clock highest growth



Source: National Statistics Office, CEIC, CRISIL Consulting

Industrial activity in the country is expected to slow in the coming months. S&P Global's PMI for domestic manufacturing moderated to 57.5 in September from 58.6 the previous month. Among other high frequency indicators, e-way bills slowed in September, but railway freight and auto sales recorded higher growth. That said, India's industrial activity has been stronger than other major economies. S&P Global PMI manufacturing was lower for the United States (US) at 49.8 in September, Eurozone at 43.4 and China at 50.6. PMI reading above 50 indicates expansion and below 50, contraction.

The external environment will be a bigger drag on domestic industrial growth, as western advanced economies slow in the second half. Interest rates are expected to stay higher for longer, with no rate cut expected in the US and Europe before 2024 second half. Rising crude oil prices amid fresh geopolitical flare-ups have given rise to renewed risks of heightening inflationary pressures. Manufacturers are also likely to see their input costs spiralling.

Domestic demand may remain supportive of growth. The latest RBI survey shows consumer confidence reaching a four-month high in September. Manufacturers remain highly optimistic about the demand conditions, while bankers expect further improvement in loan demand in the second half of the fiscal.
However, monsoon remains a risk to rural demand. With the rains extremely uneven this year and ending 6% below the long period average, kharif sowing has been mixed across crops. While sowing of paddy, sugarcane and coarse cereals was higher, that of pulses and oilseeds was lower. Rabi output also faces risks from low reservoir levels.

Also, the impact of the RBI rate hikes, which typically transmits with a lag, will likely play out in the second half this year. Due to these factors, CRISIL expects GDP growth to slow after the peak of 7.8% reached in the first quarter of fiscal 2024. Overall, CRISIL expects GDP growth at 6.4% this fiscal 2024, compared with 7.2% the previous year.

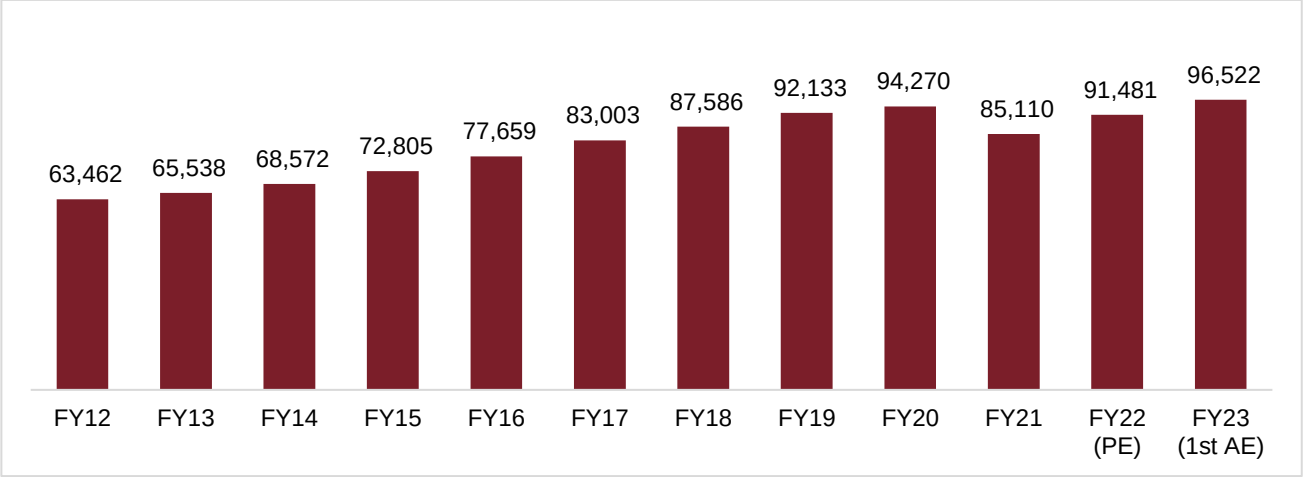
1.6.7 Per capita national income

The national income is the total amount of income accrued to a nation from various economic activities during a specified period which is generally taken as a year's time. National income helps to understand the standard of living of the people residing in a nation. It also helps in economical decision making. The more the national income, more is the economic growth.

India's per capita income is expected to rise to Rs 96,522 in fiscal 2023 from Rs 63,462 in fiscal 2012 with a compound annual growth rate of 3.89%. In fiscal 2023, per capita income is expected to rise by 5.5% against 7.5% in fiscal 2022 although on a lower base of the pandemic-affected fiscal 2021.

Some of the reasons for India's poor national income are its large population, largely agrarian economy, lack of industrial development as well as difference in socioeconomic conditions across the states. However, recent fiscal measures, emphasis on manufacturing through 'Make in India' and various packages for economic revival have helped India to grow faster. Opportunities for employment, increased private consumption along with positive consumer sentiments are expected to support higher GDP growth and per capita national income in future.

Figure 12: All-India per capita NNI at constant prices



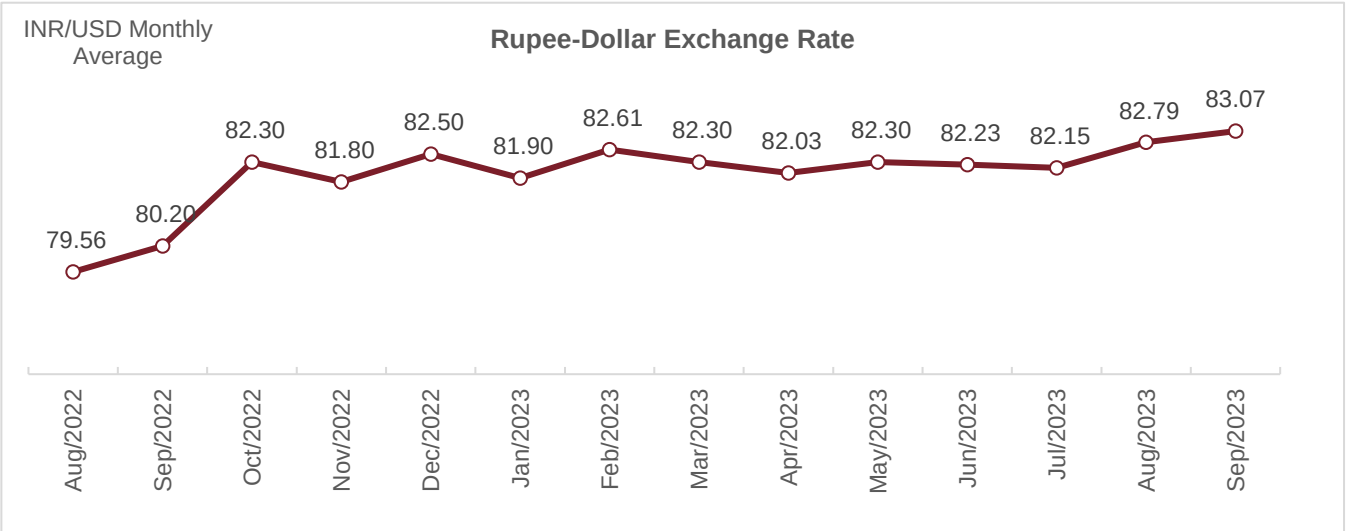
Note: PE - Provisional estimates; AE - Advance estimate

Source: RBI, Economic Survey 2022-23; CRISIL Consulting

1.6.8 Currency

The rupee remained under pressure in September, depreciating 0.3% sequentially to average 83.07/$ compared with 82.79/$ in August. It reached a record low of 83.3 on September 19 on renewed strength in the US dollar and increasing foreign capital outflows. The month saw net foreign capital outflows – for the first time in six months - led by rising oil prices and associated risks for India, Fed's hawkish outlook and the increase in US treasury yields that attracted investments. In addition, the dollar too gained considerably during the month. Despite the weakness, the rupee remained one of the better performing emerging market currencies during the month.

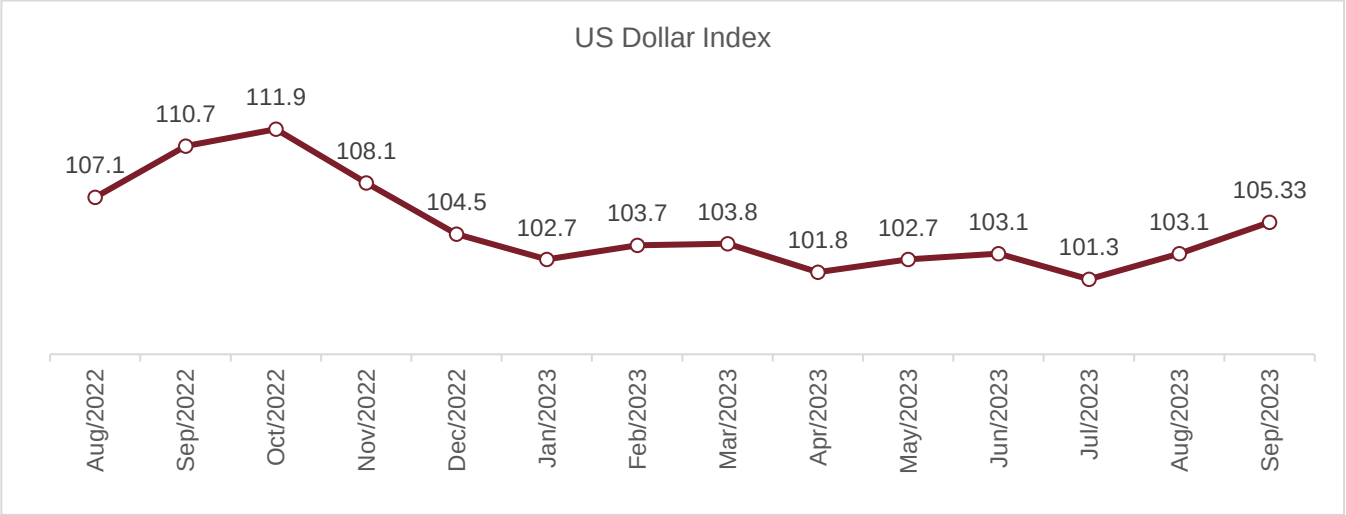
Figure 13: Rupee slumps further in September



Source: Financial Benchmarks India Pvt Ltd, CEIC, CRISIL Consulting

The US Dollar Index (DXY), which measures the greenback's strength against a basket of six currencies, grew further in September. It rose 2.2% on-month to 105.33 on account of a couple of factors such as anticipation of a continued hawkish monetary policy by the US Federal Reserve (Fed), leading to expectations that interest rates will remain elevated for an extended period. Meanwhile, economic data continued to signal the economy's resilience, with the ISM Manufacturing PMI indicating the smallest contraction in factory activity in nearly a year for September**.**

Figure 14: Dollar muscles its way back in September 2023



Note: A fall in the index indicates depreciation

Source: Bloomberg, CRISIL Consulting

The rupee is likely to average 83 against the dollar by March 2024 compared with 82.3 in March 2023 — a mild depreciation on-year. While a lower current account deficit will support the rupee, volatile external financing conditions could exert some pressure on the domestic currency.

1.7 Raising the long-term potential

Domestic economic growth hinges on revival in private consumption, lowering of banks' non-performing assets (NPAs), improvement in the investment climate and many more such factors. The GoI has taken the following steps in this regard:

- *Post-pandemic policies to revive the economy:* The Indian government has initiated several measures to revive the economy from the pandemic-induced stress, including SIDBI schemes for special liquidity support to micro, small and medium enterprises (MSMEs), state compensation schemes, increase in the threshold of default under Section 4 of the Insolvency and Bankruptcy Code, 2016 (IBC), among others. These are short-term measures, but likely to support long-term growth of the country as the economy recovers from the pandemic
- *Union Budget 2023-24:* The growth-centric and expansionary budget of fiscal 2024 focuses on giving a boost to investment in infrastructure and productive capacity, ultimately leading to rise in growth and employment. Some of the key announcements include:
  - Rs 10 lakh crore capital investment, a steep increase of 33% for the third year in a row, to enhance growth potential and for job creation, crowd-in private investments, and provide a cushion against global headwinds.

- Investment of Rs 75,000 crore, including Rs 15,000 crore from private sources, for 100 critical transport infrastructure projects, for last- and first-mile connectivity at ports, coal, steel, fertilisers, and food grains sectors.
- **New Infrastructure Finance Secretariat** established to enhance opportunities for private investment in infrastructure.
- Continuation of 50-year interest-free loan to state governments for one more year to spur investment in infrastructure and to incentivise them for complementary policy actions.
- Capital outlay of Rs 2.40 lakh crore has been provided for the railways
- **Urban Infrastructure Development Fund (UIDF)** will be established through use of priority sector lending shortfall, which will be managed by the National Housing Bank, and will be used by public agencies to create urban infrastructure in Tier 2 and Tier 3 cities.

- *Improve the investment climate through the ease of doing business:* The GoI has initiated a number of measures to ease its business environment, such as Goods and Services Tax (GST) and the insolvency law, and a number of other steps such as introducing an online single-window model for providing clearances and filing compliances, establishing the Central Registration Center, removing the Foreign Investment Promotion Board for fast-tracking foreign investments, and setting up a National Investment and Infrastructure Fund. The country has adopted a carefully designed approach to reform, with an aim to improve the business regulatory environment over the course of several years and is now among the top 10 improvers. India's position in the World Bank's Ease of Doing Business (EODB) rankings improved to 63 in 2020 from 142 in 2015; thus, it has maintained its position in the top 100 for the third straight year. However, it is still far behind large Asian economies such as China and other Brazil, Russia, India, China and South Africa (BRICS) countries. The EODB rankings of two other BRICS countries, i.e., Russia and China, have also improved impressively – to 28 and 31 in 2020 from 62 and 90 in 2015, respectively.

Table 5: EODB rankings

	Brazil	Russia	India	China	South Africa
2014	116	92	134	96	41
2015	120	62	142	90	43
2016	116	51	130	84	73
2017	123	40	130	78	74
2018	125	35	100	78	82
2019	109	31	77	46	82
2020	124	28	63	31	84

Note: The World Bank has discontinued the Doing Business Report (Press release dated September 16, 2021)

Source: World Bank, CRISIL Consulting.

Moreover, India's ranking in the Global Innovation Index improved to the 40th position in 2022 from the 81st position in 2015. That said, among its BRICS peers, India continued to lag China, but lead Russia in 2022.

Table 6: Global Innovation Index ranking

Year	Brazil	Russia	India	China	South Africa
2014	61	49	76	29	53
2015	70	48	81	29	60
2016	69	43	66	25	54

Year	Brazil	Russia	India	China	South Africa
2017	69	45	60	22	57
2018	64	43	63	10	65
2019	66	46	52	14	63
2020	62	47	48	14	60
2021	57	45	46	12	61
2022	54	47	40	11	61
2023	49	51	40	12	59

Source: Global Innovation Index WIPO, CRISIL Consulting

- *Monetary policy:* In its monetary policy in April 2022, the RBI had replaced the reverse-repo rate with a new standing deposit facility (SDF) rate as the floor of the policy corridor under the liquidity adjustment facility (LAF). The marginal standing facility (MSF) rate will remain at the corridor's upper end. The central bank restored the LAF policy corridor to the pre-pandemic symmetric width of 50 bps. Thus, the SDF will move 25 bps below, and MSF will stand 25 bps above the repo rate. In its monetary policy statement dated June 08, 2023, the Monetary Policy Committee decided to keep the policy repo rate under the LAF unchanged at 6.50 per cent. The SDF rate remained unchanged at 6.25 per cent and the MSF rate and the Bank Rate at 6.75 per cent. The MPC also decided to remain focused on withdrawal of accommodation to ensure that inflation remains within the target going forward, while supporting growth.
- *Passage of key bills:* The government has passed several key bills over the past few fiscals – the Companies (Amendment) Bill, 2020, which seeks to lower the penalties and peruse the need to decriminalise some offences by making recommendations to the GoI; the Banking Regulation (Amendment) Bill, 2020, which strives to amend the act with regard to cooperative banks; and the IBC (Second Amendment) Bill, 2019, which aims at streamlining issues of troubled companies, protect corporate debtors and prevent unnecessary revocation of insolvency proceedings under the IBC.
- *Boost infrastructure:* The capital expenditure and effective capital expenditure, which are budgeted at Rs10 lakh crore and Rs 13.7 lakh crore will account for 3.3% and 4.5% of GDP, respectively. The Budget speech also enumerated the measures to be undertaken by the GoI to support the states and the private sector in boosting investments in infrastructure.
- *Thrust on manufacturing:* The government has made some progress in improving labour market efficiency through various programmes such as Skilling India and Make in India. The sector has shown strong resilience despite lockdowns and has remained above the 50 (the mark separating expansion from contraction). However, the overall reform process remains gradual in the manufacturing sector
- *Consumption growth:* Given the favourable demographics and rising disposable income, the growing middle-class population is expected to help recover and eventually spur consumption growth in India. However, amid the raging pandemic, keeping inflation and interest rates in check is important to support consumption
- *Development of financial markets:* To develop the financial markets, the government has instituted steps such as Jan Dhan Yojana, a better monetary policy framework and the passage of bankruptcy code (amendment). Further, capital market regulator, the Securities and Exchange Board of India (SEBI), approved the framework for business trusts in India: real estate investment trusts (REITs) and infrastructure investment trusts (InvITs), both of which are new asset classes for investors. While REIT is an investment vehicle that allows monetisation of real estate assets, InvIT helps promoters monetise their completed infrastructure projects (having concessionaire/development agreement). In the budget, the government approved 100% FDI for insurance intermediaries and increased its FDI limit in the sector to 74% from 49%. This step, along with the emerging digital gold investment options and the platform for infra-debt financing, will help deepen Indian financial markets

- *Digitalisation:* The government has been quick to board the technology bandwagon with its Digital India programme, which aims to speed up financial inclusion and deliver government services electronically, by increasing internet connectivity and improving online infrastructure. Digitisation and digitalisation will create an efficiency-led growth spurt over the medium term. In the 2023-24 budget, the government announced certain initiatives in the digital space, including Digital Public Infrastructure for Agriculture, National Digital Library for Children and Adolescents, fintech services, Skill India digital platform, data embassy, fiscal support for digital public infrastructure, etc.

1.8 Atmanirbhar Bharat Abhiyan

Production Linked Incentives (PLIs) in the 14 sectors for the *Atmanirbhar Bharat* vision received outstanding response, with a potential to create 60 lakh new jobs.

The five focus points of the *Atmanirbhar Bharat Abhiyan* are economy, infrastructure, system, vibrant demography and demand. Its five phases are:

Phase I: Businesses, including MSMEs

Phase II: Poor, including migrants and farmers

Phase III: Agriculture

Phase IV: New horizons of growth

Phase V: Government reforms and enablers

Table 7: Sector-wise focus of *Atmanirbhar Bharat*

Sector	Government spend	Key schemes
Renewable energy	~Rs 24,000 crore	• Rs 4500 crore Production Linked Incentive Scheme 'National Programme on High Efficiency Solar PV Modules'. This was further increased by Rs 19,500 crore in the budget for fiscal 2023, taking it to Rs 24,000 crore; in Tranche I 8.7 GW and in Tranche II 39.6 GW capacity were allocated for domestic solar module manufacturing capacity under PLI. • Phase – II of Grid Connected Rooftop Solar Programme for achieving 40 GW capacity from rooftop solar by 2022 • Public procurement (Preference for 'Make in India') to provide for purchase preference (linked with local content) in respect of renewable energy (RE) sector • Implementation of Pradhan Mantri Kisan Urja Suraksha Utthan Mahabhiyan (PM KUSUM) scheme; MNRE, in November 2020, scaled up and expanded the PM KUSUM scheme to add 30.8 GW by 2022 with central financial support of Rs 34,422 crore. The scheme has been extended till March 31, 2026 • Approved Models & Manufacturers of Solar Photovoltaic Modules (Requirement for Compulsory Registration) Order, 2019 • List of manufacturers and models of solar PV modules recommended under ALMM Order • Scheme of grid connected wind-solar hybrid power projects • Basic customs duty (BCD) of 25% on solar cells and 40% on modules, respectively, effective April 1, 2022

Sector	Government spend	Key schemes
Power distribution companies (discoms)	Nil	• Rs 1.35 lakh crore liquidity infusion for discoms via Power Finance Corporation/ Rural Electrification Corporation (PFC/ REC) against receivables • Rebate for payment to be received by generation companies (gencos) to be passed on to industrial customers • Revamped distribution sector scheme (RDSS) to help discoms improve their operational efficiencies and financial sustainability by providing result-linked financial assistance; outlay of Rs 3,03,758 crore over 5 years i.e., fiscals 2022 to 2026. The outlay includes an estimated Government Budgetary Support (GBS) of Rs 97,631 crore.
Agriculture finance	Nil	• Rs 1 lakh crore agriculture infrastructure financing fund for the development of farm gate infrastructure for farmers • 25 lakh new Kisan Credit Cards distributed with loan disbursement of Rs 25,000 crore • Rs 1.87 lakh crore disbursed through the PM Kisan scheme • Rs 29,500 crore refinancing assistance provided through NABARD
Agriculture procurement and sales	Rs 4,000 crore	• Amendment in the Essential Commodities Act for deregulation of sales of agriculture produce, including field crops, onion and potato • Working capital limit of Rs 6,700 crore sanctioned for procurement of food grains to state government entities • Rs 3,500 crore allocated for the distribution of 5 kg rice/wheat and 1 kg pulses to 8 crore non-card holder migrants • Rs 500 crore allocated under Operation Greens for facilitation of sales of horticulture produce through 50% subsidy on storage and transport
Agri-allied	Rs 72,500 crore	• Additional allocation of Rs 40,000 crore for Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) • Rs 20,000 crore for fisherman over the next five years under Pradhan Mantri Matsya Sampada Yojana • Rs 13,343 crore for eradication of foot and mouth disease in Indian livestock population • Rs 15,000 crore for Animal Husbandry Infrastructure Development Fund (AHIDF) • Rs 4,000 crore for enhanced cultivation of herbal and medicinal plants • Rs 500 crore for the Indian apiculture industry • Rs 10,000 crore for formulation of micro food enterprises
Mining	Nil	• Expected to offer 500 mineral blocks, including 50 coal • Promoting commercial coal mining (ordinance to remove captive end-use restriction passed in January 2020); government to expedite policy formulation and auction process • Government to allow composite exploration/auction of coal bed methane reserves for extraction • Rebate offered on revenue sharing quantum to incentivise early operationalisation/ higher produce • Provision of Rs 50,000 crore for evacuation infrastructure

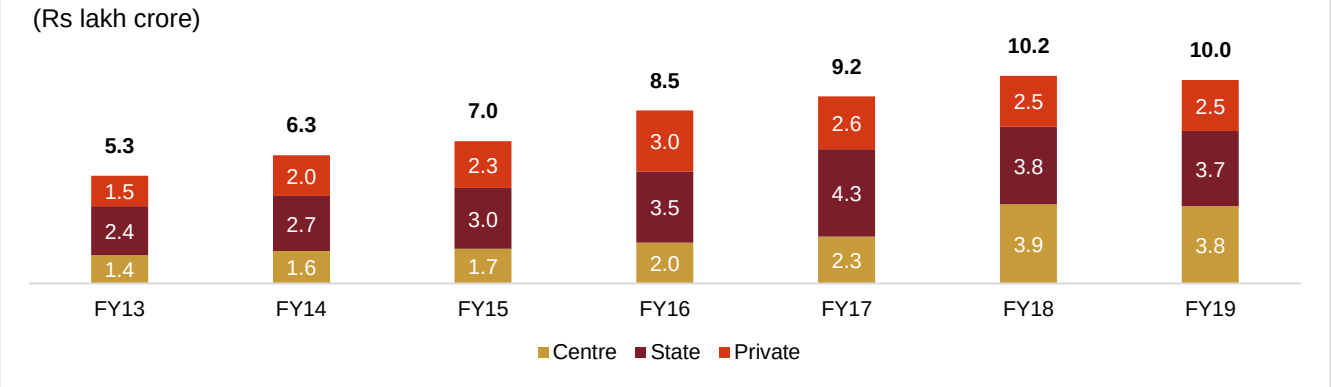
Sector	Government spend	Key schemes
Heavy electronics & IT hardware	Rs.7,352 Crore	• PLI Scheme for IT Hardware manufacturing herald a new era in laptops, tablets, all-in-one personal computers (PCs) and servers electronics manufacturing • Extends an incentive of 4% to 2%/1% on net incremental sales (over base year of FY 2019-20) of goods under target segments that are manufactured in India to eligible companies, for a period of four years (FY2021-22 to FY 2024-25) • Ministry of Electronics and IT approved 14 eligible applicants • Incentives worth Rs. 7,325 Crore will be provided over four years • Production worth Rs. 1.61 Lakh Crore and exports worth Rs. 60 thousand Crore estimated in four years. • It will bring additional investments of Rs. 2,517 Crore and create 36,066 additional employment opportunities in four years
Specialty still	Rs. 6,322 Crore	• Incentives worth Rs.6,322 crores to be provided over five years for manufacturing of specialty steel • Duration of the scheme will be five years, from 2023-24 to 2027-28 • There are 3 slabs of PLI incentives, the lowest being 4 % and highest being 12% which has been provided for electrical steel (CRGO). • Scheme to attract an additional investment of about Rs.40,000 crore • It is expected that the specialty steel production will become 42 million tonnes by the end of 2026-27
New Energy		• Rs 18,100 crore under PLI scheme for Advanced Chemistry Cell (ACC) Battery Storage in India launched in October to achieve 50 GWh manufacturing capacity • Green Hydrogen Policy launched in February 2022 to facilitate production of green hydrogen/green ammonia • PLI scheme on green hydrogen manufacturing with an initial outlay of Rs 19,744 crore with an aim to boost domestic production of green hydrogen

Source: Official portal of the Government of India; various ministries, PIB press releases, CRISIL Consulting

1.9 Overview of National Infrastructure Pipeline (NIP)

Over the period from fiscal years 2008 to 2017, India's infrastructure investment was approximately Rs. 60 lakh crore, which is equivalent to $1.1 trillion based on the average exchange rates of those respective years. Specifically, during the 11th Five Year Plan (fiscal years 2008 to 2012), the investment in infrastructure reached Rs. 24 lakh crore, and during the subsequent 12th Five Year Plan (fiscal years 2013 to 2017), it increased to Rs. 36 lakh crore, both figures being measured at current prices.

Figure 15: India's infrastructure investment trend since fiscal 2013



Source: Report of the Task Force National Infrastructure Pipeline (NIP) - DEA, CRISIL Consulting

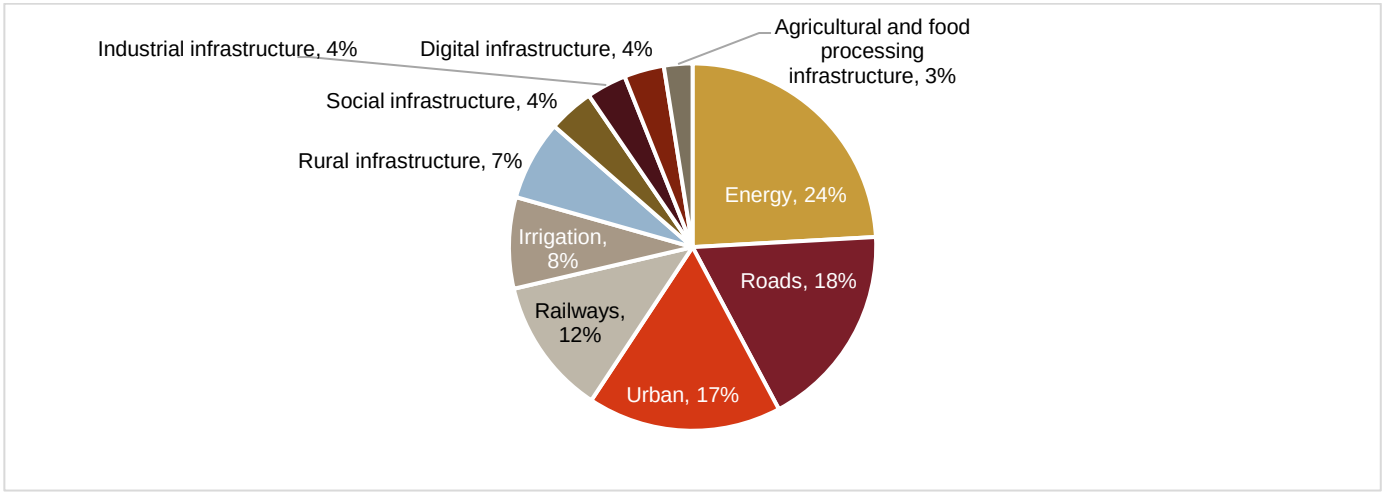
From fiscal years 2013 to 2019, approximately 85% of India's total infrastructure investment was allocated to several key sub-sectors, namely power, roads and bridges, urban development, digital infrastructure, and railways. Funding for power and roads and bridges predominantly came from both the central government and state governments, with some involvement from the private sector. On the other hand, investments in the digital sector were mainly driven by the private sector, while the irrigation sector saw a major share of investments made by the state governments.

In his Independence Day address in 2019, the Hon'ble Prime Minister emphasized a significant investment of Rs. 100 lakh crore in infrastructure projects, encompassing both social and economic aspects, to be spread out over the next five years.

To realize this ambitious goal, a Task Force was established under the approval of the finance minister to devise the National Infrastructure Pipeline (NIP) for each fiscal year, covering the period from FY 2019-20 to FY 2024-25. The Task Force, headed by the Secretary of the Department of Economic Affairs (DEA), comprises members such as the CEO of NITI Aayog, the Secretary of Expenditure, the Secretaries of the Administrative Ministries, and the Additional Secretary of Investments from DEA, along with the Joint Secretary of the Investment Promotion Fund (IPF), DEA, serving as the Member Secretary.

The estimated total capital expenditure in infrastructure sectors in India from fiscal years 2020 to 2025 is approximately Rs. 111 lakh crore.

Figure 16: Sector-wise break-up of capital expenditure of Rs 111 lakh crore during fiscals 2020-2025



Source: Report of the Task Force National Infrastructure Pipeline (NIP) - DEA, CRISIL Consulting

Table 8: Sector-wise annual capital expenditure estimated in infrastructure (Rs crore)

Ministry/ Department	FY20	FY21	FY22	FY23	FY24	FY25	No phasing	FY20-FY25
Energy	233,607	441,522	442,372	468,134	497,768	466,821	139,778	**2,690,003**
Roads	332,559	383,283	356,966	252,780	240,761	332,659	134,815	**2,033,823**
Railways	133,387	262,465	308,800	273,831	221,209	167,870	0	**1,367,563**
Ports	13,357	18,104	20,649	15,863	7,724	10,002	35,495	**121,194**
Airports	18,667	21,655	24,820	21,334	25,386	5,141	26,445	**143,448**
Urban	298,174	462,208	404,134	234,858	217,164	159,862	142,867	**1,919,267**
Digital communication	78,356	61,847	54,538	38,719	38,119	38,093	0	**309,672**
Irrigation	114,463	200,615	175,669	137,358	115,281	70,474	80,612	**894,473**

Ministry/ Department	FY20	FY21	FY22	FY23	FY24	FY25	No phasing	FY20-FY25
Rural infrastructure	140,313	176,803	210,811	111,877	107,057	27,055	0	**773,915**
Agriculture and food processing infrastructure	3,570	3,895	3,626	1,923	1,176	649	153,889	**168,727**
Social infrastructure	56,608	78,315	85,044	55,314	46,147	25,945	46,012	**393,386**
Industrial infrastructure	19,070	43,066	44,845	35,129	23,021	10,520	139,306	**314,957**
Total	**1,442,131**	**2,153,779**	**2,132,274**	**1,647,122**	**1,540,813**	**1,315,091**	**899,218**	**1.1130,428**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) - DEA, CRISIL Consulting

India will spend nearly Rs 143 lakh crore on infrastructure in seven fiscals through 2030, more than twice the ~Rs 67 lakh crore spent in the previous seven starting fiscal 2017. Of the total, ~Rs 36.6 lakh crore will be green investments, marking a 5x rise compared with fiscals 2017-2023. While the lion's share will be by the government, the private sector is increasingly focusing on the energy and transportation sectors. The biggest share in green investments, of ~Rs 30.3 lakh crore, will be in renewable energy (RE), followed by Rs 6.3 lakh crore in transportation.

Table 9: Huge investments lined up in Infrastructure

Sector	Total investments (Rs. Lakh Crores)		Green Investments (Rs. Lakh Crores)	
	FY17-FY23E	FY24-FY30P	FY17-FY23E	FY24-FY30P
Core infra	50.4	96.8	NA	NA
Energy	15.5	39.1	6.6	30.3
Transport	0.8	7.0	0.6	6.3
Overall infrastructure	**66.7**	**142.9**	**7.2**	**36.6**

Source: CRISIL Consulting

1.9.1 Energy

The energy sector comprises conventional power, renewable energy (RE), and petroleum and natural gas. Among these, the power sector receives the most significant portion of infrastructure investments. As India's economy develops, urbanization expands, and electricity access improves, there is a projected rapid growth in energy consumption to meet these demands. Despite this growth, India's per capita energy consumption remains comparatively low, especially when compared to other developing countries. To address this disparity, substantial investments are required in the sector to establish new energy capacities and upgrade existing ones.

The power sector is expected to witness a total capital expenditure of Rs. 1,410,428 crore during fiscal years 2020 to 2025, funded by both the central government and state governments. For the specific projects assigned to Central Public Sector Undertakings (CPSUs) and private players, the estimated expenditure of Rs. 953,895 crore can be broken down as follows: Rs. 326,811 crore for electricity generation projects, Rs. 323,034 crore for electricity distribution projects, and Rs. 304,050 crore for electricity transmission projects. The summary of projects is given below:

Table 10: Summary of key projects under NIP in Power sector

Category	Estimated Capex over FY20–FY25 (Rs crore)
Generation	**326,811**
NTPC	*119,991*
NHPC	*44,049*

Category	Estimated Capex over FY20–FY25 (Rs crore)
THDC	*10,385*
SJVN	*10,334*
DVC	*2,848*
State (Hydro)	*75,375*
Private (Hydro)	*63,829*
Distribution	**323,034**
DDUGJY, IPDS, Proposed New Scheme	*323,034*
Transmission	**304,050**
PGCIL	*65,500*
DVC	*549*
State	*190,001*
Private	*48,000*
States	**456,533**
Total	**1,410,428**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) - DEA, CRISIL Consulting

Regarding generation, the projects consist of establishing new and expanding existing super thermal power stations like Lara super thermal power station and Barh super thermal power station, along with the development of hydropower plants managed by NHPC, such as Dibang, Tawang – I&II, Teesta – IV, in addition to solar PV plants overseen by THDC.

In the domain of transmission, significant endeavors are being undertaken by Power Grid Corporation of India Ltd (PGCIL), which involve projects such as the HVDC Bipole Link connecting the western and southern regions, the interstate Green Energy Corridor Transmission Link, and the construction of substations.

Concerning the distribution segment, numerous initiatives are being implemented under the Integrated Power Development Scheme (IPDS) and Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY). These initiatives aim to strengthen the distribution network in both urban and rural areas, with the ultimate goal of providing uninterrupted power supply.

Table 11: Capital expenditure estimated over FY20 to FY25 in Power sector

Category	FY20	FY21	FY22	FY23	FY24	FY25	Total
Generation	30,056	53,819	63,789	63,474	64,982	50,690	**326,811**
Distribution	21,127	42,000	44,207	60,000	70,000	85,700	**323,034**
Transmission	54,875	53,897	50,712	51,522	51,522	41,522	**304,050**
States	58,081	75,834	63,027	48,491	38,732	33,090	**456,533**
Total	**164,140**	**225,551**	**221,734**	**223,487**	**225,236**	**211,002**	**1,410,428**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) – DEA, CRISIL Consulting

The categories of projects included under renewable energy are solar, wind, small hydro and bio power. The capital expenditure for these projects is estimated at Rs 929,500 crore.

Table 12: Summary of key projects under NIP in Renewable energy sector

Category	Target by Dec 25 (in GW)	Capex over FY20–FY25 (Rs crore)
Solar	149.70	472,000
Wind	96.99	419,300
Small hydro power	7.00	23,500
Bio power	12.04	14,700
Total	**265.73**	**929,500**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) – DEA, CRISIL Consulting

Table 13: Capital expenditure estimated over FY20 to FY25 in Renewable sector

Category	FY20	FY21	FY22	FY23	FY24	FY25	Total
Total	30,500	151,000	144,000	170,000	217,000	217,000	**929,500**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) – DEA, CRISIL Consulting

1.9.2 Roads and Transportation

Over the past decade, the roads sector has witnessed substantial investment. It has been a pioneer in introducing various innovative public-private partnership (PPP) models, and its contractual framework is notably robust compared to other sectors. These factors have played a crucial role in attracting significant investments from private entities into the sector. However, there remains a pressing need to enhance connectivity since national and state highways account for only 4.7% of surfaced roads in India. It becomes essential to strengthen the hinterland connectivity, linking ports, consumption centers, metros, Tier-2 cities, and strategically important locations. This way, people and goods can be transported more efficiently and quickly.

The roads sector is projected to witness a total capital expenditure of Rs. 2,033,823 crore from fiscal years 2020 to 2025, funded by both the central government and state governments. A total of 1,820 projects have been identified for implementation during this period. The estimated capital expenditure for these projects, solely by the central government, is approximately Rs. 13.8 lakh crore over the same fiscal years 2020 to 2025.

Table 14: Summary of key projects under NIP in Road sector

Category	No of projects	Length (km)	Capex over FY20–FY25 (Rs crore)
National highways	1,815	87,162	1,280,638
Expressways	5	2,142	101,742
Total	**1,820**	**89,304**	**1,382,380**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) – DEA, CRISIL Consulting

The projects encompass the development of new expressways like the Delhi-Mumbai Expressway and Bengaluru-Chennai Expressway, along with various initiatives for four-laning, two-laning, or widening of current highways. Additionally, numerous projects focus on enhancing highway safety, which involves upgrading or reconstructing existing roads and bridges, as well as constructing Railway Over Bridges (ROBs) at level crossings.

Table 15: Capital expenditure estimated over FY20 to FY25 in Road sector

Category	FY20	FY21	FY22	FY23	FY24	FY25	Total
Centre	247,838	259,714	251,695	172,484	170,238	280,411	1,382,380
State	84,721	123,569	105,271	80,296	70,523	52,249	651,444
Total	**332,559**	**383,283**	**356,966**	**252,780**	**240,761**	**332,659**	**2,033,823**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) - DEA, CRISIL Consulting

1.9.3 Railways

Indian Railways has made substantial investments to improve safety, increase train speeds, enhance freight efficiency, upgrade passenger amenities, and ensure better connectivity. To stay competitive with other transportation modes, there is an immediate requirement to modernize and expand the railway infrastructure. Therefore, involving the private sector becomes crucial to attract additional funds and efficiency, ultimately leading to the enhancement of railway infrastructure.

Table 16: Summary of key projects under NIP in Railways sector

Category	No of projects	Capex over FY20–FY25 (Rs crore)
New lines/gauge conversion	259	440,072
Capacity augmentation	266	247,985
Dedicated Freight Corridor	7	166,171

Category	No of projects	Capex over FY20–FY25 (Rs crore)
Rolling stock	31	275,539
High-speed rail	2	110,647
Others	159	118,406
Total	**724**	**1,358,820**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) - DEA, CRISIL Consulting

There are approximately 259 projects, accounting for around 33% of the estimated capital expenditure, focused on constructing new railway lines or gauge conversion. Another 266 projects, representing about 18% of the estimated capital expenditure, are aimed at augmenting the railway capacity. Additionally, 7 projects, making up approximately 12% of the estimated capital expenditure, are dedicated to constructing Dedicated Freight Corridors (DFC). Furthermore, 31 projects, accounting for approximately 20% of the estimated capital expenditure, are related to the production of locomotives and rolling stocks. Two projects, comprising about 8% of the estimated capital expenditure, are dedicated to the development of a high-speed network. Lastly, 159 projects, representing approximately 9% of the estimated capital expenditure, focus on coach and freight terminals, as well as maintenance sheds.

Table 17: Capital expenditure estimated over FY20 to FY25 in Railway sector

Category	FY20	FY21	FY22	FY23	FY24	FY25	Total
Centre	132,463	260,811	307,466	272,024	219,747	166,309	**1,358,820**
State	924	1,655	1,334	1,808	1,462	1,560	**8,743**
Total	**133,387**	**262,465**	**308,800**	**273,831**	**221,209**	**167,870**	**1,367,563**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) - DEA, CRISIL Consulting

1.9.4 Civil construction (Urban Infra)

In recent times, urban infrastructure has gained increasing significance due to its correlation with economic growth, poverty reduction, and overall quality of life. Urban local bodies often face financial constraints, prompting the exploration of new funding methods like land leasing, value capture finance, and asset monetization to secure additional resources for improving urban infrastructure. India requires substantial investments to enhance urban services, including water supply, solid waste management, sewerage systems, storm water drains, urban mobility, and the development of public spaces.

Table 18: Summary of key projects under NIP in Urban infrastructure sector

Category	No of projects	Capex over FY20–FY25 (Rs crore)
Affordable Housing	98	540,711
Urban Transport / MRTS (Mass Rapid Transit System)	50	573,366
Street Lighting / Solid Waste Management (Smart City Mission)	809	131,460
Water Supply and Sanitation / Green Parks / Sewage Treatment Plant (AMRUT)	405	47,382
Water supply, rejuvenation of water bodies, wastewater collection and treatment (Jal Jeevan Mission)	-	279,492
Total	**1,362**	**1,572,410**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) - DEA, CRISIL Consulting

Table 19: Capital expenditure estimated over FY20 to FY25 in Urban infrastructure sector

Category	FY20	FY21	FY22	FY23	FY24	FY25	Total
Centre	271,698	421,412	362,144	194,608	183,773	138,776	1,572,411
State	26,475	40,796	41,990	40,251	33,391	21,086	346,856
Total	**298,174**	**462,208**	**404,134**	**234,858**	**217,164**	**159,862**	**1,919,267**

Source: Report of the Task Force National Infrastructure Pipeline (NIP) - DEA, CRISIL Consulting

2 India's power sector

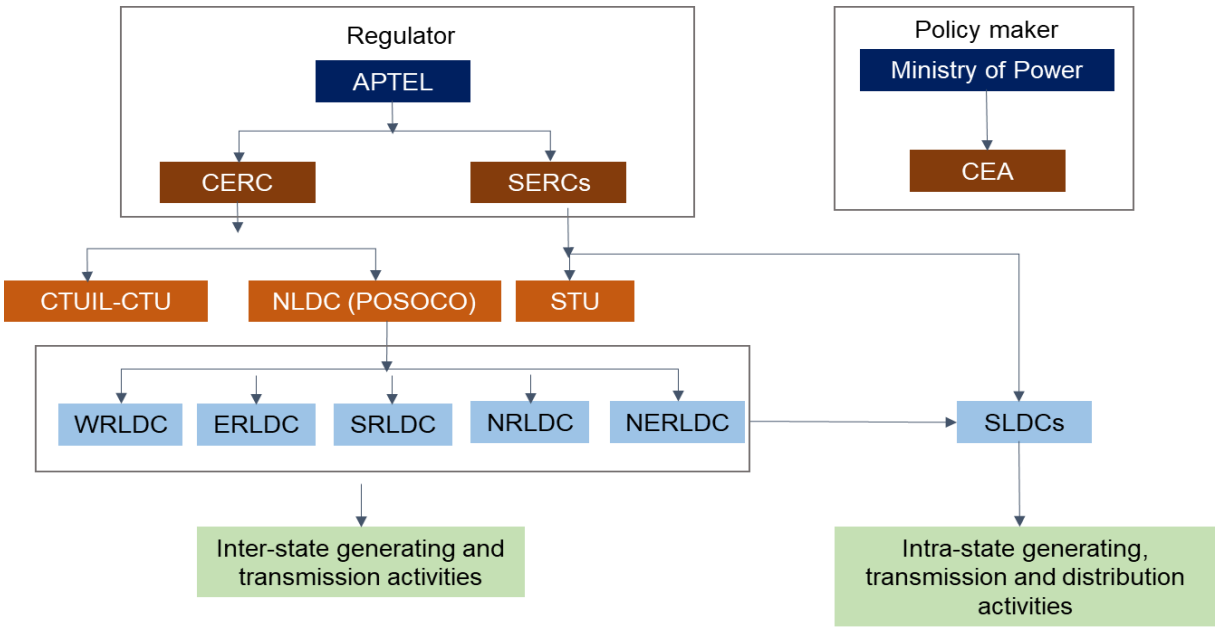
2.1 Review of the sector

2.1.1 Evolution and structure

India's power sector is highly diversified, with sources of power generation ranging from conventional (coal, lignite, natural gas, oil, hydro and nuclear power) to viable, non-conventional sources (such as wind, solar, and biomass and municipal waste). T&D infrastructure has expanded over the years for evacuation of power from generating stations to load centres through the intra-state and inter-state transmission system (ISTS).

The sector is highly regulated, with various functions being distributed between multiple implementing agencies. The three chief regulators for the sector are: the Central Electricity Regulatory Commission (CERC), the Central Electricity Authority (CEA), and the State Electricity Regulatory Commissions (SERCs).

Figure 17: Institutional and structural framework



Note: APTEL - The Appellate Tribunal for Electricity; CERC- Central Electricity Regulatory Commission; CEA - Central Electricity Authority; CTUIL: Central Transmission Utility of India Limited; WRLDC - Western Regional Load Despatch Centre; ERLDC - Eastern Regional Load Despatch Centre; SRDLC - Southern Regional Load Despatch Centre; NLDC: National Load Despatch Centre, NRLDC - Northern Regional Load Despatch Centre; NERLDC - North-Eastern Regional Load Despatch Centre; POSOCO: Power System Operation Corporation, SLDC - State Load Despatch Centre; CTU - Central Transmission Utility; STU - State Transmission Utility

Source: CRISIL Consulting

The Ministry of Power (MoP) works in close coordination with the CERC and CEA. While the CERC's role is more of a regulator for approving tariffs of central utilities, approving licenses, etc., the CEA is primarily a technical advisor focused on planning, i.e., estimating power demand and generation and transmission capacity.

2.1.2 Key policy and regulatory reforms in support of RE growth

The development of grid interactive renewable power has essentially taken off with the Electricity Act 2003, which mandates the SERCs to promote cogeneration and generation of electricity from renewable energy (RE) sources by providing suitable measures for connectivity with the grid and sale of electricity and fix certain minimum percentages for purchase of renewable power in the area of each distribution licensee. In June 2008, a National Action Plan on Climate Change (NAPCC) was announced, which included eight major national missions, with the

one on solar energy the Jawaharlal Nehru National Solar Mission (JNNSM) being central. The JNNSM was launched in January 2010, with a target of 20 GW grid solar power. In June 2015, this target was increased to 100 GW by 2022 and a cumulative target of 175 GW of RE capacity addition by 2022 was set which included 100 GW from solar, 60 GW from wind, 10 GW from bio-power, and 5 GW from small hydropower.

Furthermore, the GoI has committed in the COP 26 summit to reduce its emission to net zero by 2070. To achieve the said target India updated its intended nationally determined contributions (NDCs) in August 2022, for the period up to 2030. India set an ambitious target of achieving 500 GW of non-fossil fuel-based capacity addition, 50% of energy needs from non-fossil fuels, reduction of emissions by 1 billion tonnes between 2021 and 2030 and emissions intensity of the GDP by 45% by 2030. This is expected to provide further impetus to the renewable energy segment.

In the past 5 years, the government has taken several initiatives to promote RE in the country:

- Permitting **foreign direct investment** (FDI) up to 100% under the automatic route
- **Waiver of ISTS charges** for inter-state sale of solar and wind power for projects to be commissioned by June 30, 2025
- Declaration of **trajectory for renewable purchase obligation (RPO)** and energy storage obligation (ESO) wherein trajectory for RPO for wind, hydro purchase obligation (HPO) and other RPOs has been laid down up to fiscal 2030
- Setting up of **ultra-mega renewable energy parks** to provide land and transmission to RE developers on a plug-and-play basis
- Laying of new transmission lines and creating new sub-station capacity for evacuation of renewable power under the **Green Energy Corridor (GEC)** Scheme
- **Standard bidding guidelines** for tariff based competitive bidding process for procurement of power from grid-connected solar PV and wind projects
- **Generation-based incentive** (GBI) is being provided to the wind projects commissioned on or before March 31, 2017
- Electricity (Promoting Renewable Energy through Green Energy Open Access) Rules, 2022 in order to further accelerate the RE programme with the end goal of ensuring access to affordable, reliable, sustainable and green energy for all
- **Letter of credit** (LC) or advance payment to ensure timely payment by distribution licensees to RE generators
- **National Green Hydrogen Mission** for the development of green hydrogen production capacity of at least 5 million tonne per annum (mtpa) with an associated RE capacity addition of about 125 GW in the country
- **Renewable generation obligation** (RGO) issued by MoP for the companies installing new coal/lignite based thermal power plants and having the commercial operation date of the project on or after April 1, 2023. These projects would have to establish/procure an RE capacity of a minimum of 40% of the thermal plant capacity
- **Issued Transmission System plan for integration of over 500 GW RE capacity by 2030** which include 8,120 ckm of high voltage direct current (HVDC) transmission corridors (+800 kV and +350 kV), 25,960 ckm of 765 kV AC lines, 15,758 ckm of 400 kV lines and 1,052 ckm of 220 kV cable at an estimated cost of Rs 2.44 lakh crore. It also includes transmission system required for evacuation of 10 GW offshore wind located in Gujarat and Tamil Nadu at an estimated cost of Rs 0.28 lakh crore.
- **Issuance of bidding trajectory for renewable power bids** aims to achieve a target of 280 GW solar capacity (of the 500 GW of installed capacity from non-fossil sources) by 2030. The bids for 40 GW of solar energy capacity per annum, of the total trajectory of 50 GW RE capacity are to be issued each year from fiscal 2024 through fiscal 2028

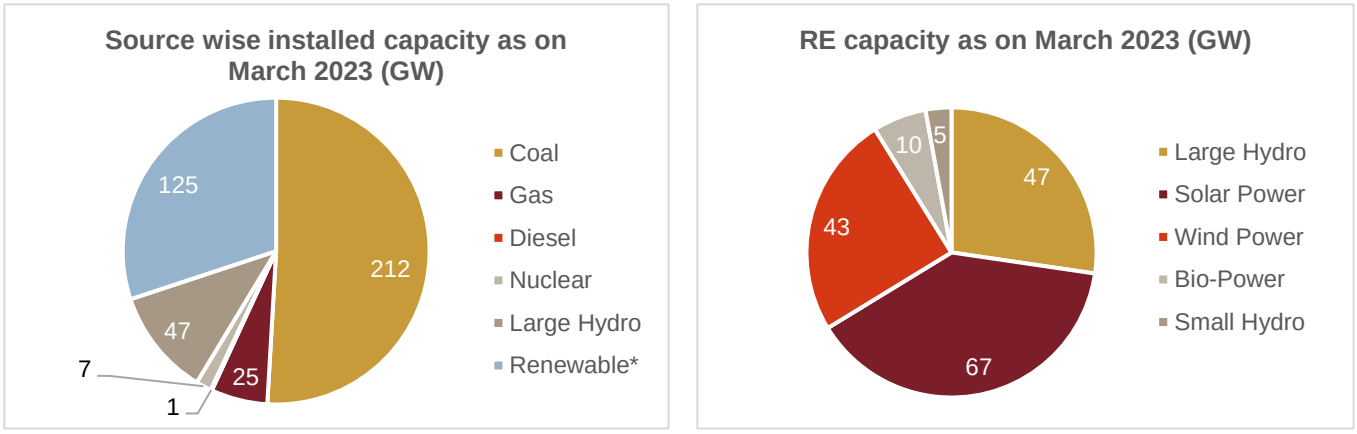
- **The viability gap funding for Battery storage** proposed in the budget for fiscal 2024 with capacity of 4000 MWh. An outlay of Rs 3,500 crore is expected by the central government to support the VGF. Central government also issued guidelines to promote pump storage projects.

2.2 Review of power demand-supply scenario in India

2.2.1 Power supply mix

The total installed generation capacity at the end of March 2023 was 416 GW, of which ~89 GW of capacity was added over fiscals 2017-23. The overall installed generation capacity has grown at a CAGR of 6.8% over fiscals 2012– 23. Coal and lignite-based installed power generation capacity has maintained its dominant position over the years and accounts for ~51% as of March 2023. However, RE installations (including large hydroelectric projects), have reached ~172 GW capacity as on March 2023, compared with 63 GW as on March 2012, constituting ~41% of total installed generation capacity as of date. This growth has been led by solar power, which rapidly rose to ~67 GW from 0.9 GW over the same period.

Figure 18: Details of installed capacity

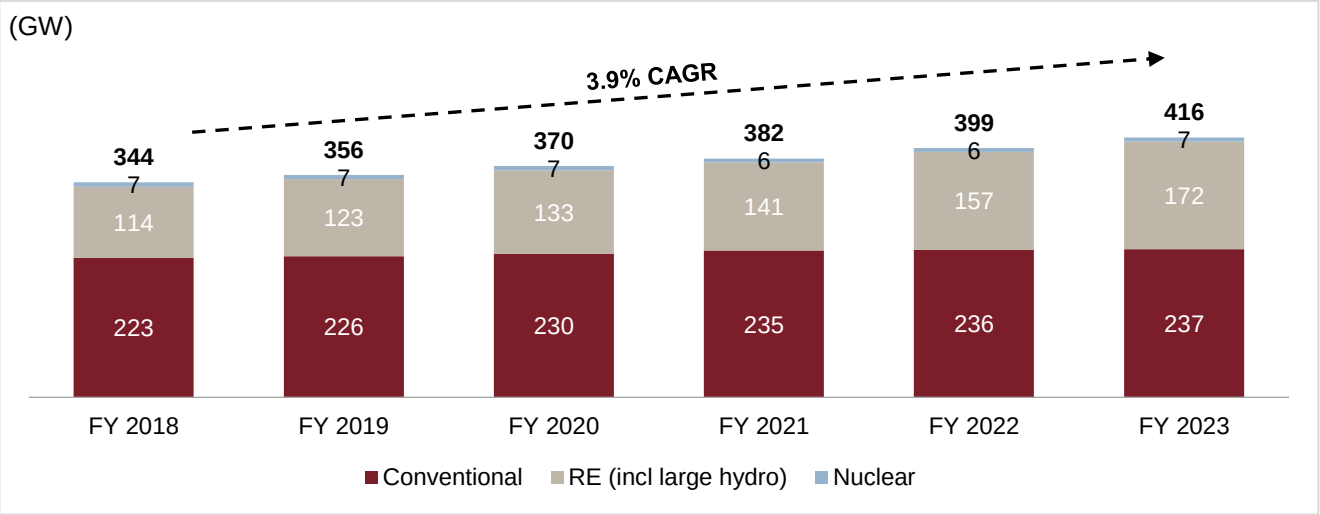


*Renewable capacity excluding large hydro

Source: CEA, CRISIL Consulting

The Electricity Act, 2003 and competitive bidding for power procurement, implemented in 2006, encouraged the participation of private market participants that have announced large capacity additions. As a result of competitive bidding, capacities of ~22 GW (fiscals 2014-23) were added by the private sector, which accounted for 73.0% of the total additions. Moreover, a strong government thrust on RE and decreasing tariffs (with falling capital costs and improving efficiency) also supported RE capacity additions. Investments from marquee foreign funds have also accelerated growth into the sector. e.g. US investment firm Augment Infrastructure acquired a majority stake in CleanMax Enviro Energy Solutions Pvt. Ltd. Copenhagen Infrastructure Fund has signed agreement with Amp Energy India Private Ltd for joint equity investment of over USD 200 million (around Rs 1,500 crore) in renewables. PTT group bought stake in Avaada Energy. The Norwegian Climate Investment fund, managed by Norfund, and KLP, Norway's largest pension company, together committed equity and guarantees for a 168 MW wind power plant developed by Enel Green Power in India, Tata Power has signed up for MUFG's Sustainable Trade Finance Facility to expand its clean and green energy portfolio

Figure 19: Evolution of all India installed generation capacity (GW)



Note: 3.9% CAGR is for capacity additions growth between FY18 and FY23

Source: CEA, CRISIL Consulting

In 2014, the GoI set a target to achieve 175 GW of renewable energy in India by fiscal 2022, with a focus on solar energy (100 GW) and wind energy (60 GW), in addition to other renewable energy sources such as small hydro projects, biomass projects and other renewable technologies (~15 GW).

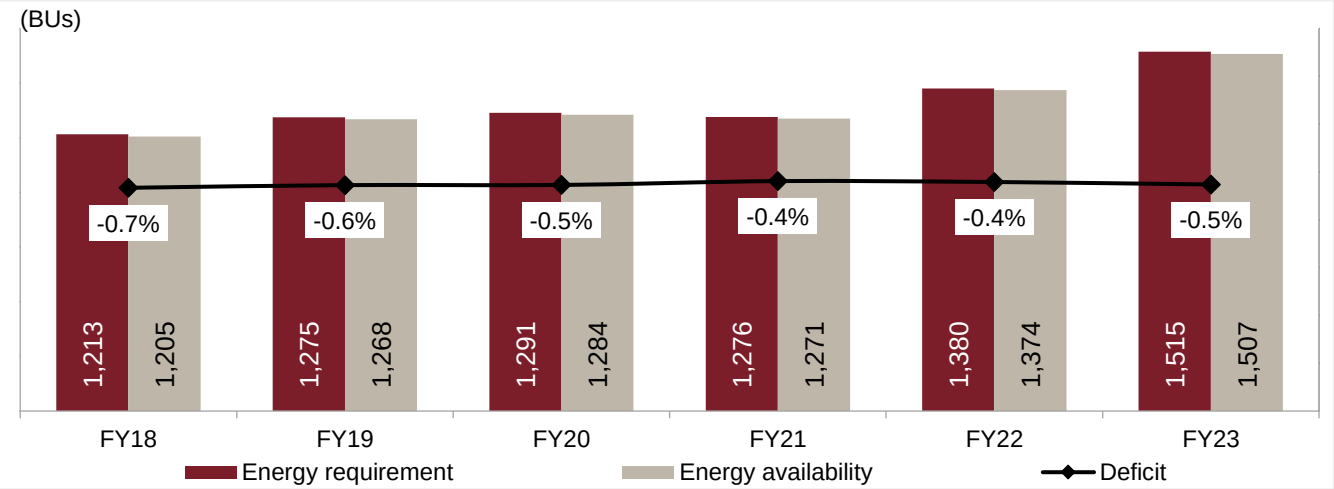
Between fiscal 2014 and 2023, ~69 GW of conventional power and ~93 GW of renewable power generation capacities were added. However, beyond fiscal 2018, only 15 GW of conventional power capacity were added (~2.5 GW of annual capacity addition) as against an average of 11 GW of annual capacity addition witnessed over the past five years (fiscal 2014-2018). Over the same period, ~56 GW of RE capacity was added with an annual capacity addition of 11 GW.

Additions in both wind and solar power were driven by strong government focus, which is evident from fiscal and regulatory incentives, VGF, and execution support in terms of land and evacuation infrastructure. Improved availability of low cost finance through various instruments/sources would also support RE capacity additions. In solar power, in particular, further decreases in capital costs and consequently, tariffs, have driven the capacity additions.

2.2.2 Review of power demand-supply gap

India's electricity requirement has risen at a CAGR of ~4.5% between fiscals 2018 and 2023, while power availability rose at ~4.6% CAGR on the back of strong capacity additions, both in the generation and transmission segments. As a result, the energy deficit declined to 0.5% in fiscal 2023 from 0.7% in fiscal 2018. Strengthening of inter-regional power transmission capacity over the past five years has supported the rapid fall in deficit levels as it reduced supply constraints on account of congestion and lower transmission corridor availability, thereby lowering the deficit to 0.6% in fiscal 2019. For fiscal 2022, the average energy deficit across states and UTs stood at 0.4%.

Figure 20: Aggregate power demand supply (in billion units, or BUs)

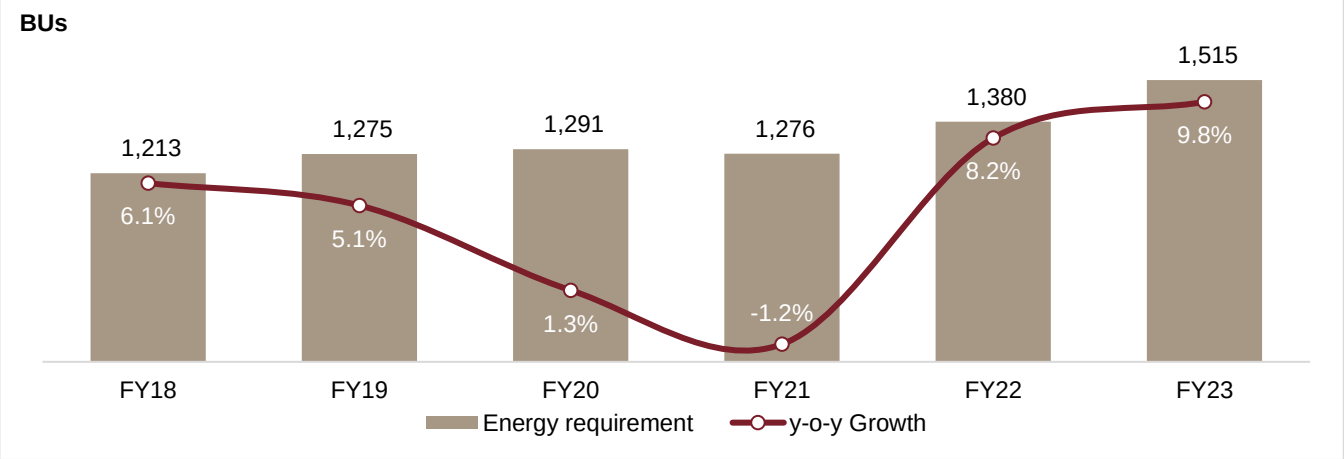


Source: CEA, CRISIL Consulting

In fiscals 2018 and 2019, power demand grew at 6% and 5% on-year, respectively, led by a low base and gradual pickup in consumption across categories, with impetus from electrification of un-electrified households, T&D network expansions, and healthy economic activity. However, in fiscal 2020, power demand grew at a slower 1.3% due to weakening economic activity and extended monsoon. By the end of the fiscal, economic activity and capacity additions (both generation and transmission) slowed further due to the pandemic.

After a minor (1.2%) decline in fiscal 2021, power demand saw a strong rebound in fiscal 2022, registering a ~8% on-year growth on the back of healthy revival in economic activity, and as demand picked up with the lifting of COVID-19 restrictions.

Figure 21: Trend in energy requirement

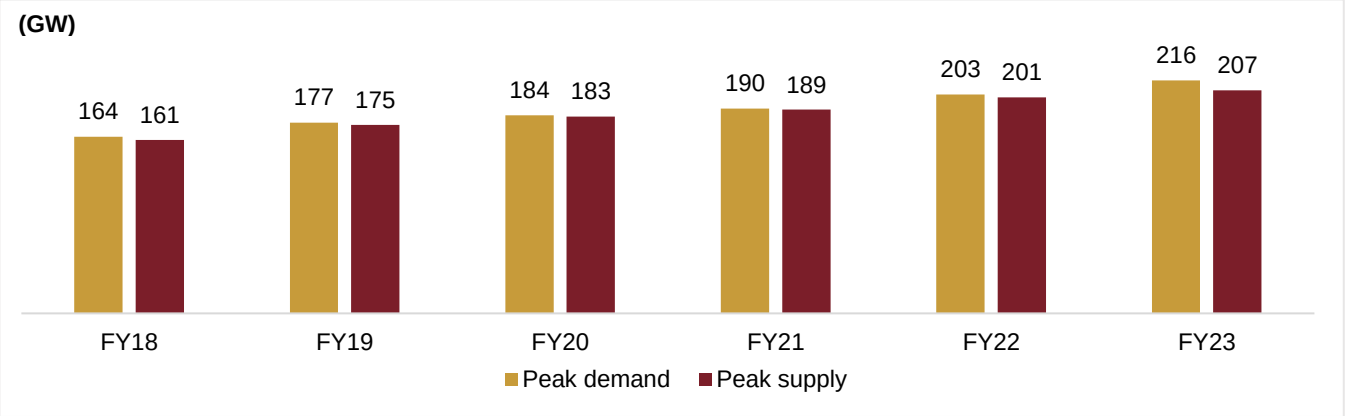


Source: CEA, CRISIL Consulting

Peak electricity demand in India has grown from 164 GW in fiscal 2017 to 216 GW in fiscal 2023 clocking an average growth rate of 5% in the past six years. Peak demand has managed to constantly rise over the past years during fiscal 2021 which witnessed base demand falling into negative territory. Before the pandemic, electricity demand in India usually peaked in August-September, mostly covering the monsoon season. This spike in peak demand was primarily due to an increase in domestic and commercial load, mainly space cooling load due to high humidity conditions. However, post pandemic, annual peak demand is occurring in the summer season (April-July), due to extreme heatwave conditions. Peak demand touched record high levels of 216 GW in fiscal 2023 during April 2022, attributed to an increase in cooling demand as intense summers scorched several regions of the

country. Generation has struggled to keep up with the booming demand, resulting in an increase in peak deficit to 4.3% in fiscal 2023 (up to February) as compared with 1.2% for the same period in fiscal 2022.

Figure 22: Peak power demand and supply



Source: CEA, CRISIL Consulting

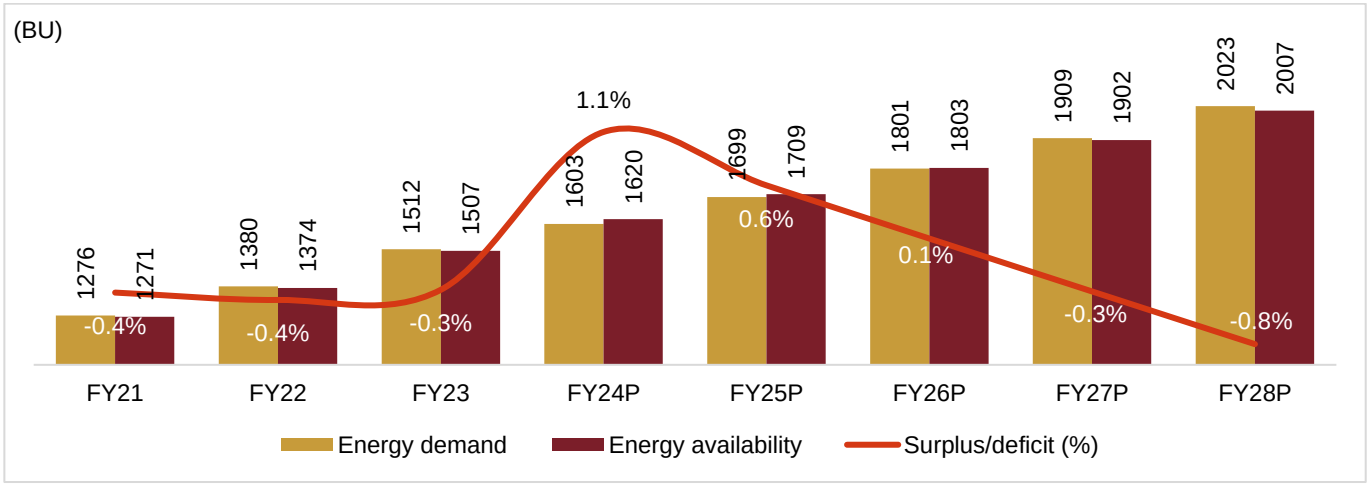
2.3 Demand-supply outlook

2.3.1 Energy demand-supply forecast, fiscals 2024 to 2028

Power demand maintained a strong growth momentum in fiscal 2023 logging a double-digit growth of 10% albeit a moderate base of fiscal 2022. Extreme seasonal vagaries, sustained buoyancy in economic activities along with robust industries activities accelerated power demand. Infrastructure-linked capex, strong economic fundamentals along with expansion of the power footprint via strengthening of T&D infrastructure, coupled with major reforms initiated by the GoI for improving the overall health of the power sector, particularly that of state distribution utilities, are expected to improve the quality of power supply, thereby propelling power demand. CRISIL Consulting expects power demand to log a healthy 5.5-6.0% CAGR between fiscals 2024 and 2028, with the growth trajectory sustaining above the long-term historical growth rate of 5% over the next five years.

Further, the power generation is expected to grow at 5.0 – 5.5% CAGR between fiscals 2024 and 2028. The energy availability across fuels has grown at 4.6% CAGR between fiscals 2018 and 2023, reaching 1,507 BU in fiscal 2023. However, coal-based generation has seen a slower growth at ~2.5% CAGR, with its share in total generation falling from ~75% in fiscal 2017 to ~71% in fiscal 2023. Coal generation is expected to remain flat over the medium term as it peaks by fiscal 2028, however, coal generation will remain a key part of the nation's energy supply mix in the long term. On the other hand, generation from renewable sources grew at a strong ~24% CAGR over the period, thus taking its share up to ~12% in fiscal 2023. Renewable generation is poised for strong growth at 17-18% CAGR over the next five years, with robust capacity additions and improving capacity utilisation factor (CUF) across solar and wind plants on the back of technological improvements. Other fossil and other non-fossil-based generation is expected to grow at a muted pace over the period, with their share in generation remaining falling to 3-4% and 12-13% respectively.

Figure 23: Energy demand outlook (fiscals 2021-28)



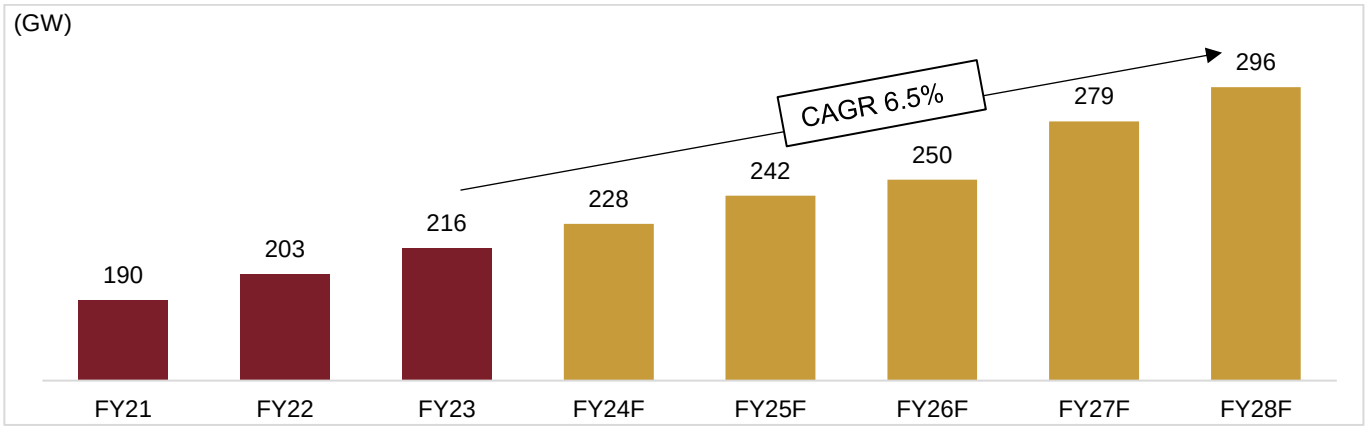
P: Projected,

Source: CEA, CRISIL Consulting

2.3.2 Peak demand outlook

Peak demand has outpaced base demand on several instances. While base demand has grown at a CAGR of nearly 4% over fiscals 2017-22, peak demand has grown at 5%. Even in fiscal 2021 which was marred by the COVID-19 pandemic, base demand entered into negative territory and fell 1.2%, while peak demand grew 3% to 190 GW, which was about half of the country's installed capacity, from almost 184 GW in the prior year. The constant rise in peak demand can be attributed to economic growth, seasonal vagaries, and the increasing daily average temperature India experienced over the last decade. Peak demand is expected to grow annually at ~6.5% over fiscal 2023-28 to nearly 296 GW by fiscal 2028 with expected persistent high temperatures, rising urbanisation, economic growth and infrastructure push leading to higher power consumption.

Figure 24: Peak demand outlook (fiscals 2021-28)



F: Forecast

Source: CEA, CRISIL Consulting

2.3.3 Expected capacity installation by fiscal 2028

A thermal power generation capacity of ~27 GW was under construction as of April 2023. However, CRISIL Consulting expects only 27-28 GW of coal-based power to be commissioned over fiscals 2024-28. In addition, 16-18 GW of hydro including pumped storage projects (PSP) and 6-7 GW of nuclear capacities are expected to be added. National Thermal Power Corporation (NTPC) will dominate capacity additions, with 8.4-8.8 GW being added over the next five years. NTPC also announced five brownfield expansion projects with a cumulative capacity of

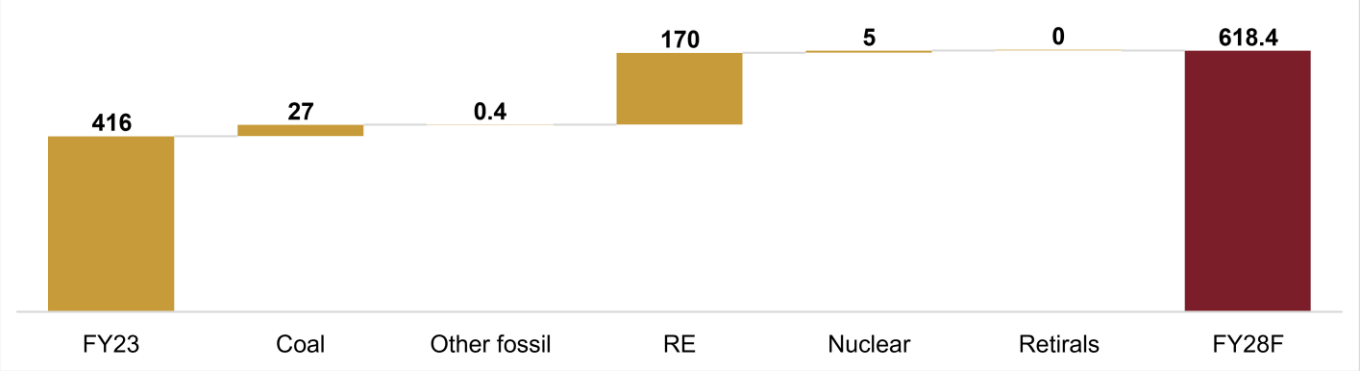
~6.1 GW in fiscal 2023, for which tendering is expected to be carried out over fiscals 2023-25, whereas commissioning is expected to be beyond the next five years. On the other hand, the contribution of private players to conventional capacity additions over fiscals 2024-28 is expected to be 7.8-8.0 GW as compared with ~6.5 GW over the past five years.

Installed generation capacity across fuels reached 416 GW as of fiscal 2023, on the back of healthy renewable capacity additions of ~56 GW over fiscals 2018-23 and is expected to reach 550-600 GW by fiscal 2028 as renewable capacity additions (solar and wind) nearly triple to 166-172 GW over the next five years. Storage-based capacity, consisting of pumped hydro and battery energy storage systems, is likely to reach 24-25 GW by fiscal 2028, driven by PSP and battery energy storage system (BESS) capacity additions of 5-6 GW and 19-20 GW, respectively, over fiscals 2023-28. Also, India's renewed ambitious target of reaching 500 GW of non-fossil fuel capacity by 2030 is likely to involve enhancement of the hydro capacity pipeline to support core renewables such as solar and wind.

The impact of industrialization on big corporates would require transition to environmentally sustainable practices, specifically with regards to reducing carbon emissions and being compliant with Environment, Social and Governance (ESG) standards. This would require companies to expand or install RE based captive power plants which would result in additional capacity installation by private players.

CRISIL Consulting expects 142-147 GW of solar capacity addition between fiscals 2024 and 2028, followed by 24-25 GW through wind. Growth in capacity additions will be driven by government support, with an aggressive tendering roadmap outlined by the government. A few external factors such as an improvement in technology (floating solar and module efficiency), low-cost financing and policy push are enablers. However, a surge in component pricing, additional taxation will increase capital costs consequently affecting the ability of state discoms to offtake power at higher prices.

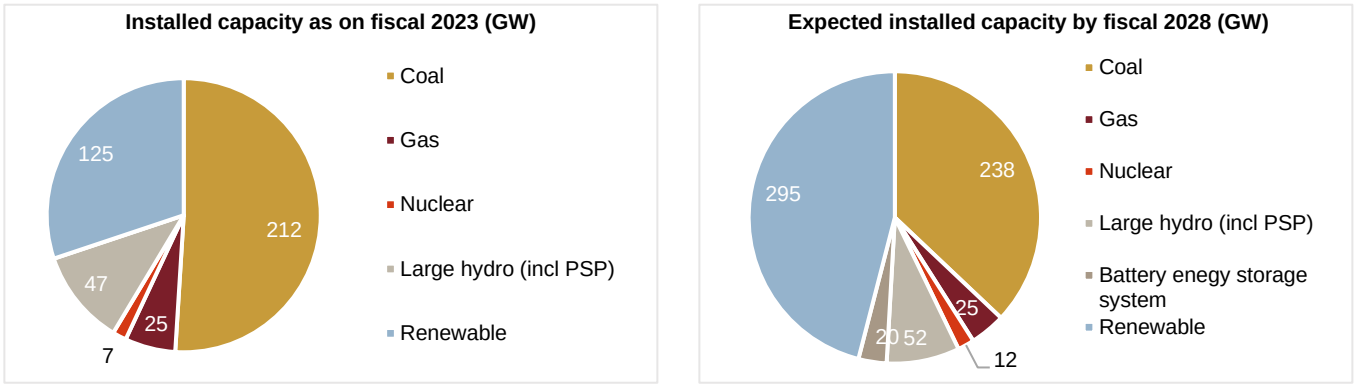
Figure 25: All India installed capacity addition by fiscal 2028 (in GW)



Source: CEA, CRISIL Consulting

The expected installation pipeline would increase the share of renewable capacity (including large hydro and BESS) from 41% in fiscal 2023 to ~57% in fiscal 2028. The share of coal would reduce to 37% from 51% over the same period.

Figure 26: Details of installed capacity

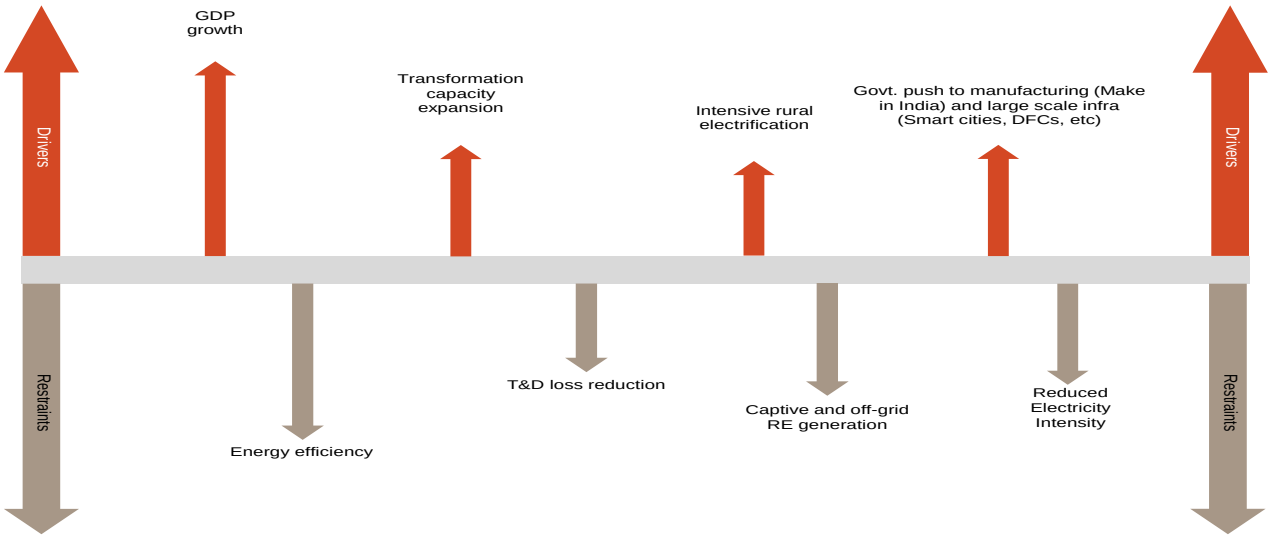


Source: CEA, CRISIL Consulting

2.3.4 Long-term drivers and constraints for demand growth

Power demand is closely associated with a country's GDP. A booming economy automatically leads to a surge in power demand. India is already the fastest-growing economy in the world, with average GDP growth of 5.5% over the past decade. The trickle-down effect of Aatmanirbhar Bharat relief package, government spending on infrastructure through the National Infrastructure Pipeline, commissioning of the dedicated freight corridors, expansion of the services industry, rapid urbanisation, and increased farm income from agriculture-related reforms are key macroeconomic factors fostering power demand. Significant policy initiatives such as 24x7 power for all, Sahaj Bijli Har Ghar Yojana (SAUBHAGYA) scheme to provide electricity connections to all households, green energy corridor to facilitate evacuation of RE power, green city scheme to promote the development of sustainable and eco-friendly cities, Production-Linked Incentive (PLI) scheme and low corporate tax rates among others have aided large scale manufacturing in India, further boosting power demand in the country.

Figure 27: Factors influencing power demand



Source: CRISIL Consulting

Apart from macroeconomic factors, power demand would be further fueled by railway electrification, upcoming metro rail projects, growing demand for charging infrastructure due to increased adoption of electric vehicles, higher demand from key infrastructure and manufacturing sectors. However, increasing energy efficiency, a reduction in technical losses over the longer term, and captive as well as off-grid generation from renewables would restrict growth in power demand.

Figure 28: Infrastructure development to drive power demand

Source: CRISIL Consulting

Railway electrification and metro rail projects to drive a majority of incremental power demand

To become a net zero emitter by 2030, the government aims to achieve 100% electrification of Indian Railways by December 2023. However, given delayed electrification works due to pandemic-induced lockdowns, coupled with the sluggish pace of electrification, 100% electrification is expected to be achieved by fiscal 2027 and lead to incremental power demand of around 27 BUs on average every year. The power sector is poised to witness a majority of incremental demand from railway electrification; however, lower energy consumption for electrification per km due to energy efficiency improvements will partially offset the demand.

Metro rail has seen substantial growth in India in recent years, and the rate of growth is set to double or triple in the coming years with multiple cities seeking metro rail services to meet daily mobility requirements. Around 987 km of metro rail is under construction and 245 km is proposed to be added. These developments are expected to add incremental power demand of 4-5 BUs every year on average. Currently, metro rail projects constitute a marginal share of total incremental demand, but the share is expected to increase due to a large quantum of upcoming metro projects.

Further, EV charging requirements are likely to boost power demand over the medium term, with a gradual increase in the share of EVs in the vehicle population. CRISIL Consulting projects that adoption of EVs will boost power demand by 4-5 BUs annually on average over fiscals 2024 to 2028.

Declining T&D losses, an increase in off-grid/rooftop projects and open access transactions to drive power demand downward

T&D losses have been declining, and the reduction in losses is expected to continue further aided by a slew of government measures, namely the Revamped Distribution Sector Scheme (RDSS). RDSS is a reform-based and result-linked scheme for improving the quality and reliability of power supply to consumers through a financially sustainable and operationally efficient distribution sector. Power demand would be reduced by 16-18 BUs on average every year owing to lower T&D losses.

Further, with a boost to rooftop solar and the declining cost of renewable energy generation, off-grid solar generation is expected to increase, reducing power demand from the grid. By fiscal 2028,15-16 GW of rooftop capacities are expected to come onstream, resulting in a reduction of 1-2% in base demand.

Captive consumption has been on a rising trajectory since fiscal 2013. The top four industries namely iron and steel, sugar, aluminium and steel account for 62% of the total captive consumption. Captive consumption is expected to maintain its growing trajectory going forward driven by increasing production in the mentioned industries. These industries are expected to add 9 GW of captive capacity over the next five years between fiscal 2024 and 2028 adding on an average 160 BUs of demand over the period which may lead to reduction in demand from the grid.

Open access or short-term market transactions currently account for nearly 12% of total electricity generation. The share of short-term transactions is expected to increase to 14% by fiscal 2028 primarily driven by demand pressure, better price discovery at exchanges and a slew of exemptions to the prices in the short term. Demand on the short-term market is expected to increase on average by 27 BUs, resulting in a decline in power demand from the grid.

2.4 Key factors driving solar capacity additions

a. Central and state tendering grows multi-fold with a healthy pipeline giving comfort; resolution of execution-related hurdles critical

In June 2015, the Union Cabinet approved the revision of cumulative targets under NSM, from 20 GW by 2021-22 to 100 GW over the same period. Hence, phase II of the NSM comprised a variety of schemes to attract investments in solar.

In April 2021, ~14 GW under various schemes had been tendered under NSM phases I and II, comprising:

460 MW in phase I, Batch I and II – fully commissioned

680 MW in phase II, Batch I – fully commissioned

3,000 MW under NTPC Vidyut Vyapar Nigam Ltd. (NVVN) Batch II, Tranche I

This scheme was created to lower the cost of solar power by bundling it with thermal power from NTPC's power stations in the ratio of 2:1 (MW terms) and then selling it to discoms. In Tranche I of Batch II, 3,000 MW of projects (of which some capacity was allocated in the Domestic Content Requirement or DCR category) has been fully awarded. The scheme was initially planned in three tranches and for a cumulative capacity of ~12 GW. However, with solar tariffs falling below thermal power tariffs, the scheme has been restricted till Tranche I.

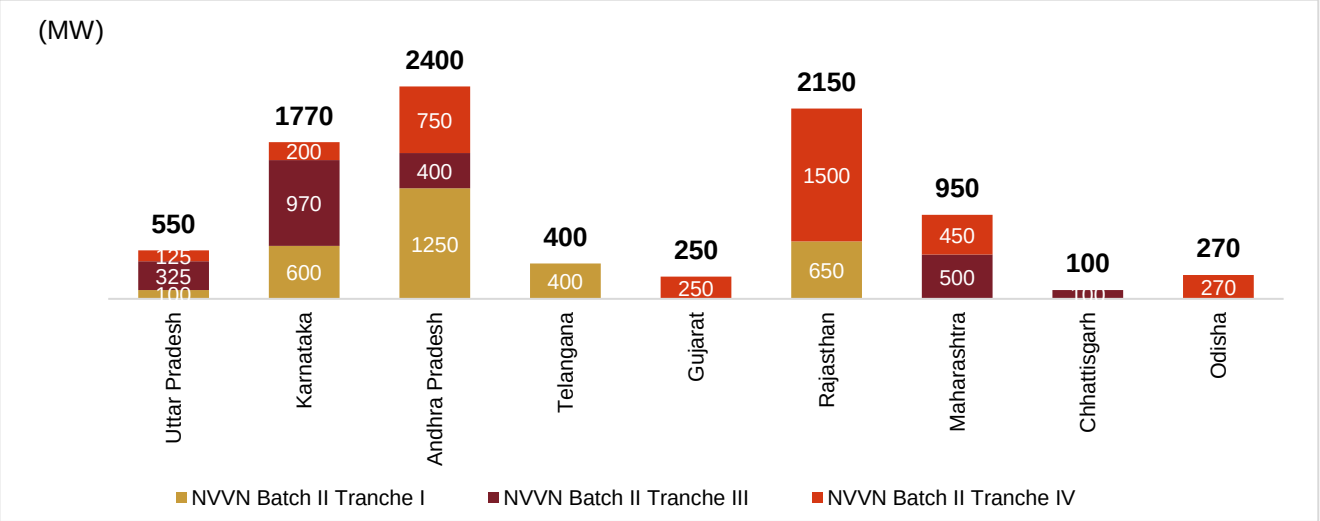
5,840 MW under Batch III and IV of NSM in various locations

Under NSM phase II, Batch III, 2,000 MW of solar PV capacity was envisaged to be installed through a state specific VGF scheme by SECI, but 2,300 MW has already been tendered in this batch, which is estimated to be fully commissioned.

Subsequently, the next batch under the same scheme, i.e., phase II, Batch IV VGF scheme, was envisaged for ~5,000 MW, with ~3,545 MW already tendered and most of the capacity commissioned in this scheme.

The state specific VGF scheme received approval from Cabinet Committee on Economic Affairs (CCEA) and budgetary sanction of ~Rs 7,000 crore (~Rs 1 crore/MW) for VGF disbursement.

Figure 29: Phase II, Batch III and IV (SECI) – state-wise break-up of allocated capacities



Source: CRISIL

b. 12,000 MW (2,027 MW allocated by SECI) under NSM's CPSU programme, 357 MW to be set up on defence establishments.

Through the CPSU programme under JNNSM, the government is encouraging cash-rich central PSUs to set up renewable energy projects. The government expanded the CPSU programme from 1 GW to 12 GW in February 2019, to provide impetus to the domestic solar module manufacturing industry, as procurement by CPSUs for self-consumption is exempt from the WTO ban on DCR. Apart from the CPSU programme, CPSUs such as NLC India Ltd. (NLC) and NTPC have been tendering capacities to set up solar assets outside of this programme, in a bid to diversify portfolios.

With a significant chunk of phase 1 executed, under phase II (programme expanded in February 2019), SECI has issued two tenders of 2,000 MW and 1,500 MW. Both SECI's and NTPC's tenders failed to attract sufficient interest from CPSUs, due to which they undersubscribed (SECI 2 GW, subscribed for only 932 MW and 922 MW allocated, SECI 1,500 MW only ~1,104 MW allocated). However, after that, for a 5 GW tender, the entire capacity has been allocated under CPSU Tranche III and is under construction.

NTPC, for instance, has already commissioned ~2,120 MW of projects under its capacity addition at the end of September 2022. It has commissioned large-scale solar projects of 250 MW each in Andhra Pradesh, Madhya Pradesh, and Rajasthan to achieve the ~60 GW solar target by fiscal 2030.

NTPC is expected to continue robust capacity additions of solar, with the following key tenders allocated/ pending allocation by it as of September 2022:

* 450 MW allocated at SECI 1.2 GW wind-solar hybrid in August 2021.

* 1990 MW allocated at IREDA's 5 GW CPSU Tranche III in September 2021.

* 500 MW allocated at SECI's 1785 MW Rajasthan Tranche IV in December 2021.

* 450 MW allocated at Wind-Solar Hybrid Tranche V in May 2022.

NTPC releases tenders periodically, which are pending allocation and will be a part of the pipeline over the medium to long term.

Similarly, NLC aims to achieve a 2.1 GW renewable portfolio in the medium term and a 6 GW+ renewable portfolio in the long term. It had awarded Engineering, Procurement and Construction (EPC) tenders to BHEL and Jakson Engineers Ltd for a 130 MW (~650-acre) project in Neyveli, Tamil Nadu, which was commissioned in January 2018.

It also completed the commissioning of another 500 MW in Tamil Nadu in March 2019. Further, it has won 510 MW under wind-solar hybrid Tranche IV and is yet to be commissioned. It also has 4 GW+ under the planning stage, comprising more than 2.5 GW of solar. It has announced plans to set up 500 MW projects in Odisha (300 MW), Andaman Islands (50 MW), etc. based on the availability of land and other necessary infrastructure. However, these are still in the planning phase. NLC also won 709 MW under the Tamil Nadu – TANGEDCO 1,500 MW auctions in June 2017, which is now fully commissioned. Other CPSUs such as NHPC, ONGC and GAIL also plan to generate solar power. The Indian Railways has also committed to generating 25% of its power consumption needs through renewables by 2025, and targets 5 GW of solar capacity for the same. It has floated three solar tenders of 1GW, 1.55 GW, 740 MW, and 1 GW RTC tender to date, which are yet to be allocated.

The government plans to set up 357 MW of solar projects in defence establishments, such as cantonments, military stations, ordinance factory boards, and other defence factory establishments. MNRE provided the administrative approval for this scheme on January 7, 2015. It intends to disburse VGF of up to Rs 2.5 crore/MW for projects selling power to the grid at the tariff of Rs 5.5 per unit. CRISIL estimates fulfilment of the entire capacity last fiscal.

c. Other schemes – SECI/MNRE

As of March 2022, SECI is driving certain other schemes:

- ISTS Scheme – ~14.4 GW allocated across various tranches
- Wind-solar hybrid scheme – ~5.6 GW allocated (part of the capacity will be wind)
- Other schemes – ~7 GW allocated across various states

ISTS scheme

Under this, SECI has already allocated 14.4 GW. Projects under this scheme shall be directly connected to PGCIL 's ISTS network and can be located in any part of the country. Land and transmission connectivity costs would be borne by the developer.

Wind-solar hybrid schemes

Under this, SECI has already allocated ~5.6 GW, and would entail setting up of projects with both solar and wind resources to better utilise resources, enhance the energy generation pattern (solar and wind can be complementary in terms of energy generation hours), and ensure better grid stability.

Other schemes – SECI has also been actively issuing tenders other than the ISTS and hybrid schemes. It has issued the following so far:

Table 20: Schemes allocated by SECI as of February 2023

Scheme	Capacity allocated (MW)
SECI Rajasthan Tranche II	680
SECI Dhule Solar Park, Maharashtra	250
SECI Floating Solar Rihand Dam	150
SECI assured peak power supply	1,200
SECI RTC-I	400
SECI Rajasthan Tranche III	1,070
SECI RTC-II (bundled with thermal)	250
SECI Rajasthan Tranche IV	1,785
SECI Karnataka Tranche X	1,200
Total	**6,985**

Source: SECI, CRISIL

d. Manufacturing capacity-linked projects

SECI had floated an expression of interest (EOI) with the proposition of linking solar project tendering to the setting up of module manufacturing capacities. The initially floated proposal was for 5 GW of manufacturing capacities linked to 10 GW of solar projects. This was subsequently reduced to 3 GW of manufacturing capacities but linked to 10 GW of projects. Under the initiative, developers would have had to comply with a 1:3 ratio between manufacturing capacities and projects and adhere to timelines; failure to do so would attract strict penalties. Additionally, developers could only import polysilicon. The remaining manufacturing chain, from silicon wafers to modules, was to be set up. However, they were not necessarily required to use modules manufactured in these capacities for the projects to be set up concurrently; modules from other sources could be used for the purpose.

However, the above tenders failed to attract bidder response, except for a bid from Azure Power for 600 MW of manufacturing capacity and 2,000 MW of solar projects. However, the bid was cancelled due to a disagreement over the final bid price (no auction was conducted, given there was only one bidder).

SECI reissued the tender in January 2019, having reduced the manufacturing component to 1.5 GW and solar project capacity to 3 GW. The tender saw several bid extensions again due to low developer interest. The tariff cap was also set low, at Rs 2.7 per unit. Despite the extensions, the tender could not be allocated, and in June 2019, SECI issued a similar tender again. This time, it was for 2 GW of manufacturing capacity and 6 GW of solar projects, but with a tariff cap of Rs 2.7 per unit. This tender was also extended several times. In October 2019, the tender was scaled up to 7 GW of power generation capacity linked to 2 GW of PV manufacturing capacity. This also included a green-shoe option that developers could avail of if they wished. The tender got allocated in January 2020, with a 1 GW oversubscription (several clauses were amended, and the tariff ceiling was raised). Adani Green Energy (6W of power generation) and Azure Power (2 GW) won the bid. The companies also availed 2 GW each under the green-shoe option. Both these companies recently signed PPAs with SECI for ~4.67 GW and 2.3 GW, respectively.

The capacities for manufacturing-linked tenders are expected to be commissioned in phases from fiscal 2025. Additionally, in September 2021, SECI revised the tariff to Rs 2.54 from Rs 2.92 per unit. This led to a pickup in PSA signing activity for manufacturing-linked tenders, with 1 GW of PSAs signed by TANGEDCO, 0.5 GW by GRIDCO, and the remaining capacity signed by AP discoms.

e. Capacity additions of ~10 GW under construction from different state policies, ~11 GW in tendering, with the majority under the PM-KUSUM scheme

Vide its notification dated July 22, 2019, MNRE issued guidelines for implementation of Pradhan Mantri Kisan Urja Suraksha evem Utthan Mahabhiyan (PM KUSUM) scheme. The scheme has the following components:

- Component-A: Setting up of 10,000 MW of decentralised ground-mounted grid-connected solar power plants of individual plant size up to 2 MW
- Component-B: Installation of 17.50 lakh standalone solar powered agriculture pumps of individual capacity up to 7.5 HP
- Component-C: Solarisation of 10 lakh grid-connected agriculture pumps of individual pump capacity up to 7.5 HP

All three components of the scheme targeted to add solar capacity of 25,750 MW by 2022, with total central financial support of Rs 34,422 crore.

Subsequently, MNRE, in November 2020, scaled up and expanded the PM KUSUM scheme to 30.8 GW. Subsequently, in February 2023, the government extended the Scheme till 31.03.2026.

Some of the key tenders issued by States under KUSUM:

- RRECL, Rajasthan, 725 MW

- TANGEDCO, Tamil Nadu, 500 MW
- OREDA, Odisha 500 MW
- MPUVNL, Madhya Pradesh, 595 MW (Component A)
- MPUVNL, Madhya Pradesh, 1110 MW (Component C)
- MSEDCL, Maharashtra, 1820 MW (Combined for component A and C)
- KSEB Kerala, 40 MW
- UPNEDA, Uttar Pradesh, 100 MW
- Jharkhand, JBVNL, 50 MW etc.

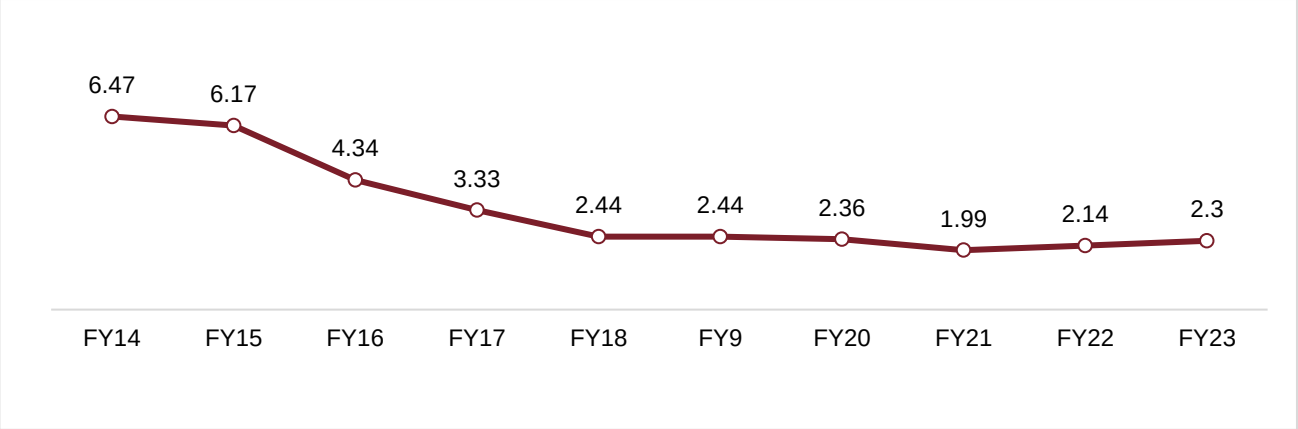
As per KUSUM Website, as on May 31, 2023, the total installed capacity under component A is 106.95 MW against total sanctioned capacity of 4913 MW. Some of the reasons for low response could be aggressive ceiling tariffs, payment security risks, requirement of DCR Modules, poor monetary power of farmers for putting in equity.

f. Considerable under-construction capacity expected to be commissioned

Solar tariffs have been trending downward in the recent past, led by lower capital costs amid falling module prices, the availability of cheaper debt, and a short window of duty pass-throughs, among other factors. This resulted in a record low tariff of Rs 2.36 per unit in the SECI ISTS-IX auctions in June 2020 and an even lower ~Rs 2.0 per unit tariff bid in the SECI Rajasthan-III auctions in November 2020. However, developers have kept bids in the range of Rs 2.3-2.5 per unit in most auctions, be it central or state, as the supply-side pricing surge has led to a rise in tariffs.

Solar tariffs have been trending upward in fiscal 2023, led by higher capital costs amid increasing module prices and higher interest rates on debt, among other factors. This resulted in solar tariffs increasing to Rs 2.7-2.9 per unit until February 2023. However, module prices have started to fall, and with the abeyance of ALMM tariffs, are expected to decline to Rs 2.5-2.7 per unit.

Figure 30: Minimum tariff discovered for solar (Rs. /kWh)



Source: MNRE, Industry, CRISIL Consulting

That said, state bids, unlike central bids, have higher variability in terms of payment security, provision of infrastructure, penalty clauses, and commissioning schedules. State income credibility and back-down incidents in the state also affect state bids. As a result, bid tariffs are influenced by these factors and vary between auctions.

CRISIL Consulting expects a large proportion of the under-construction capacity, of ~12 GW, to be commissioned between 2024 and 2028, and the upcoming 11 GW currently tendered, to likely come up over fiscals 2024 to 2028.

g. 14-15 GW of rooftop solar capacity addition expected over fiscals 2024 to 2028

Rooftop projects are small-scale solar PV installations on the roofs of buildings. In the government's 100 GW target, 40 GW is attributed to rooftop solar projects. The total solar rooftop installed capacity as of February 2023 is estimated at ~8.5 GW (refer to the chapter on solar rooftop for a detailed analysis), which is quite far from the required target. In fiscal 2023, to date, rooftop capacity additions are estimated to be ~1.8 GW.

Although the MNRE has entrusted SECI with the implementation of large-scale, grid-connected rooftop PV projects with subsidy support from the NCEF, inherent technical and operational issues associated with discoms, coupled with delayed clearances, have slowed growth in capacity additions. This issue is proposed to be resolved via the Solar Rooftop Implementation for Solar Transfiguration of India (SRISTI) scheme. It has been proposed by the MNRE with an approval of Rs 11,000 crore and is aimed at making state distribution utilities the nodal agency for the central rooftop subsidy programme, while providing incentives to promote rooftop installations in their areas of jurisdiction.

Considering the sector's slow growth rate in the residential segment, while also factoring in the spurt in installations by commercial, industrial, and government organisations, CRISIL Consulting expects 14-15 GW of rooftop solar capacity additions over fiscals 2024 to 2028 and Karnataka, Andhra Pradesh, Telangana, Rajasthan, Tamil Nadu, Maharashtra, and Gujarat to account for over 50% of total additions, led by favourable economics and incentives.

h. 500 GW non-fossil target by 2030 under COP26 to drive solar capacity additions

India set an ambitious goal at the COP26 summit. Addressing the UN's Climate Change Conference in Glasgow in November 2021, Prime Minister Narendra Modi announced that India would achieve a net-zero emissions target by 2070, revised the non-fossil-based target from 450 GW to 500 GW by 2030, and pledged to reduce the carbon intensity of the country's economy by 45% within the decade. Further, the MOEFCC has stated that 50% of the installed power generation capacity will likely be from renewable energy, indicating increased thrust towards renewable capacity additions. This is expected to ensure continued positive regulatory support, which is a critical enabler of capacity additions in the segment.

i. PLI scheme for domestic module manufacturing

On November 11, 2020, the government introduced the PLI scheme for 10 key sectors (which was later extended to 14 sectors) to enhance India's manufacturing capabilities and exports under its Aatmanirbhar Bharat initiative.

One of the 14 sectors for which PLI was approved is high-efficiency solar PV modules, for which, the MNRE has been designated as the implementing ministry. The financial outlay for the PLI scheme is Rs 4,500 crore over a five-year period. This was later increased to Rs 24000 crore.

The scheme is aimed at promoting the manufacture of high-efficiency solar PV modules in India and thus, reducing import dependence in the area of renewable energy. The MNRE will implement the scheme through IREDA as the implementing agency. For Tranche II, SECI was given the responsibility of conducting bidding process.

Beneficiaries of the scheme were to be selected via a bidding process. To qualify, a manufacturer was required to set up a plant of minimum 1,000 MW capacity. Manufacturers were also required to fulfil the following minimum performance parameters:

- Minimum module efficiency of 19.50% with the temperature coefficient of Pmax better than -0.30% per degree Celsius, or
- Minimum module efficiency of 20% with the temperature coefficient of Pmax equal to or better than -0.40% per degree Celsius

In September 2021, IREDA, the implementing agency, released the list of PLI scheme participants, and the scheme received a response of 54.8 GW worth of bids for a 10 GW scheme. Bids of ~19 GW were submitted for the manufacture of polysilicon, 32 GW for wafers, and 54.8 GW for cells and modules.

The following bidders were announced as winners for Tranche I

Table 21: Winners for Tranche I

Sr. No.	Bidder name	Manufacturing capacity (MW)	Eligible capacity (for PLI) (MW)	Integration
1	Shirdi Sai Electricals Ltd.	4,000	2,000	Stage 1+ Stage 2+ Stage 3+ Stage 4
2	Reliance New Energy Solar Ltd.	4,000	2,000	Stage 1+ Stage 2+ Stage 3+ Stage 4
3	Adani Infrastructure Pvt. Ltd.	4,000	2,000	Stage 1+ Stage 2+ Stage 3+ Stage 4

Source: IREDA, CRISIL Consulting

Reliance New Energy Solar's PLI award amount was Rs 1,917 crore for a capacity of 4 GW. Shirdi Sai Electricals was Rs 1,875 crore for 4 GW and Adani Infrastructure's was Rs 663 crore, out of the total quoted amount of Rs 3,600 crore for a capacity of 737 MW under the bucket-filling method. Details of stages 1 to 4 of the manufacture of polysilicon, ingot wafers, cells, and modules, are summarised below.

Table 22: Solar PLI scheme manufacturing stages

Mfg. stage	Input	Final product
1	M.G. silica	Polysilicon (P)
2	Stage 1 polysilicon	Ingot wafer (W)
3	Stage 2 ingot wafer	Cell (C)
4	Stage 3 cell	Module (M)

Source: IREDA, CRISIL Consulting

In March 2023, the government, through SECI, allocated 39.6 GW of domestic solar PV module manufacturing capacity under the PLI scheme (Tranche-II) to 11 companies, with a total outlay of ~Rs 14,000 crore. Total manufacturing capacity of 7,400 MW is expected to become operational by October 2024, 16,800 MW by April 2025, and the remaining 15,400 MW by April 2026.

Table 23: Capacity awarded under the PLI scheme (Tranche-II)

Sr. No	Bidder	Manufacturing capacity (MW)	Eligible capacity (For PLI) (MW)	Integration
1	Indosol	6,000	3,000	Stage 1+ Stage 2+ Stage 3+ Stage 4
2	Reliance	6,000	3,000	Stage 1+ Stage 2+ Stage 3+ Stage 4
3	First Solar	3,400	1,700	Stage 1+ Stage 2+ Stage 3+ Stage 4
Total		**15,400**	**7,700**	
1	Waaree	6,000	3,000	Stage 2+ Stage 3+ Stage 4
2	Avaada	3,000	1,500	Stage 2+ Stage 3+ Stage 4
3	ReNew	4,800	2,400	Stage 2+ Stage 3+ Stage 4
4	JSW	1,000	500	Stage 2+ Stage 3+ Stage 4
5	Grew	2,000	1,000	Stage 2+ Stage 3+ Stage 4
Total		**16,800**	**8,400**	
1	Vikram	2,400	1,200	Stage 3+ Stage 4
2	AMPIN	1,000	500	Stage 3+ Stage 4
3	Tata Power Solar	4,000	2,000	Stage 3+ Stage 4
Total		**7,400**	**3,700**	
Grand total		**39,600**	**19,800**	

Source: SECI, CRISIL Consulting

2.5 Key factors driving wind capacity additions

a) New tender opportunities

New opportunities have emerged in the wind sector in India with SECI coming up with newer kind of project tenders in the form of hybrid, round-the-clock, and peak power supply projects.

Although the exact split of wind vs solar for hybrid projects is based on developer choice and technical design, they tend to have a higher share of solar energy, due to lower capital costs and ease of installation. However, since hybrid projects have a floor cap on capacity contribution from solar and wind (power capacity of one resource is at least 33% of the rated power capacity of the other resource), they contribute to capacity additions for wind. Similarly, round-the-clock and peak power supply projects also generate substantial demand for wind capacity addition as developers require a good mix of sources (solar, wind and/or energy storage) to get the maximum possible efficiency. Furthermore, solar-wind hybrid tenders will lead to 5-6 GW capacity additions of wind over the next five years with existing schemes. With fresh hybrid tenders in the industry, the additions will further increase gradually over the long term.

b) Improved technology

Newer wind turbines are being launched that have higher rated capacity and higher hub height (over 100 m), which can be set up at low-quality wind sites, otherwise considered economically unattractive. However, plant load factors and subsequent viability would vary. Technological advancements have allowed players to set up windmills in states/sites with lower wind density. Based on our estimates, for every 100-bps change in PLFs, equity IRRs improve by 100-150 bps. As per industry interactions, the capital costs will also encompass improvement in turbine technology, and 2-3.5 MW wind turbine technology will possibly be summoned. This improvement in technology will enable capacity additions outside the windy region and allow developers to transition from key windy regions to other areas, thereby driving capacity additions.

c) Large-scale central allocations

Post competitive bidding of 1 GW by SECI in February 2017, SECI further allocated ~15 GW (excluding cancelled contracts) of capacities over March 2017-June 2023 through wind only schemes. MNRE has outlined further plans to tender 10GW of capacity each year, of which the majority portion should be expected from SECI/PTC. This bodes well as central sector PPAs have lower counterparty risk compared with PPAs directly with discoms. The latter are known to delay payments to developers and have poor financial ratings, while SECI and PTC are better rated and provide various payment security mechanisms (LCs, payment security fund and SECI being party to the tripartite agreement).

d) Upward revision in RPO targets

The Ministry of Power (MoP) provided a new RPO long-term trajectory for wind energy till fiscal year 2030 which propose target of 0.81% for wind in fiscal 2023, increasing consecutively to 6.94% in fiscal 2030 for wind.

Currently, most of the states in India have set lower RPO targets (pan-India avg. non-solar RPO target in fiscal 2023 is 8.9% vs 10.50% required as per MoP), resulting in higher compliance vis-à-vis the set targets. To meet the increased targets, states would have to procure more renewable energy either via the REC route (which still leads to capacity additions) or via competitively bid out capacities. The waiver of Inter-state transmission system (ISTS) charges by Central electricity regulation commission (CERC) for all projects set up until fiscal 2025 also enables the states with low renewable potential to procure renewable power from more able states. However, RPO compliance is dependent on strict enforcement by regulatory authorities. Amendment to the Electricity Act, 2003 has been proposed to include stricter provisions on penalisation for non-compliance; however, this is yet to be passed.

e) Accelerated depreciation

Historically, particularly in fiscals 2015 and 2016, accelerated depreciation (AD) had been a key driver for capacity additions. However, going forward, CRISIL Consulting expects capacity additions under this mode to be restricted only to large conglomerates in other unrelated businesses but seeking tax breaks. While AD was halved to 40% from April 2017 onwards, it will continue to support additions in open-access segment.

f) High industrial tariffs in select states

In states such as Maharashtra, Karnataka, Tamil Nadu and West Bengal, where industrial tariffs are high (Rs 6-6.5/unit), wind power is an attractive option since generation cost is about Rs 3.0-4.0 per unit. Capacity can be set up via the open-access mode, i.e., bilateral agreements directly with consumers such as commercial/industrial entities.

g) National Green Hydrogen Mission

The National green Hydrogen Mission with an objective to make India leading producer and supplier of Green Hydrogen by developing at least 5 MMT of Green hydrogen per annum by 2030. But production of green hydrogen is expected to start from fiscal 2026 itself, necessitating installation of renewable from fiscal 2024. Demand from green hydrogen is expected to be 9-10 GW between fiscals 2024 and 2028 which will drive the additions but will remain a key monitorable.

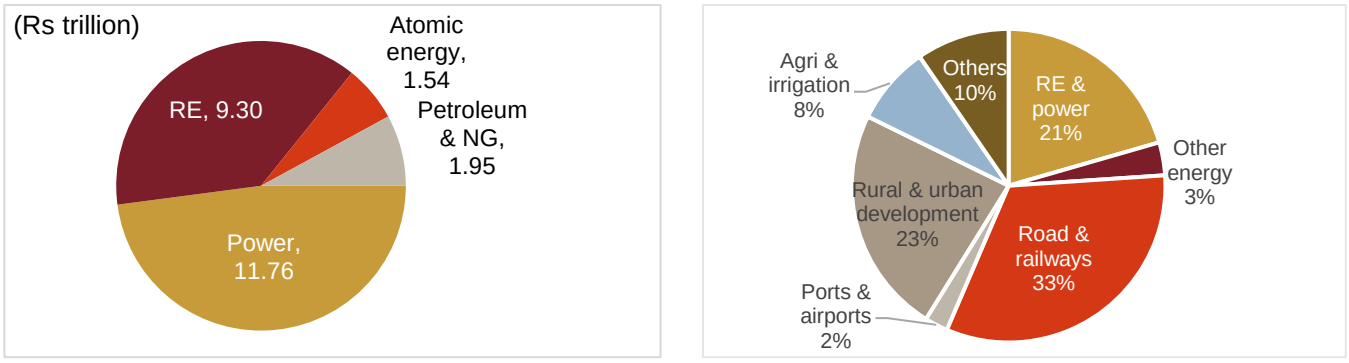
2.6 Proposed investments in the power sector

2.6.1 National Infrastructure Pipeline

The National Infrastructure Pipeline (NIP) is a roadmap to boost infrastructure across India and showcase investment opportunities in the domestic infrastructure sector, improve project preparation and attract investments into the country. The NIP aims to raise investments for key greenfield and brownfield projects across all economic and social infrastructure sub-sectors on a best-effort basis.

A total investment of ~Rs 102 lakh crore has been proposed between fiscals 2020 and 2025 out of which around 24% has been allocated to the energy sector. The allocation of projected capital expenditure is as follows:

Figure 31: Proposed investment in energy sector under NIP & the share of key infrastructure sectors

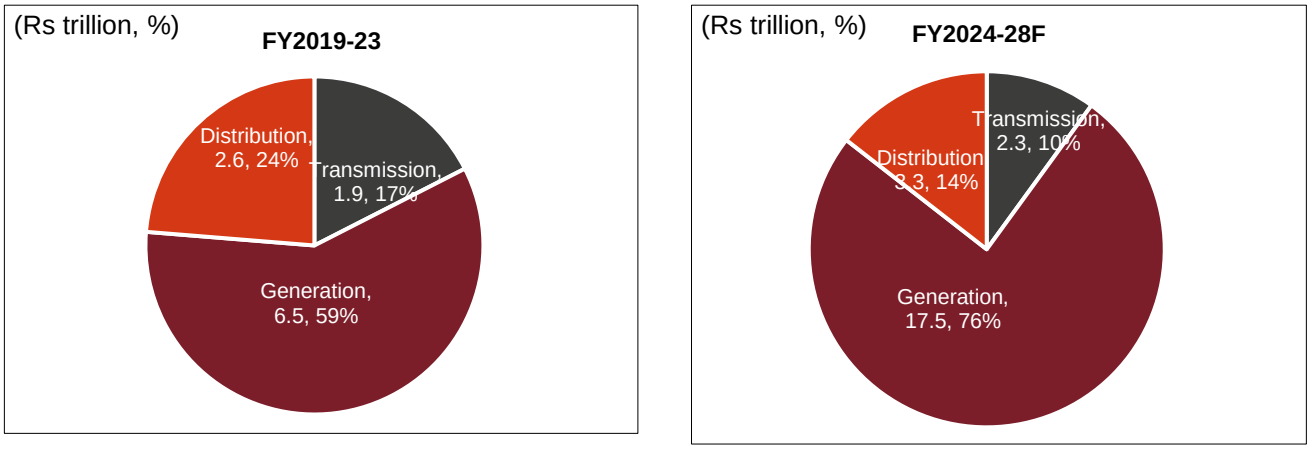


Source: CEA, CRISIL Consulting

2.6.2 Investments in generation, transmission, and distribution infrastructure

CRISIL Consulting projects investments of Rs 23-23.5 trillion in the power sector over the next five years. The share of investments in generation is expected to increase and that of distribution to decrease over the next five years compared with fiscals 2019-23 due to capacity additions aimed at clean energy.

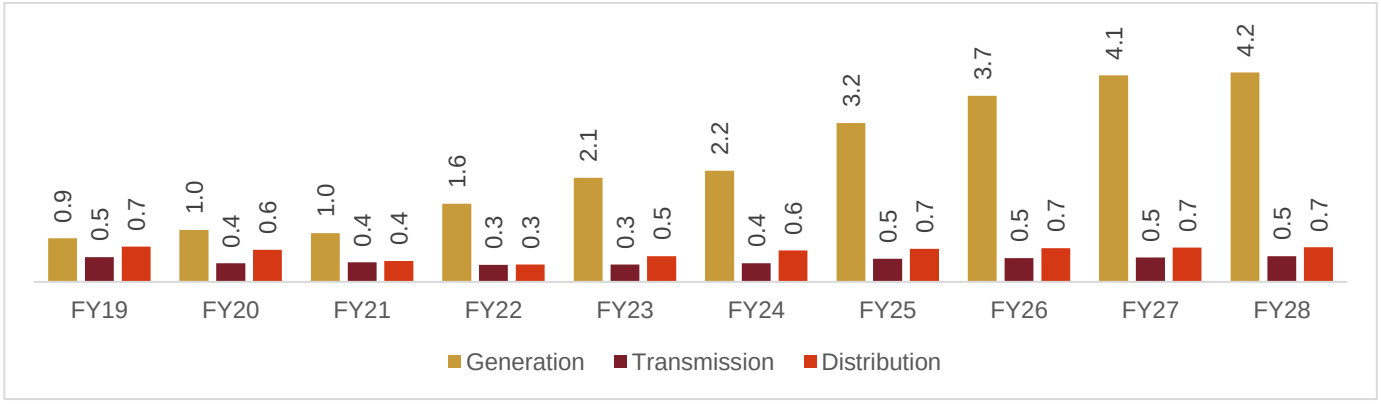
Figure 32: Segment-wise break-up of total investments shows dominance of the generation segment



The numbers do not include private sector investments in T&D sector

Source: CRISIL Consulting

Figure 33: Year wise break up of investments (Rs. Trillion)

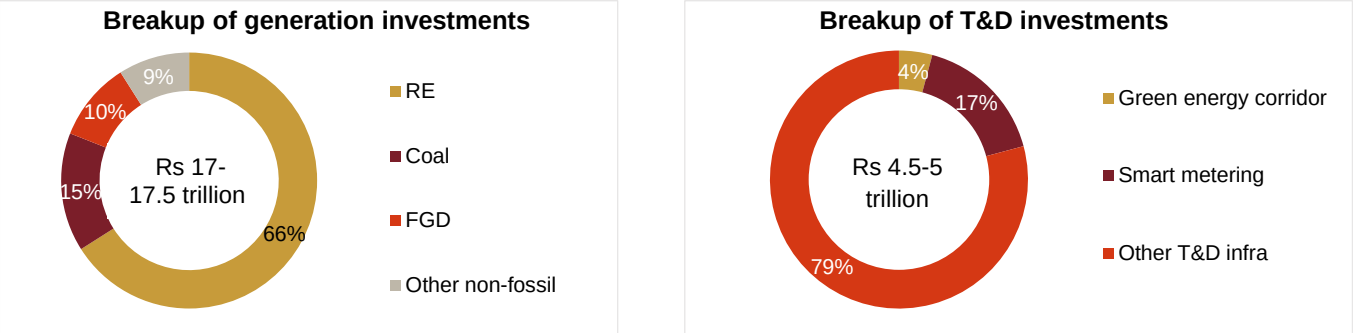


The numbers do not include private sector investments in T&D sector

Source: CRISIL Consulting

Investments in the generation segment are expected to almost triple from ~Rs 6.5 trillion to Rs 17.5 trillion over the next five years driven by renewable and conventional capacity additions of 275-280 GW. Investments in distribution to marginally increase over the next five years from Rs. 2.6 trillion to Rs. 3.3 trillion, on the back of RDSS envisaged over fiscals 2023-26. Transmission sector investments will grow to Rs 2.3 trillion, led by upcoming ISTS and GEC projects.

Figure 34: Breakup of investments (FY24F-FY28F)



The numbers do not include private sector investments in T&D sector

Source: CRISIL Consulting

Investments in generation will be led by renewable energy capacity additions, followed by investments in conventional generation and flue gas desulfurization (FGD) installations, indicating a shift in fund flows towards enhancing clean energy supply. Investments in RE capacity, which are expected to more than double over the next five years, in line with capacity additions, will constitute over 65% of overall generation investments. Investments in the segment will be bolstered by ~40% increase in conventional generation investments over the next five years as against the last five years, as new coal-based plants will be set up to meet the fast-growing peak load demand and increased installation of emission controlling FGD equipment in thermal stations. Total generation investments are expected to grow ~3x over fiscals 2024-28 compared with fiscals 2019-23.

To service a large generation installed base, the estimated investment in the transmission sector is expected to cumulatively reach ~Rs 2.3 trillion for fiscal 2024-28 driven by the need for a robust and reliable transmission system to support continued addition in generation capacity and the strong push to the renewable energy sector as well as rural electrification. Also, strong execution capability, coupled with healthy financials of PGCIL, will drive investments.

The distribution segment is expected to attract investments worth Rs 3-3.5 trillion over fiscals 2024-28 compared with ~Rs 2.6 trillion over the last five years, led by the government's thrust on improving access to electricity and providing 24x7 power to all. Investments in the segment are likely to pick up gradually from this fiscal onwards with central/state government(s) expected to provide the required funding support.

The share of the private sector in overall power sector investments during fiscals 2024-28 is expected to increase to 48% from ~30% over the past five years largely driven by renewable capacity additions, bulk of which are funded by private investments. The share of the central sector would decrease to ~16% over fiscals 2024-28 compared with ~24% over the previous five years. The state sector is expected to account for over 36% of power investments led by both RDSS and generation investment.

2.7 Technological advancements in the power sector through artificial intelligence

Artificial intelligence (AI) holds immense potential in revolutionizing the energy sector by mitigating energy waste, reducing cost, and expediting the adoption of renewable energy sources. It plays a pivotal role in enhancing the overall efficiency and effectiveness of power system operations, maintenance, control, planning, and plan execution.

The power sector in developed countries has already started using AI, Data Analytics, Internet of Things (IoT), and related technologies that allow for communication between smart grids, smart meters, and computer devices. These technologies help prevent power mismanagement, inefficiency, and lack of transparency, while increasing

the use of renewable energy sources.

Electricity providers and grid operators have the capacity to leverage AI and machine learning technologies to predict power generation, plan maintenance schedules, and efficiently manage the distribution of electricity. Concurrently, consumers can access real-time information about the electricity supply, enabling them to better regulate their consumption, adopt distributed energy generation, and utilize energy storage solutions, ultimately leading to reduced energy costs. The growing integration of smart meters facilitates the collection of valuable data, which AI algorithms can then utilize to forecast demand and network loads, thereby optimizing energy consumption from RE and battery systems.

AI technology can analyse real-time and historical weather data to deliver highly accurate weather forecasts. This, in turn, enhances the dependability of solar and wind power systems. By processing vast volumes of meteorological data related to solar intensity, AI can make informed predictions and optimal decisions on when to collect, store, and distribute wind or solar energy.

The power industry stands to benefit significantly from the implementation of AI-managed smart grids, promising and bright future. These smart grids, if well-implemented, have the capability to optimize power utilization, thereby elevating the efficiency of power delivery and consumption. Notably, AI acts as a link that connects power generators, grid managers, and end consumers, ensuring seamless and efficient service delivery.

Some of the areas where AI can be implemented are:

- Power load forecasting: Future demand forecasting for optimization of generation and distribution resources.
- Renewable energy integration: Improved integration of variable renewable energy and reduced dependence on harmful fossil fuels.
- Grid security: Improving detection and response to cyber-attacks.
- Asset management: Tagging of assets, prediction of conditions and scheduling maintenance on time.
- Demand response: Demand side management especially during peak so as to avoid any damage to the system.
- Intelligent fault detection: Advance prediction of faults in power transmission equipment/lines
- Smart grid optimization: Optimization of electrical grid by managing real time demand supply

The use of AI in the power sector is still in nascent stage, but it has the potential to revolutionize the way power is being generated, distributed, and consumed.

3 Overview of power transmission segment

3.1 Overview and structure – India

The transmission segment plays a key role in transmitting power continuously to various distribution entities across the country. The transmission sector needs concomitant capacity addition, in line with generation capacity addition, to enable seamless flow of power.

A transmission and distribution (T&D) system comprises transmission lines, substations, switching stations, transformers, and distribution lines. To ensure reliable supply of power and optimal utilisation of generating capacity, a T&D system is organised in a grid which interconnects various generating stations and load centres. This is done to ensure uninterrupted power supply to a load centre, even if there is a failure at the local generating station or a maintenance shutdown. In addition, power can be transmitted through an alternative route if a particular section of the transmission line is unavailable.

In India, the T&D system is a three-tier structure comprising distribution networks, state grids, and regional grids. The distribution networks and state grids are owned and operated by the respective state transmission utilities or state governments (through state electricity departments). Most inter-state and inter-regional transmission links are owned and operated by the PGCIL which facilitates the transfer of power from a surplus region to one with deficit.

The T&D system in India operates at several voltage levels:

- Extra high voltage (EHV): 765 kV, 400 kV and 220 kV
- High voltage: 132 kV and 66 kV
- Medium voltage: 33 kV, 11 kV, 6.6 kV and 3.3 kV
- Low voltage: 1.1 kV, 220 volts and below

Transmission and sub-transmission systems supply power to the distribution system, which, in turn, supply power to end consumers. To facilitate the transfer of power between neighbouring states, state grids are inter-connected through high-voltage transmission links to form a regional grid. There are five regional grids:

- Northern region: Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Rajasthan, Uttarakhand, and Uttar Pradesh
- Eastern region: Bihar, Jharkhand, Orissa, Sikkim, and West Bengal
- Western region: Dadra and Nagar Haveli, Daman and Diu, Chhattisgarh, Goa, Gujarat, Madhya Pradesh, and Maharashtra
- Southern region: Andhra Pradesh, Karnataka, Kerala, Puducherry, and Tamil Nadu
- North-eastern region: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura

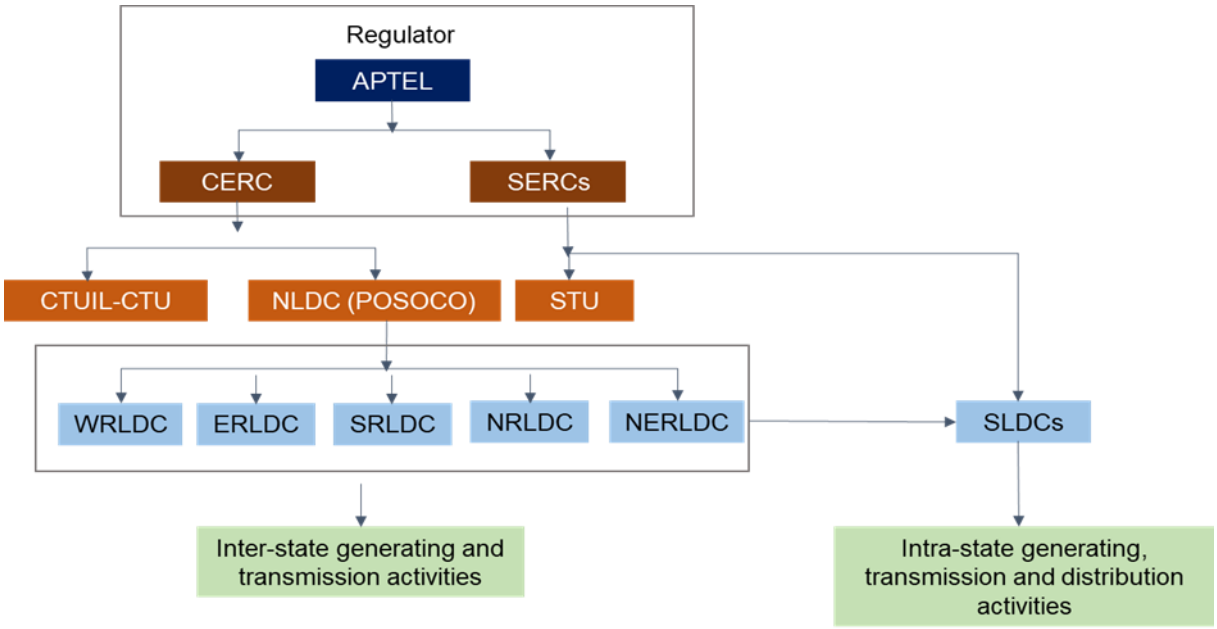
As peak demand for power does not take place at the same time in all states, it results in a surplus in one state and deficit in another. Regional or inter-state grids facilitate the transfer of power from a surplus region to the one facing a deficit. Additionally, they also facilitate the optimal scheduling of maintenance outages and better coordination between power plants.

3.1.1 Regulatory overview

Power transmission regulations in India are governed by various regulatory bodies and frameworks that ensure the efficient and reliable transmission of electricity across the country. The key regulatory and legislative aspects related to power transmission in India include:

Electricity Act, 2003: The Electricity Act, 2003, is the primary legislation governing the power sector in India. It provides the legal framework for generation, transmission, distribution, and trading of electricity.

Figure 35: Transmission sector regulatory framework



Central Electricity Regulatory Commission (CERC): The CERC is the central regulatory authority in India responsible for regulating the power sector, including transmission. It sets tariffs, regulates inter-state electricity transmission, and ensures fair competition in the sector. CERC also oversees the development of the National Grid and interstate transmission.

State Electricity Regulatory Commissions (SERCs): Each Indian state has its own State Electricity Regulatory Commission, which is responsible for regulating power generation, distribution, and transmission within the state. These commissions set tariffs for intrastate transmission and ensure compliance with relevant regulations.

CTU (Central Transmission Utility): CTU is a central-level organization responsible for operating and managing the national or inter-state transmission system. CTUIL operates as the CTU in India

Grid Controller of India Limited (GRID-INDIA): The new name of Power System Operation Corporation Limited (POSOCO) is Grid Controller of India Limited (Grid-India) since 09th November 2022. It is responsible to monitor and ensure round the clock integrated operation of Indian Power System. It consists of 5 Regional Load Despatch Centres (RLDCs) and the National Load Despatch Centre (NLDC).

PGCIL (Power Grid Corporation of India Limited): PGCIL is a Maharatna public sector undertaking in India. It is responsible for the planning, development, and maintenance of the country's high-voltage transmission systems.

STU (State Transmission Utility): STUs are state-level organizations responsible for the planning, development, maintenance, and operation of intra-state transmission systems. They ensure the efficient and reliable transmission of electricity within their respective states.

SLDC (State Load Despatch Centre): It is the nerve centre for State Power System operating. Principal activities include operating State power system in most economical way by economic load despatching, merit order operation.

Tariff Regulations: CERC and SERCs regularly review and set tariffs for transmission services, which include charges for using the transmission network. These tariffs are based on various factors, including capital costs, operational expenses, and return on equity for transmission companies.

Open Access Regulations: The Electricity Act, 2003, promotes open access in the transmission system, allowing consumers to choose their source of power supply and utilize the transmission network efficiently. Regulations related to open access vary by state.

Grid Standards: The Central Electricity Authority (CEA) is responsible for setting and enforcing grid standards and codes to ensure the reliability and safety of the power transmission network.

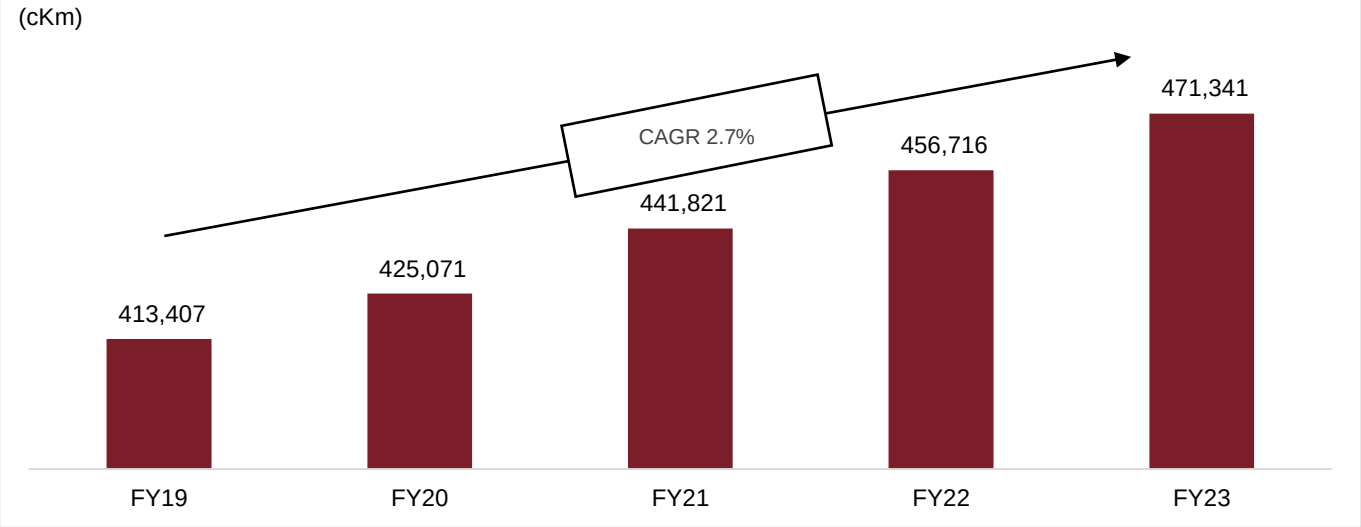
Cross-Border Transmission: India also has cross-border electricity transmission interconnections with neighbouring countries like Nepal, Bhutan, and Bangladesh. These interconnections are governed by bilateral agreements and specific regulatory frameworks.

3.2 Transmission Infrastructure Growth

3.2.1 Market Review

Robust generation capacity addition over the years and government's focus on 100% rural electrification through last mile connectivity has led to extensive expansion of the T&D system across the country. The total length of domestic transmission lines rose from 413,407 circuit kilometres (ckm) in fiscal 2019 to 471,341 ckm in fiscal 2023.

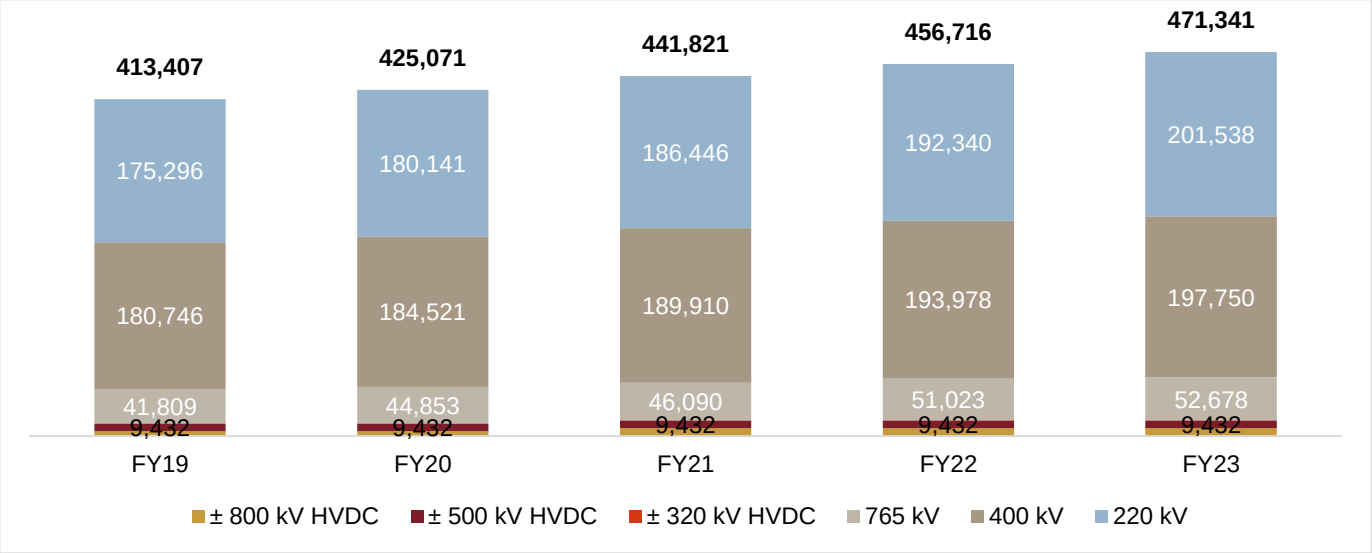
Figure 36: Total transmission line network in the country (220 kV and above)



Source: CEA, CRISIL Consulting

There has been strong growth in the transmission system at higher voltage levels and substation capacities. This is a result of increased requirement of the transmission network to carry bulk power over longer distances and at the same time optimise the right of way, minimise losses and improve grid reliability.

Figure 37: Strong growth in the length of high voltage transmission lines (220 kV and above)



Source: CEA, CRISIL Consulting

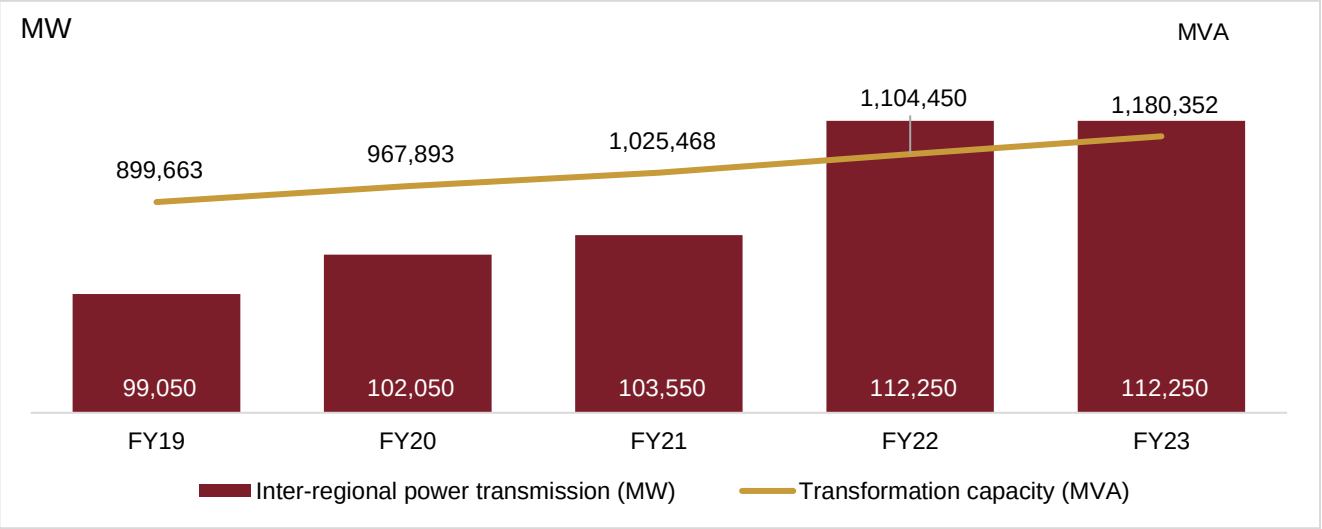
Strong growth of transmission system at higher voltages has grown due to increased requirement of the transmission network to carry bulk power over longer distances and at the same time optimise the right of way, minimise losses, and improve grid reliability.

The transmission sector, a crucial part of the power industry, required more attention to meet the growing demand for electricity and the expanding generation capacity. Existing investments from budgets, internal funds, and PSU loans were insufficient to meet this demand. To address this issue, the Electricity Act allowed private companies to participate in the power transmission sector through a competitive bidding process called tariff-based competitive bidding (TBCB). The National Tariff Policy of 2006 provided guidelines for this process, aiming to promote competition, attract private investment, and increase transparency in constructing transmission infrastructure. India stands out as one of the few countries that have opened its transmission sector to private participation, generating significant interest from private businesses. The Electricity Act, 2003 coupled with TBCB for power procurement, encouraged private participation in the power transmission sector and has supported the growth of transmission lines in India sector.

The total transmission line length (above 220 kV) has increased at 3.3% CAGR from fiscal 2019 to fiscal 2023. This increase can also be attributed to an increase in the commissioning of the 765-KV lines, growing at a CAGR of ~6% over the same period. 765 kV lines have higher transfer capacity and lower technical losses thereby reducing the overall number of lines and rights of way required to deliver equivalent capacity. Performance in a transmission line improves as voltage increases and as 765 kV lines use one of the highest voltage levels, they experience comparatively lesser amount of line loss. 800 kV lines have also shown strong growth momentum, rising at 12.1% CAGR over the last 5 fiscals, majorly owing to strong investments by the central sector.

Inter-regional power transmission capacity of the National Grid has grown strongly from 99,050 MW in fiscal 2019 to 112,250 MW in fiscal 2023*, at a CAGR of 3.2%. Subsequently, transformation capacity rose from 899,663 MVA in fiscal 2019 to 1,180,352 MVA in fiscal 2023, growing at a CAGR of ~7.0%.

Figure 38: Growth in transformation capacity and inter-regional power transmission capacity

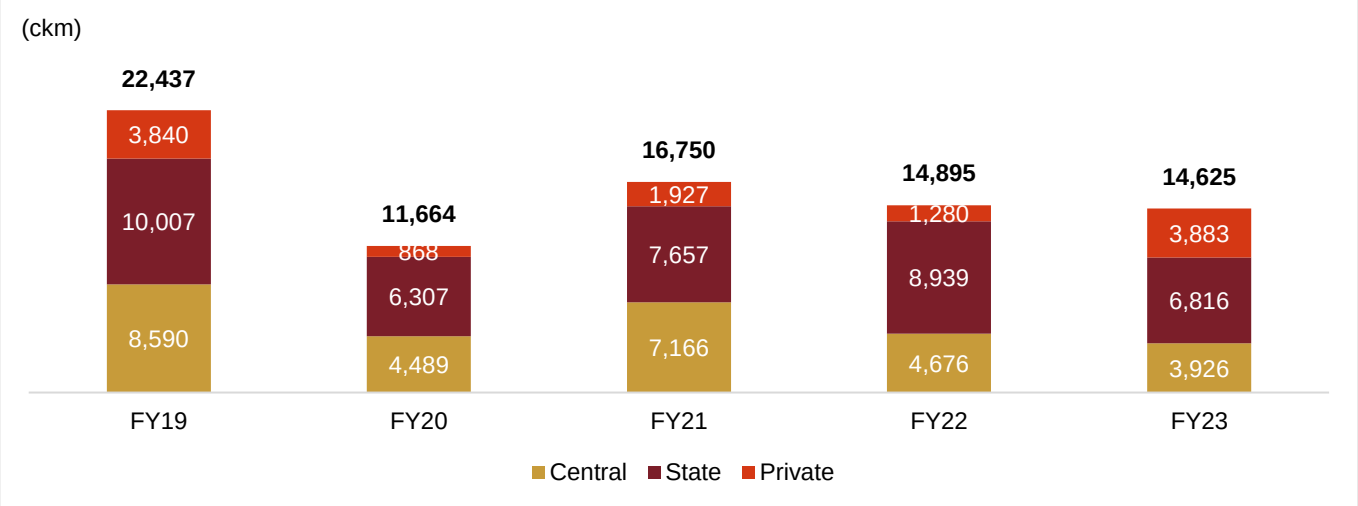


**Till February 2023*

Source: CEA, CRISIL Consulting

Investments in transmission line additions continue to be dominated by the central and state sectors. In the 13th five-year plan (2017- 2022), a total of 88,865 ckm was set up in the country, with the central and state sectors contributing to 38% and 50%, respectively.

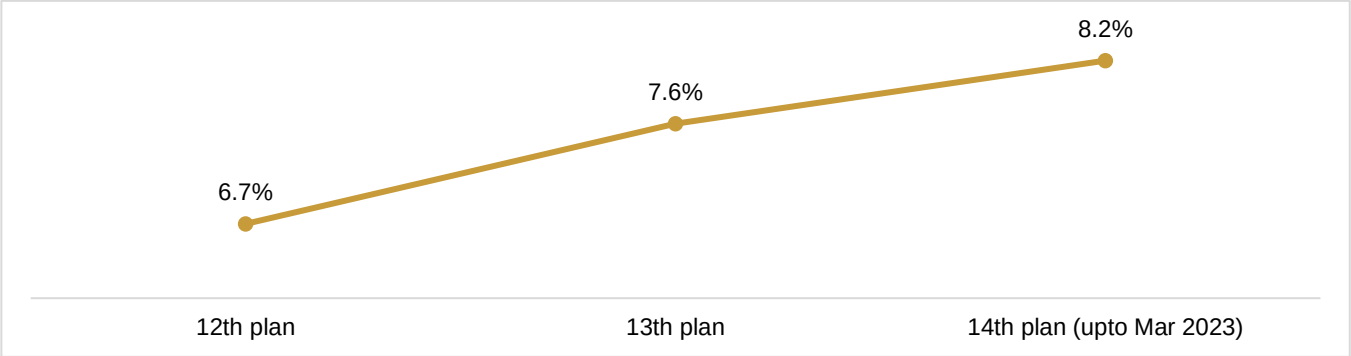
Figure 39: Sector-Wise share of transmission line additions



Source: CEA, CRISIL Consulting

Although private sector participation has been growing in the segment, with contribution reaching ~8.2% in FY23. However, private participation in the transmission segment still lags the generation segment, where private contribution has grown strongly from 46% in fiscal 2019 to 51% in fiscal 2023.

Figure 40: Private sector participation in transmission sector

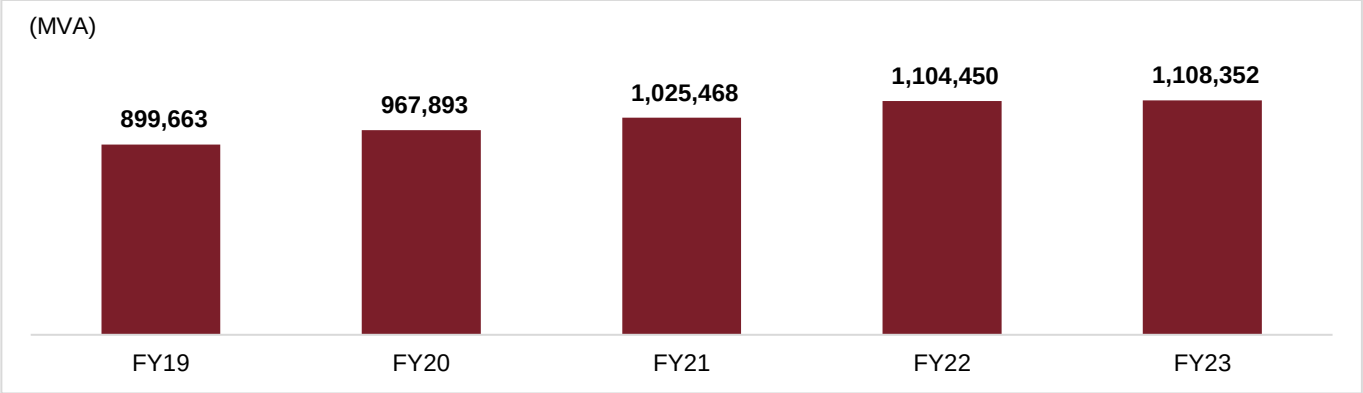


Source: CEA, CRISIL Consulting

Although to encourage private-sector participation in building transmission capacity, the central government notified power-transmission schemes to be undertaken through TBCB, but still lower private player penetration in the transmission sector necessitates higher allotment of transmission lines to private players by the central transmission utilities.

Sub-station capacities in the country have grown from 899,663 MVA in fiscal 2019 to reach 1,180,352 MVA in fiscal 2023, at a CAGR of 7.0%.

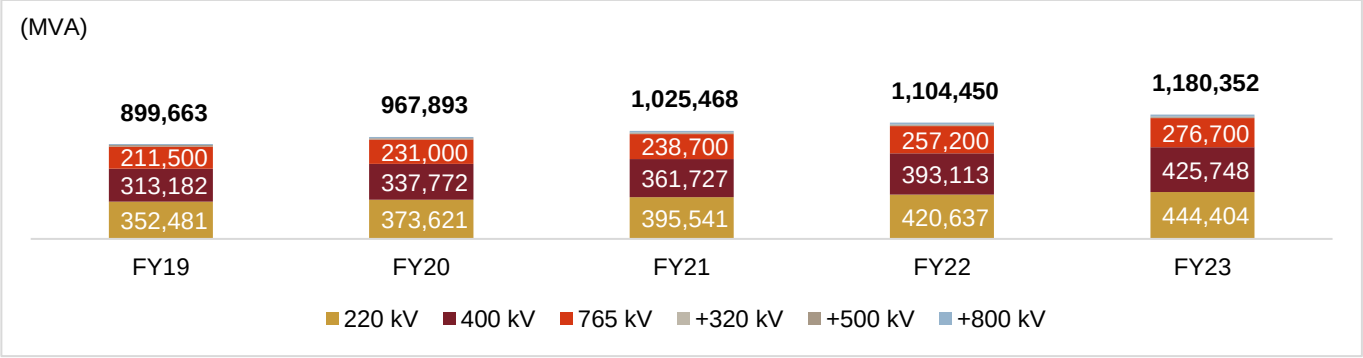
Figure 41: Total substations in the country



Source: CEA, CRISIL Consulting

The growth in sub-station capacities has majorly seen traction in 220 kV, 400 kV and 765 kV segments, contributing to 33%, 40% and 23% of the incremental additions between fiscals 2019 and fiscal 2023.

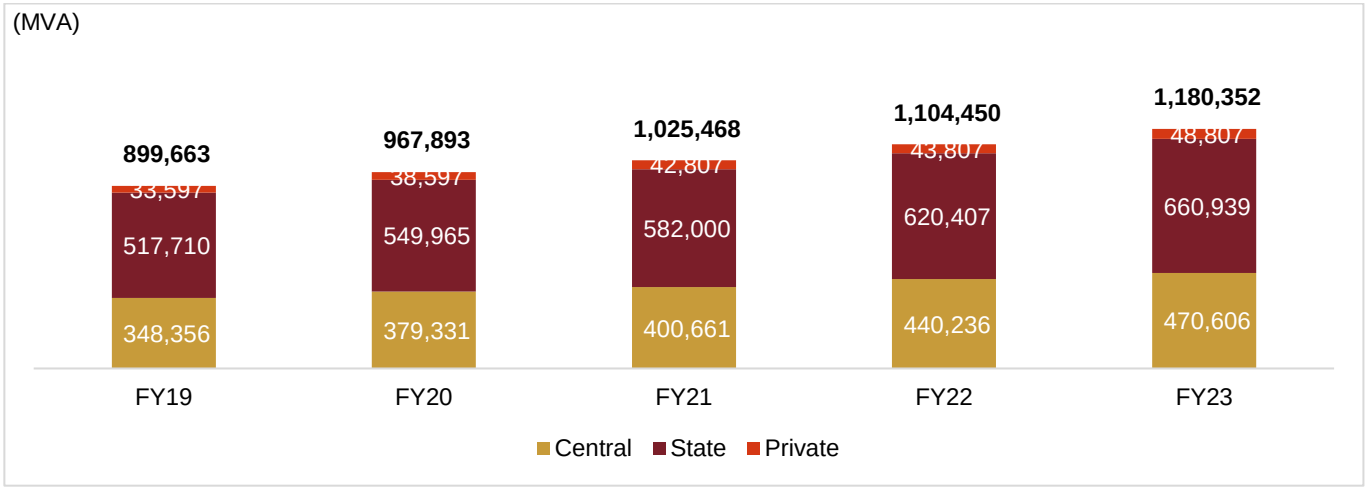
Figure 42: Robust growth in high voltage sub-station capacity (above 220 kV)



Source: CEA, CRISIL Consulting

Substation additions have been dominated by the central sector and state sector, contributing to 40% and 56% of the cumulative capacity as of fiscal 2023 respectively.

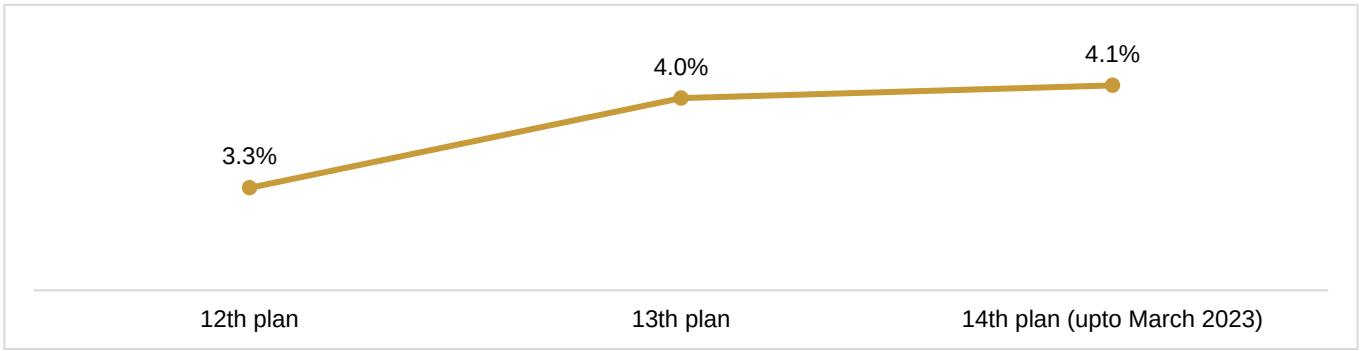
Figure 43: Sector-Wise share of substation additions



Source: CEA, CRISIL Consulting

Of the total substation capacity-additions of 280,689 MVA during the fiscal 2019 to fiscal 2023, about 51% can be attributed to the state sector, followed by central (44%) and JV/ private sector (6%). Private sector investments continue to be tepid, with the cumulative share reaching 4.1% in fiscal 2023.

Figure 44: Share of private sector in substation investments



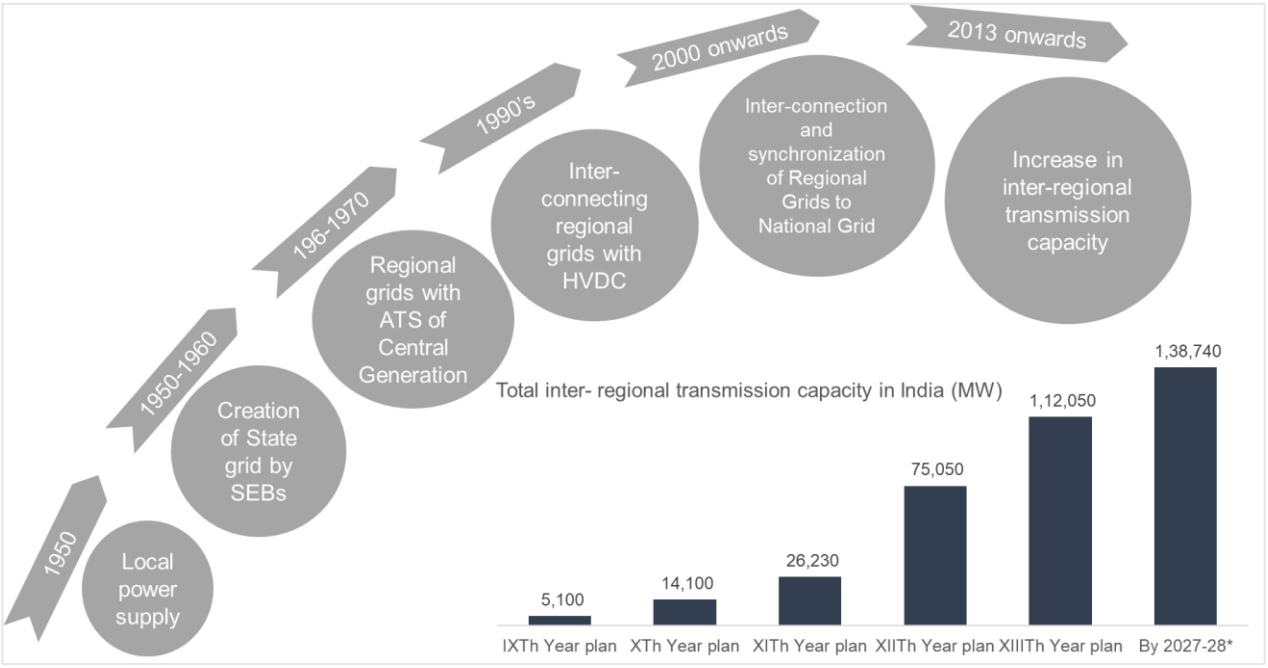
Source: CEA, CRISIL Consulting

3.2.1.1 Unification of regional grids into the national grid

To facilitate the transfer of power between neighbouring states, state grids are inter-connected through high-voltage transmission links to form a regional grid. There are five regional grids, namely, Northern, Western, Southern, Eastern and North-eastern regional grid. As peak demand for power does not take place at the same time in all states, it results in a surplus in one state and a deficit in another. Regional or inter-state grids facilitate the transfer of power from a surplus region to the one facing a deficit. Additionally, they also facilitate the optimal scheduling of maintenance outages and better coordination between power plants.

The Indian national grid has evolved over a period of past 60 years all the way from isolated state grids to regional grids and finally with the commissioning of 765 kV transmission line between Raichur and Solapur in December 2013 India achieved one nation one Grid status. Although the interregional transmission capacity is still low, unification of grid has helped in bridging the gap between load centers to the demand centers in India. The detailed evolution of the grid is as discussed in the section given below:

Figure 45: Integration and growth of transmission network in India



*Source: CEA, *CTUIL ISTS Rolling plan 2027-28 Report; CRISIL Consulting*

Table 24: Major milestones in national grid

Year	Key milestones
1994	Synchronous operations of ER & NER
2003	Synchronous operations of WR, ER & NER
2006	Synchronous interconnection of NR, WR, ER & NER with total installed capacity of over 88,000 MW
2013	SR connected to national grid through synchronization of Raichur-Solapur line
2016	Successfully commissioned Indo-Nepal cross border
	Successfully Commissioned second link of Indo-Bangladesh link.
2017	ER-SR Interconnection (Angul-Srikakulam-Vemagiri)
2018	Pole-II of Champa-Kurukshetra HVDC Pole-III & Pole-IV of NER-Agra HVDC
2019	POWERGRID declared as Maharatna CPSU Pole-III of Champa-Kurukshetra HVDC Srinagar-Leh Transmission System (SLTS) commissioned
2020	11 REMCs dedicated to the nation Transmission system associated with Solar Ultra Mega Power Projects Transmission system associated with GEC-I completed Pole-IV of Champa-Kurukshetra HVDC
2021	1st InvIT sponsored by a CPSE: POWERGRID Infrastructure Investment Trust (PGInvIT) launched
2022	All 13 REMCs assigned to POWERGRID became operational

Source: Power Grid Corporation of India Ltd, Ministry of Power, CRISIL Consulting

Note: ER: Eastern Region; NER: Northeastern Region; WR: Western Region; SR: Southern Region; HVDC: High-Voltage Direct Current; CPSU: Central Public Sector Undertaking; CPSE: Central Public Sector Enterprise; SLTS: Srinagar-Leh Transmission System; GEC: Green Energy Corridor; REMC: Renewable Energy Management Centers

To optimise the utilisation of generation capacity through the exchange of power between the surplus and deficit regions and exploit the uneven distribution of hydroelectric potential across various regions, the central government

in 1981 approved a plan for setting up a national grid. The plan envisaged setting up high-voltage transmission links across various regions to enable the transfer of power from surplus to deficit regions. The advantages of a national grid system are:

- A flatter demand curve (or a higher system load factor) on account of the exchange of power among regions, resulting in a better PLF and more economical operations
- Lower investments required for new generation capacity
- Surplus power from one region being made available at economical costs to consumers in other regions;
- Better scheduling of planned outages of power plants; and
- Improved stability of the grid, as the share of an individual generating station in the total capacity declines with greater integration of the power system.

The process of setting up the national grid was initiated with the formation of the central sector power generating and transmission companies – National Thermal Power Corporation (NTPC), National Hydroelectric Power Corporation (NHPC) and PGCIL. PGCIL was given the responsibility for planning, constructing, operating, and maintaining all inter-regional links and taking care of the integrated operations of the national and regional grids.

Setting up a national grid requires the gradual strengthening and improvement of regional grids, and their progressive integration through extra high voltage (EHV) and HVDC transmission lines. Coordination among the states within a region and among the various regions is critical for the operation of the national grid. This would require an efficient and reliable communication system, comprising microwave links and dedicated data/voice transmission lines between the load dispatch centers and generating stations. In addition, synchronization of frequencies is required to integrate regional grids. In the case of a difference in frequencies, HVDC transmission would be effective in integrating the grids through an asynchronous link. Although some inter-regional links are operational, these do not have adequate capacity to transmit bulk power and are often loaded to capacity.

Integration of the regional grid networks into the national grid involves several institutional, technical, and commercial issues. Over the medium term, investments in the transmission sector are expected to focus on forming the national grid, by setting up inter-regional links and strengthening the regional and intra-state grids. Inter-regional power transmission capacity has increased from 14 GW in fiscal 2007 to 112.25 GW as of February 2023.

3.2.1.2 Plans to increase grid infrastructure

Report on “Transmission System for Integration of over 500 GW RE Capacity by 2030” published by CEA portrays the broad transmission system roadmap for reliable integration of 537 GW RE capacity by the year 2030.

The length of the transmission lines and sub-station capacity planned under ISTS for integration of additional wind and solar capacity by 2030 has been estimated as 50,890 ckm and 433,575 MVA respectively at an estimated cost of Rs 244,200 crores.

The present inter-regional transmission capacity is 112,250 MW. With the additional inter-regional transmission corridors under implementation/planned, the cumulative inter-regional transmission capacity is likely to be about 150,000 MW in 2030

Table 25: Planned Transmission capacity additions by CEA till 2030

Transmission system type/ voltage class	Unit	Capacity additions till 2030
(a) ± 800 kV	ckm	6,200
(b) ± 350 kV	ckm	1,920
(c) 765 kV	ckm	25,960
(d) 400 kV	ckm	15,758
(e) 220 kV cable	ckm	1,052
Total transmission lines	**ckm**	**50,890**

(a) ± 800 kV	MVA	20,000
(b) ± 350 kV	MVA	5,000
(c) 765 kV	MVA	274,500
(d) 400 kV	MVA	134,075
(e) 220 kV cable	MVA	0
Total substations	**MVA**	**433,575**

Source: CEA, CRISIL Consulting

Table 26: Inter-regional capacity addition till 2030

Inter-regional capacity	Capacity additions till 2030 (MW)
West – East	22,790
West – North	62,720
West – South	28,120
North – East	22,530
South – East	7,830
East – Northeast	2,860
Northeast – North	3,000
Total	**149,850**

Source: CEA, CRISIL Consulting

3.2.2 Power transmission infrastructure has better risk-return profile

Returns from various infrastructure projects (other than transmission line projects) like roads, ports and power generation rely mostly on the operational performance of the assets, which in turn is dependent on factors where developers have limited control. For instance, in the roads sector (non-annuity-based project) the company's profits are dependent on collection of toll revenues, the port sector bears risk of cargo traffic, while in the case of power generation, it depends on availability of fuel and offtake by distribution companies.

Further, the counter party risk is higher in annuity-based roads projects as the sole revenue counter party for annuity-based payments is National Highway Authority of India (NHAI), while in the case of ISTS transmission projects the revenue counter party is a pool of distribution and generation companies, thus reducing the counterparty risk based on account of diversification.

Also, in the case of an inter-state transmission asset, the revenue stream is consistent based on the unitary charge (Rs. Million/annum) determined at the time of bidding for the entire concession period of 35 years. These charges are independent of the total power transmitted through the transmission lines and hence factors such as volume and traffic do not fluctuate the revenues.

Moreover, inter-state transmission assets have limited O&M costs as compared to other infrastructure assets. Typically, transmission projects incur relatively low O&M costs of 7-8 per cent of revenues in order to ensure normative availability. In comparison, road projects incur as high as 35-40 per cent as O&M costs.

In addition, transmission lines could also be used for providing telecom services thereby diversifying the revenue profile. Telecom and data service companies leverage the reach of the transmission towers in potential semi-urban and rural regions to offer their services. The telecom companies could plan low cost and high-quality telecom infrastructure on the existing and planned transmission line infrastructure. This can be done by using technologies such as OPGW – Optical Fibre Ground Wire over high voltage Transmission line and MPLS – Multi Protocol Label Switching. In fact, PGCIL has been able to leverage its assets by supporting telecom service providers. PGCIL operates its telecom business through a wholly-owned subsidiary named Powertel. During the year 2022-23, the Company's telecom network coverage increased to 82,294 km. The revenue from the telecom business rose to Rs. 728 crores in fiscal 2023, which constituted ~2% of its net revenues.

The company is also exploring new business segments and offering novel solutions such as MPLS, VPN, content delivery networks etc. Further, a few of the other government institutions have leveraged their existing tower infrastructure assets for generating additional revenue stream. For instance, RailTel (a subsidiary of Indian Railways and provider of neutral telecom infrastructure) has created its optical fiber network by having point of presence (PoP) at each of the station (for the purpose of signaling and tracking), spaced at every 8 to 10 Kms, thereby generating additional revenues by leasing their network and microwave tower assets to telecom operators. Also, GAILTel, the telecom and telemetry services arm of GAIL (India) Limited, which is primarily in the business of processing and distributing natural gas has been leasing its OFC network and towers spaces to telecom operators across India.

For renewable power generation, counter-party risk remains a key concern, especially for those which do not have any payment security mechanism. Certainty of cash flows remain strong while future growth potential is robust.

The chart given below compares other infrastructure assets to the transmission assets.

Figure 46: Comparison of transmission assets with other infrastructure assets

	Inter-state power transmission	Roads	Ports	Conventional power generation	Solar energy power generation	Wind energy power generation	Commercial Real Estate
Certainty of cash flows	Driven by long-term agreements	Traffic risk in BOT projects	End-user industry risk	Offtake and cost of fuel	Broadly driven by long term agreements	Broadly driven by long term agreements	Preffered by global institutional investors and HNI investors but risks of seasonality
Counterparty risk	Exposure limited to systemic risk	Cost overruns, limited O&M impact toll collection	Exposure to multiple end users	Direct exposure to debt laden SEBs	Faster clearance to payments under NVVN/ SECI Scheme (2-3 months). Weaker discoms delay the payments (5-6 months)	Faster clearance to payments under NVVN/ SECI Scheme (2-3 months). Weaker discoms delay the payments (5-6 months)	Regular challenges of delays and cancellations
Operational Risk	Limited O&M requirements	High O&M required	Limited O&M requirements	Substantial periodic maintenance needs	Limited O&M requirements	Substantial periodic O&M requirements	Limited O&M requirements
Future Growth Potential	Severe deficit in power transmission capacity	High growth potential	Good potential, limited by feasible locations	Moderate potential from baseload power demand	Governments to scale up capacity to 100 GW by FY2022 from ~12 GW in FY2017	Governments to scale up capacity to 60 GW by FY2022 from ~32 GW in FY2017	Pivoting towards hybrid models as work from home becomes more acceptable with digital means of communication
Competitive Environment	Few credible players	Highly competitive given multiple private players	Few private players	High competitiveness given multiple players	Highly competitive given multiple private players	Highly competitive given multiple private players	Low number of large players, smaller ones merging due to impact on business
Summary							

Most Favourable Favourable Marginally Favourable

Source: CRISIL Consulting

Thus, other infrastructure projects, over and above the construction risk, also bear the risk of poor returns in case of lower utilization of assets. Transmission projects, on the other hand, are insulated from such risk, thus making it an attractive investment.

3.3 Regulatory overview – Region wise

3.3.1 Asia Pacific

Asia Pacific region can broadly be divided into Southeast Asia, Central Asia, SAARC and Rest of Asia Pacific.

SAARC

- Bangladesh

The Bangladesh Energy Regulatory Commission Act, 2003 (Act No. 13 of 2003) became effective in the year 2004 to draw provisions for the formation of an impartial & independent regulatory commission for the energy sector. It displays the details concerning the establishment of the commission, powers and proceedings, the financial matters of the commission, its functions, the relation between commission and government, license, tariff, commission's power to issue order and implement its decision, flow of information, arbitration - settlement and appeal, offence and penalty, receipt of complaint of consumer and disposal.

The Electricity Grid Code 2019 of Bangladesh is a set of regulations and guideline– that govern the operation, management, and utilization of the electricity grid in the country. The Bangladesh Power Development Board (BPDB) is the authority responsible for implementing and enforcing the Electricity Grid Code. The Electricity Grid Code 2019 aims to create a transparent and well-regulated electricity grid system in Bangladesh, ensuring fair access to the grid for different stakeholders, promoting grid stability, and supporting the growth of the power sector.

- Sri Lanka

Electricity Act 2009 was enacted to provide for the regulations of the generation, transmission, distribution, supply and use of electricity in Sri Lanka; to repeal the electricity reform act, no. 28 of 2002 and the electricity act (chapter 205), and for matters connected there with or incidental there.

Central Asia

- CASA-1000 Project

A new electricity transmission system to connect four countries, namely, Kyrgyz Republic, Tajikistan, Pakistan, and Afghanistan, called the CASA-1000 project, will make the most efficient use of clean hydropower resources in the Central Asian countries by enabling them to transfer and sell their electricity surplus during the summer months to the deficient countries in South Asia. The CASA-1000 project also complements the countries' efforts to improve electricity access, integrate and expand markets to increase trade, and find sustainable solutions to water resource management.

South East Asia

- APAEC

The ASEAN Plan of Action for Energy Cooperation (APAEC) is a series of guiding policy documents that aims to promote multilateral energy cooperation and integration to attain the goals of the ASEAN Economic Community (AEC). It serves as the platform for deeper cooperation both within ASEAN as well as with Dialogue Partners (DPs) and International Organizations (IOs) towards enhancing energy security, accessibility, affordability, and sustainability within the framework the AEC.

The APAEC 2016-2025 is the fourth and current APAEC extended over a longer period of 10 years. The implementation plan is divided into two phases, namely, Phase I: 2016-2020 and Phase II: 2021-2025.
The APAEC Phase I: 2016-2020 focused on the short- to medium-term strategies with the theme "Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability for All". The APAEC Phase II: 2021-2025 is the continuation of Phase I with higher aspirational targets and new initiatives to enhance energy transition and resilience towards a sustainable energy future.

3.3.2 USA

Regulatory reform aimed to create a more resilient, sustainable, and flexible T&D system capable of meeting the evolving energy needs and challenges in the U.S. Regulatory reforms including grid modernization & smart grid initiative, clean energy and renewable integration policies, interstate transmission planning and coordination, grid resilience and reliability, distributed energy resources (DER) integration, among others are aimed to ensure efficient power supply across the region.

The construction of a record number of overhead power lines across the world along increasing HVDC transmission projects has raised the need for precise models and data for electrical conductors. A new proposed standard, “WK35208” for test methods for creep testing & stress-strain for electrical overhead conductors which will meet the necessity of global demand. The proposed standard is being created by Subcommittee B01.02 on methods of sampling & test procedure as part of the International ASTM Committee B01 on electrical overhead conductors. WK35208 will deliver transparent specifications for executing the test used to create a template for electrical conductors utilized in processing the data resulting from the tests and overhead power lines.

3.3.3 Africa

Power sector reform in developing countries began over ten years ago. Generally, the reforms include restructuring and overall process for transparent decision making across the entire value chain. The past two decades have witnessed power transformation in Africa following the liberalization, gradual opening and initiating reforms, policies, programmes and schemes across the national electricity sector. A fundamental component of the process involves the establishment of national regulatory organizations and institutions that are tasked with independently regulating along with maintaining and overseeing their effective electricity network. In addition, the African government have made significant efforts in recent years to develop robust regulatory frameworks for their electricity sectors to ensure efficient power supply across the region.

Access to affordable clean energy remains one of Africa’s biggest challenges as electricity demand across the continent is expected to triple by 2040 due to various factors notably industrialization, urbanization, higher household incomes, and climate change. As a result, various laws, regulations, & policies are being undertaken to ensure resilient transmission & distribution infrastructure across the region. For instance, below are the initiative taken to form various regulatory frameworks for electricity transmission across the region:

African Single Electricity Market (AfSEM)

- In June 2021, the African Union (AU) launched the African Single Electricity Market (AfSEM) in association with the European Union (EU) aimed at creating a single and unified electricity market across the African continent. The main goal of AfSEM is to promote electricity trading, cooperation, and integration among African countries to improve access to electricity, boost energy security, and facilitate the development of renewable energy resources.
- AfSEM is part of the broader efforts by the African Union (AU) to advance regional integration and boost economic development through improved energy cooperation. By enhancing electricity trade and promoting renewable energy development, AfSEM envisions a more sustainable and interconnected electricity landscape across the African continent.
- Key objectives & features include regional integration, electricity trading, renewable energy development, and harmonization of regulations. AfSEM seeks to foster closer collaboration and integration among African countries in the energy sector. By sharing energy resources and infrastructure, countries can better manage electricity supply and demand imbalances and enhance grid stability.

The Continental Power Systems Masterplan (CMP)

The Continental Power Systems Masterplan (CMP) was a proposed initiative by the African Union (AU) to develop a comprehensive and integrated master plan for the development of power systems across the African continent.

The CMP aimed to address the challenges and opportunities related to electricity generation, transmission, distribution, and access to power in Africa. The African Union Commission, in collaboration with regional economic communities and other stakeholders, was responsible for leading the development and implementation of the Continental Power Systems Masterplan (CMP).

Key objectives of the Continental Power Systems Masterplan (CMP) included:

- **Infrastructure Development:** The CMP aimed to identify and plan for the development of critical power infrastructure, including power generation facilities, transmission lines, substations, and distribution networks. It sought to improve the reliability and efficiency of the power systems across Africa.
- **Renewable Energy Integration:** The CMP focused on promoting the integration of renewable energy sources, such as solar, wind, hydro, and geothermal, into the power systems of African countries. By harnessing the continent's abundant renewable resources, the plan aimed to increase the share of clean and sustainable energy in the electricity mix.
- **Regional Power Interconnections:** The CMP emphasized the importance of establishing regional power interconnections and cross-border electricity trading. It aimed to facilitate the exchange of surplus electricity between countries, enhance energy security, and promote economic cooperation.
- **Energy Access and Inclusivity:** The CMP sought to address the issue of energy poverty in Africa by promoting initiatives to improve energy access in underserved and remote areas. This included implementing off-grid and mini-grid solutions to reach communities beyond the reach of conventional power grids.
- **Institutional Strengthening:** The CMP aimed to enhance the capacity of African institutions and regulatory bodies to plan, develop, and manage power systems effectively. It sought to foster a conducive policy and regulatory environment for sustainable energy development.
- **Private Sector Participation:** The CMP recognized the importance of private sector involvement in the development of power infrastructure. It aimed to attract private investments and foster public-private partnerships to accelerate the implementation of power projects.

African Energy Efficiency Strategy (AfEES)

AFREC and U4E will provide technical assistance to all African countries targeting one African Regional per year. The aim of the Program is to transform Africa towards a Harmonized Regional Market for energy efficient Lighting, Refrigerators, Room Air Conditioners, Motors and Power Distribution Transformers. The Project will seek to achieve concrete objectives, such as:

- Development of Saving Assessment for the Region and its country members, to quantify electricity, climate and financial benefits from the switch to energy efficient lighting, appliances and equipment.
- Development of recommendations for supporting strategic policies and frameworks, such as MEPS, Labelling programs and MVE for energy efficient lighting, cooling appliances and equipment, harmonized for each region with the appropriate international best practices.
- Support Testing Laboratories for the enforcement of MEPS and Labelling
- Delivery of Capacity Building Workshops to relevant stakeholders on Product Registry Systems and Sustainable Public Procurement practices.
- Support the on-going national and regional efforts on Market Transformation through strategic 5-year policy programs and the development of specific tools/resources for its implementation.

3.4 Evolution of Tariff Based Competitive Bidding and PoC mechanism in the transmission segment

Being a critical link in the power sector value chain, the transmission sector needed more attention to cater to the growing power demand and the increasing generation capacity. Investments in the form of budgetary allocations, internal accruals and PSU borrowings were unable to fund this growing need. Keeping this in mind, the Electricity Act permitted private sector participation through the tariff based competitive bidding or TBCB route in the power

transmission sector. Guidelines for the TBCB process were laid down in the National Tariff Policy, 2006; The National Tariff Policy, released in January 2006, introduced the guidelines for TBCB for all transmission projects, promoted competition in the construction of the transmission infrastructure, encouraged greater investment by private business in the sector and increased transparency. India is one of the few countries which has opened up its transmission sector for private participation and has garnered significant interest from private business. In May 2018, the government proposed amendments to the national tariff policy 2006, which aims to improve power supply, provide clarity to competitively bid projects, reduce cost burden on consumers and boost renewable energy segment.

Some of the major amendments proposed under the National Tariff policy in May 2018 are as given below:

1. AT&C losses of more than 15% shall not be taken into consideration for tariff determination purpose for tariff orders post FY 2019.
2. AT&C losses shall be brought down to 10% within 3 years from the year of achievement of 15% AT&C loss.
3. Direct benefit transfer (DBT) of power subsides to consumers, rather than cross subsidizing few categories of consumers during tariff determination.
4. Cross subsidization of tariffs across each category of consumers should be brought within +/-20% range of the cost of supply.
5. Provisions for carving out a separate tariff category for charging of electric vehicle infrastructure. Further determined tariffs to be near to the average cost of supply.
6. Cross subsidy surcharge to be paid by the open access consumers for a maximum period of one year from the date of opting for open access.
7. Open access customers must schedule conventional power for at least eight consecutive hours and Renewable power for four consecutive hours to prevent frequent changeover of supply from open access consumers.

Moreover, all future procurement of transmission enhancements is compulsorily being made through the TBCB route, with PGCIL itself bidding through TBCB except for certain high technology projects.

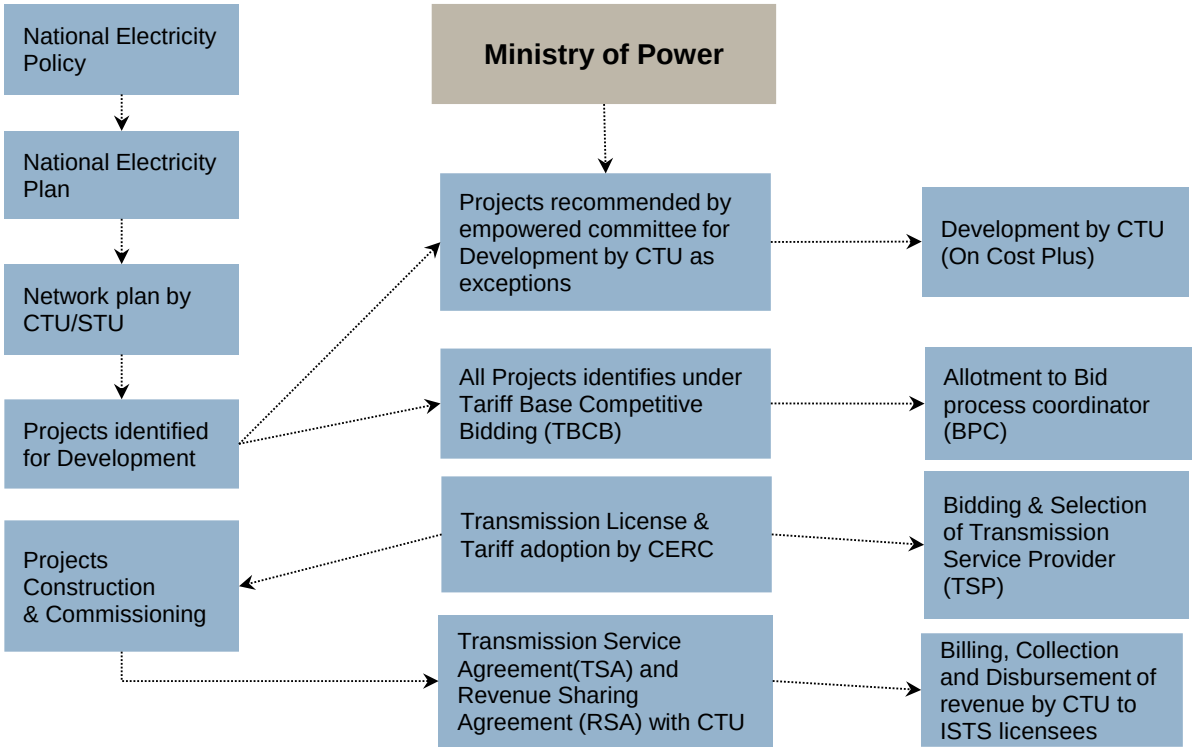
The highlights of TBCB guidelines issued by the MoP are:

1. The transmission line will be awarded under the build-own-operate-and-maintain (BOOM) basis to the successful bidder.
2. Procurement of transmission services will include all activities related to the survey, preparation of DPR, arranging finance, project management, obtaining transmission license, getting RoW and other site clearances, providing compensation for land, engineering and project design, arranging for equipment, material supplies, construction services, testing and commissioning, maintenance and operation of transmission lines and/or switching substations or HVDC links, including terminal stations and HVDC transmission lines.
3. A bid process coordinator (normally central government appoints central PSUs) such as Rural Electrification Corporation (REC) or Power Finance Corporation (PFC), would be appointed for each project as the bid process coordinator (BPC) for procurement of required transmission service. Further, the charges incurred by the BPC under the bidding process would be recovered from the winning bidder.
4. The successful bidder will be designated as the transmission service provider (TSP) and shall seek appropriate license from the regulatory commission if it is not a deemed license. The transmission service agreement (TSA) would be effective from the date of grant of license from the appropriate regulatory commission.
5. The TSP should commission the line as per the schedule specified in the TSA.
6. The TSA shall include an agreement for payment security, which will include a revolving letter of credit of required amount and escrow mechanism.
7. Under tariff-based competitive bidding, technically qualified developers quoting the lowest levelised tariff is

awarded the project, as against the erstwhile 'cost-plus' model.

Hence in a nutshell, under the TBCB, tariff for projects is not on a cost-plus basis and bidders are required to quote tariff for a period of 35 years for establishing transmission lines. The bidder quoting the lowest levelised tariff is selected. The successful bidder is then required to acquire a special purpose vehicle or SPV incorporated by the bid process coordinator or BPC. Once the process of acquisition is complete, the SPV approaches CERC to obtain a transmission license.

Figure 47: Mechanism of awarding of transmission projects

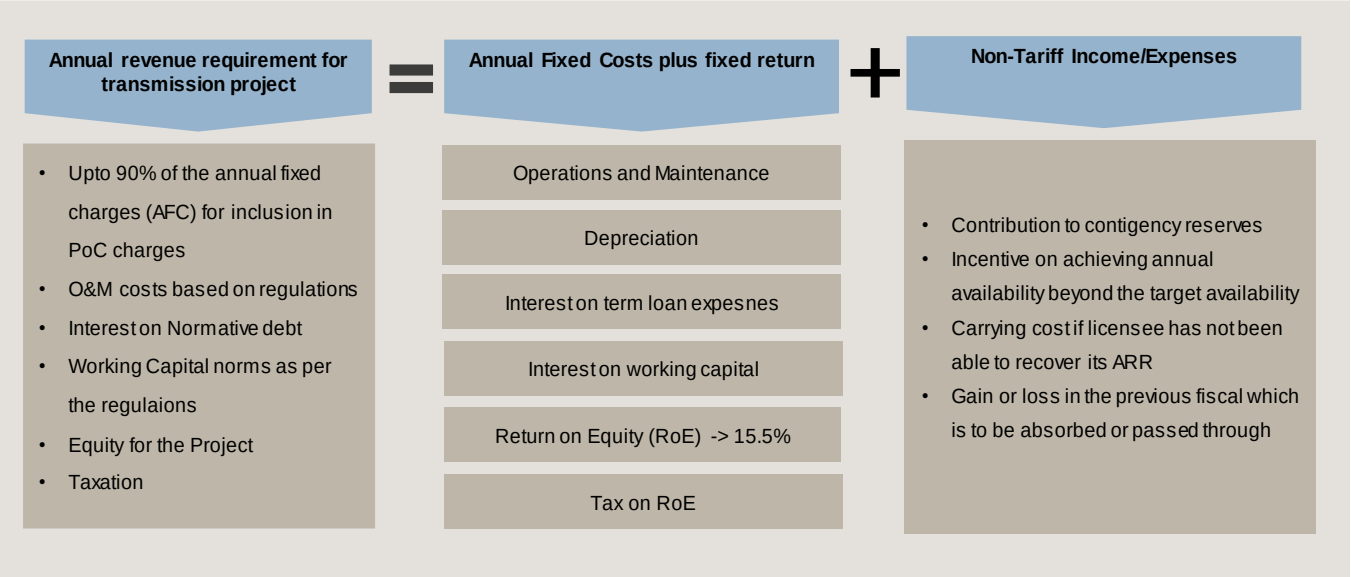


Source: Ministry of power; CRISIL Consulting

Box item: Cost-plus tariff model

Before the introduction of TBCB, PGCIL was mandated with the development inter-state transmission lines on a 'cost-plus basis', which generally means that transmission tariffs are worked out as a 'mark-up' over the transmission-line cost, providing fixed returns to the developer. Hence, any cost escalation would be reflected in transmission tariffs. Intra-state utilities have also used this cost-plus method till recently. Under this methodology, the aggregate revenue requirement (which includes a fixed return on equity) of each of the transmission licensee forming part of transmission system is determined. The methodology for determination of cost-plus tariff based on annual revenue requirement is as given below:

Figure 48: Methodology for determination of cost-plus tariff



Note: AFC, Interest on normative debt, working capital norms and Tax is computed on "True up" basis

Source: CERC regulations; CRISIL Consulting

3.4.1 Point of Connection (PoC) mechanism

In 2011, the CERC introduced the 'Point of Connection' (PoC) method for determining inter-state transmission charges. The PoC methodology was introduced to meet the requirements of an integrated grid with rapidly increasing inter-regional transmission of power. It replaced the regional postage stamp method, which was more suited to simple power flows restricted to a small geographical area or electric network. With the new system, the regulator also aims to promote an efficient transmission pricing regime that is sensitive to distance, direction, and quantum of power flow – factors which were not addressed by the postage stamp method.

In the PoC method, the transmission charges to be recovered from the entire system have been allocated between users based on their location in the grid. The inter-state grid has been divided into generation and withdrawal (demand) zones, and prices for each zone are determined by an algorithm based on the load profile of the zone. Separate transmission charges are attributable to both generators and distribution companies as they are both deemed to be beneficiaries of the transmission network. However, in almost all cases, transmission charges attributed to the generator are recovered from the discoms.

The transmission grid is divided into injection and withdrawal nodes and for the sake of simplicity, various nodes of a contiguous region have been further aggregated into zones. The charges for each node are determined by an algorithm. The algorithm is based on load flow analysis of the entire transmission network and how a change in injection or withdrawal of 1 MW of power at each node affects the network. Thus, it captures the network utilisation of each zone. The algorithm also considers the electrical distance and direction of power flows for each node in the system.

The total PoC charges to be paid for a transaction between two locations is the sum of the PoC charges and losses of a generator zone and injection zone.

3.4.2 General Network Access (GNA) Regulations 2022

CERC GNA Regulations, 2022 are a set of regulations that govern the grant of GNA to the ISTS in India. These Regulations allow generators to connect to and evacuate power through the inter-state transmission system without specifying where the power will be delivered. This is a significant shift in how transmission systems are planned, as it allows for more flexibility and non-discriminatory access.

The earlier open access system for the ISTS required generators to identify a consumer before they could be granted open access. This meant that generators had to know where they were going to sell their power before they could connect to the ISTS.

Under GNA, generators do not have to identify a consumer before they can be granted open access. This gives generators more flexibility, as they can connect to the ISTS and then sell their power to any buyer. However, there are some restrictions on GNA. For example, at the time of application, generators must indicate their preferred point of connection with the ISTS and the maximum amount of power they plan to interchange with the ISTS.

CERC in April 2023 amended the GNA Regulations and added general network access-renewable energy (GNA_{RE}) as the open access to the interstate transmission system granted under these regulations for drawal of power exclusively from the renewable sources. Further, the said amendment also temporary general network access-renewable energy (T-GNA_{RE}) as the T-GNA open access to the ISTS granted under these regulations for drawal of power exclusively from the renewable sources.

It is expected that these amendments will benefit the power generator and consumer, who now are dealing with challenges of transmission. GNA would fundamentally change the way transmission system planning is done by giving power sector constituents easier access to the transmission network across the country.

3.4.3 Project awarding under TBCB has increased in the last few fiscals

Between 2010-11 and 2014-15, the pace of award of project was slow with only Rs. 180-190 billion (~USD 2.48-2.62 billion) of projects being awarded. However, the pace of award of project has significantly increased. In fact, in 2015-16, projects aggregating to ~Rs. 260 billion (~USD 3.58 billion) were awarded. Awarding of projects through TBCB picked up from fiscal 2017 onwards. In fact, between fiscals 2017 and 2020, projects worth Rs ~312 billion have been awarded by BPCs (REC, PFC). This is sharp contrast with the tenure from fiscals 2011 to 2016 where cumulatively Rs ~400 billion of transmission projects were awarded by the BPCs. Presently, 44 projects, awarded under the TBCB route have been commissioned. Additionally, 33 transmission projects, which have been bid out though TBCM, are under construction.

3.4.4 Projects continue to get added through the RTM route

The National Committee on Transmission (NCT) decides the route under which a project will be developed—through a regulated tariff mechanism (RTM) or TBCB. Furthermore, The Electricity Act 2003 entrusts the Central Transmission Utility (CTU) with planning and co-ordination of inter-state transmission system functions.

As per MoP Order dated 17 June 2020, a new company was to be incorporated under Companies Act 2013, as a wholly Government owned Company under Ministry of Power to carry out CTU functions. Accordingly Central Transmission Utility of India Ltd., a 100 % subsidiary of PGCIL has been established as separate company to undertake function of CTU vide OM dated 9 March 2021. CTUIL is responsible for undertaking transmission of electricity ISTS. It draws out plan for ISTS up to next five years on a rolling basis every year in consultation with various stakeholders.

CTUIL as CTU, along with the CEA decides the technical specifications (tower designs, conductor type, etc.) for each transmission project. Some of key reasons attributed for allocating the projects to RTM include “Compressed timeline”, “Technical upgradation/ augmentation” and “Strategic importance”.

3.5 Investments of Rs 2.3-2.5 trillion expected in transmission segment

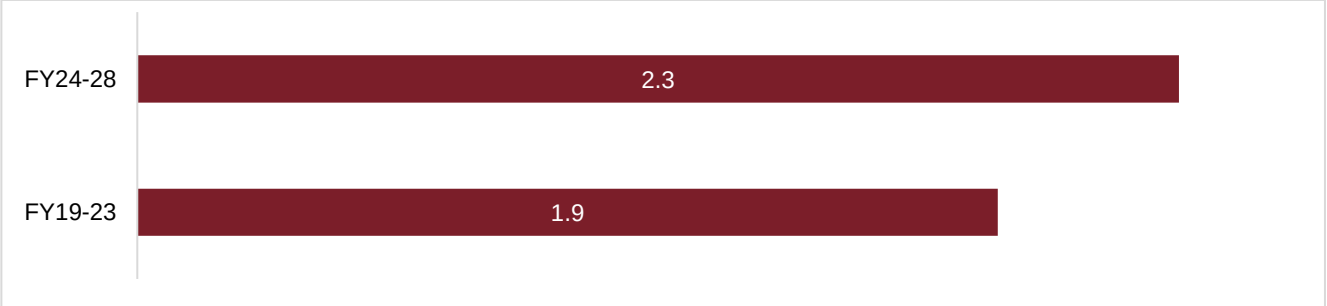
To service a large generation installed base, the estimated investment in the transmission sector is expected to cumulatively reach Rs ~2.3 trillion for fiscal 2024-28. Investments in the sector are expected to be driven by the need for a robust and reliable transmission system to support continued generation additions and the strong push to the renewable energy sector as well as rural electrification. Also, strong execution capability coupled with healthy financials of PGCIL will drive investments.

As capacity additions in the country are not evenly distributed geographically, few regions in the country will be in deficit and others in surplus. To cater to this, there will be need to import/export from/to regions. A number of inter-regional transmission corridors have been planned, and some of these high capacity transmission corridors are in various stages of implementation. Newly sanctioned projects under the North-Eastern System Strengthening Scheme and system strengthening schemes focused in the Ladakh region are also expected to augment investments in the transmission segment.

1. North-Eastern region power system improvement project
2. Comprehensive scheme of T&D system in Arunachal Pradesh and Sikkim
3. 220 kV transmission system from Alusteng (Srinagar) to Leh (via Drass, Kargil, Khalsti and Leh Sub-stations in Jammu and Kashmir)

Overall, the inter-regional transmission capacity is expected to increase from ~112 GW in March 2022 to ~145 GW by fiscal 2024

Figure 49: Investment in transmission sector (Rs. Trillion)

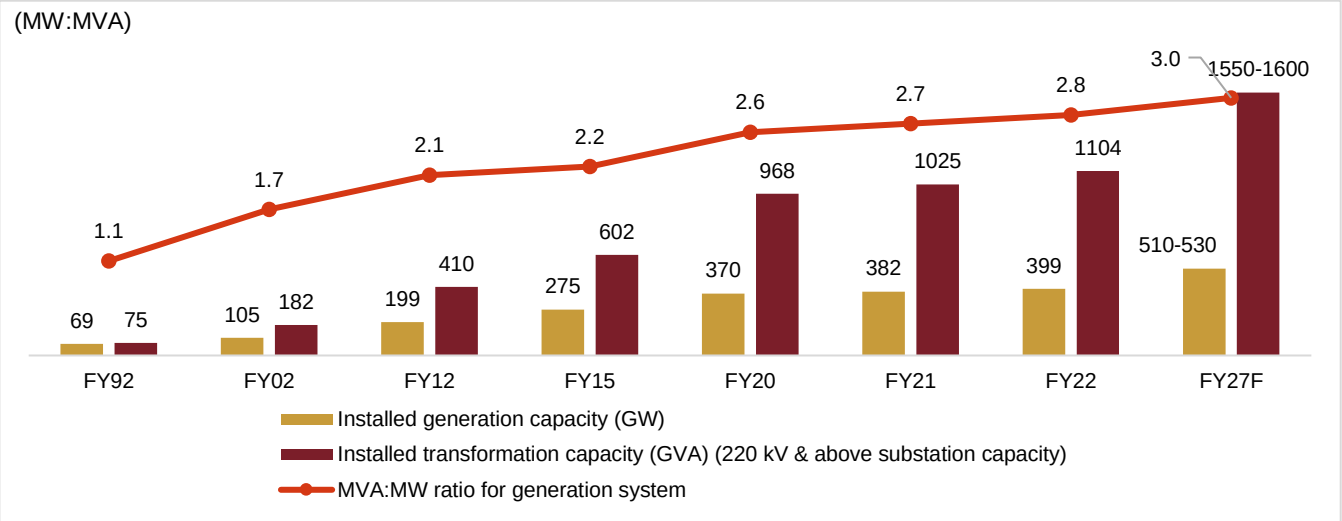


The numbers do not include private sector investments in T&D sector
Source: CRISIL Consulting

3.5.1 Domestic investments in T&D to be led by intra-state augmentation

In order to ensure free and uninterrupted flow of power, every MW of new generation capacity needs a certain transformation capacity added to the system. In Indian context, 220 kV and above level transformation to generation addition ratio (MVA: MW) has remained low over the years. At the end of March 1985, this ratio was 1.1 times and has improved to 2.8 times as of March 2022. Lower transformation capacity results in line congestion, which has been visible particularly in inter-state transmission of power. With the government's focus on alleviating congestion, transmission capacities are expected to witness growth in transformation capacity additions during 13th Plan.

Figure 50: Transformation vs generation capacity



Source: CEA, CRISIL Consulting

Consequently, in the transmission line segment, robust growth in HV lines of 400kV and 765kV is expected due to its importance in inter-state transmission lines. Higher voltage level enhances power density, reduces losses, and efficiently delivers bulk power. Moreover, it reduces requirement of right-of-way due to less land requirement, a key challenge facing the transmission sector. Thus, CRISIL Consulting believes the MVA:MW ratio would further improve to around 3.0 by March 2027.

3.5.2 Continued state investments and renewable energy integration schemes to support domestic demand; PGCIL ordering to be lumpy

In contrast to the previous few years, where the central sector used to drive investments in the sector, focus has now shifted to intra-state transmission additions and improving the intra-state transmission network. The rise in investments by states is expected on account of plans to decongest transmission networks so as to accommodate higher renewables, allow ISTS transmission of power and improve grid availability for open access of power.

Demand has been seen in the states of Madhya Pradesh, Andhra Pradesh, Rajasthan, Jharkhand, and Tamil Nadu, with ongoing system strengthening initiatives for the Western and Southern regions in the past few fiscals and is now being witnessed in the Eastern and North-Eastern regions of the country with several strengthening schemes approved for the same.

3.5.3 Integration of renewable energy integration to further support domestic demand

The rapid addition of renewable capacities requires adequate grid infrastructure so as to evacuate incremental power. This has increasingly emerged as a concern, with developers lowering participation in bids where this has been a key issue. Specifically, for wind, majority of the best wind sites are concentrated in few states such as Rajasthan, Gujarat, Tamil Nadu, Andhra Pradesh, and Karnataka, which causes increased congestion in specific regions of these states.

However, nodal agencies (PGCIL, SECI) have planned various schemes to alleviate grid congestion and improve connectivity to RE projects. The grid capacity additions will come under two main schemes, namely the Green Energy Corridor Scheme and Renewable Energy Zones (REZ). This would add ~80 GW of transmission grid capacity to an existing ~24 GW, taking grid capacity planned for RE integration to ~100 GW.

The GEC scheme is aimed at developing specific evacuation corridors for renewable energy in key renewable rich states. The government has planned to integrate renewable energy into the national grid by setting up inter-state and intra-state schemes for evacuation of power from wind and solar projects, termed as green energy corridors. GEC target of ~9,700 ckm of intra-state transmission lines by December 2020 has overshot the timeline both due

to operational reasons and covid related restrictions. The constructed lines stood at 8,697 ckm till November 2022, while the interstate transmission units with Phase I of the ISTS program were already completed by PGCIL in 2020. The next growth driver for ISTS projects is the Inter-State transmission system planned for evacuation and grid integration of 66.5 GW REZ spread across the states of Tamil Nadu, Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Rajasthan, and Madhya Pradesh.

PGCIL has also come out with a scheme for setting up grid infrastructure in identified REZ. Under this, key areas with concentration of existing / planned renewable energy projects have been identified in the Western and Southern regions of the country. Out of this, 8 GW of grid capacity will be added for wind projects in the Western region and 9 GW in the Southern region.

Table 27: Intra-state transmission system planned & constructed under Green Energy Corridor project

State	Lines Target (ckm)	Lines constructed (ckm) as of 30 November 2022
Tamil Nadu	1,068	1,068
Rajasthan	1,054	984
Andhra Pradesh	1,073	739
Himachal Pradesh	502	470
Gujarat	1,908	1,429
Karnataka	618	609
Madhya Pradesh	2,773	2,773
Maharashtra	771	625
Total	**9,767**	**8,697**

Source: MNRE, CRISIL Consulting

3.5.4 Government plans to increase TBCB to shift focus from PGCIL

At present private sector participation in the T&D space is low. However, with the introduction of TBCB and viability gap funding (VGF) schemes for intra-state projects, the share of private sector players in the power transmission sector is expected to increase gradually over the long term. This is in a move to shift the burden from PGCIL and increase private sector participation in the sector, although PGCIL is also allowed to bid for the same. Even for the renewable energy projects mentioned above, half are to be awarded via the TBCB route.

A few key players that bid in the recent project allocations were Sterlite Grid Ltd., Adani Transmission Ltd, Essel Infra Ltd, ReNew Transmission Ventures, PGCIL and Kalpataru Power Transmission Ltd. With increased awarding of projects under TBCB in the future, private participants shall also be key in driving domestic demand going forward. Overall, 81 projects have been awarded under TBCB. Of these, 44 projects have been commissioned/ready for commissioning, 33 are under construction. Construction of two projects could not be started due to litigations, while one project has been cancelled by CERC and another one is expected to be cancelled as per the request of the transmission service provider. Of the 33 projects under construction, 17 are of PGCIL and the balance are of private players.

3.5.5 Key Growth Drivers for growth in transmission sector

Some of the key growth drivers for the transmission segment in India are:

Widening gap between inter-regional power demand-supply to drive transmission capacity additions

As per CTUIL, the total power generation capacity (including renewable energy and energy storage) at a pan India would rise to ~703 GW in fiscal 2027 from ~416 GW in fiscal 2023. However, the upcoming generation capacity will not be spread evenly across India. Most of the upcoming renewable capacities would be concentrated in the northern (specifically in Rajasthan), western and southern regions of India, while significant thermal capacities would commission close to the coal mines in eastern and central regions of India. The addition of such large

quantity of generation capacities would necessitate the investments in transmission segment to supply power to different demand centers.

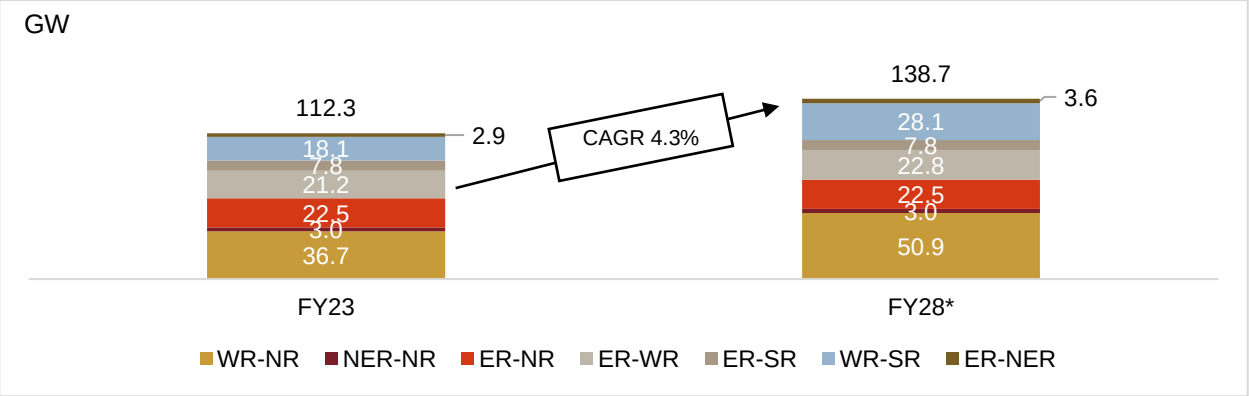
Further, the infirm nature of renewable energy (extreme variations in the power output) would give rise to grid issues unless the generated power is distributed over longer distances and to multiple demand centers via transmission lines. Moreover, there exists significant variation in demand on account of seasonal differences and time of day demand differences, which will necessitate large inter-regional transmission capacities to prevent grid fluctuations.

As a result, to reduce the demand-supply mismatch, government has planned to increase the interregional power transfer capacity to 138,740 MW by FY 2028. Moreover, the share of inter-regional transmission capacity is expected to increase from 13.9% in fiscal 2012 to 20% in fiscal 2028 (inter-regional transmission capacity as a fraction of total installed generation capacity), resulting in growth of investment in the power transmission sector.

To facilitate inter-regional power transfer capabilities from power surplus regions to deficit regions, CTUIL estimates regional power transmission capacity by fiscal 2028 at 138,740 MW.

The inter-regional transmission line corridor expansion requirement, as per CEA estimates, would be as follows:

Figure 51: Inter-regional transmission links and capacity (GW)



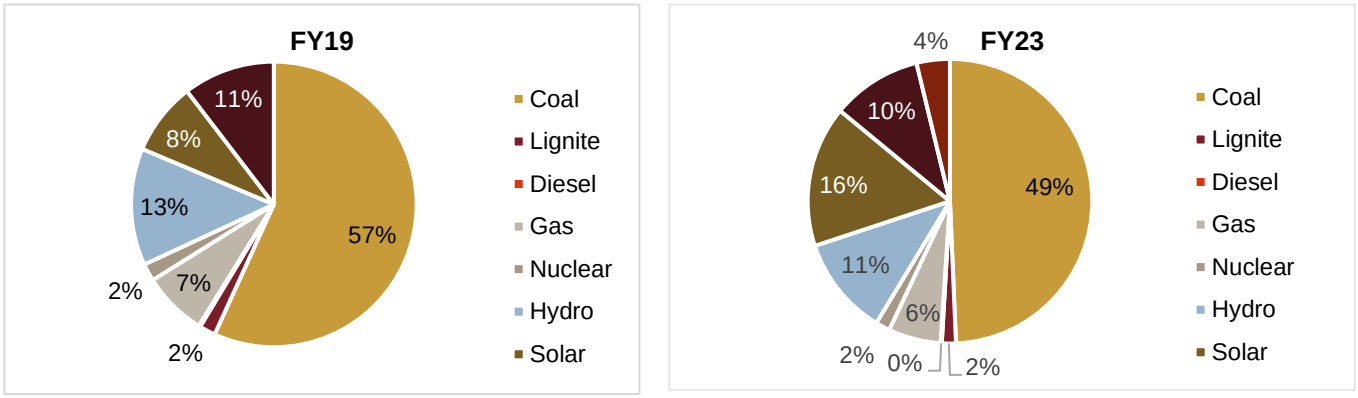
Source: CEA, CTUIL ISTS Rolling plan 2027-28 Report; CRISIL Consulting

To cater to the above import/export requirement, several inter-regional transmission corridors have been planned and some of these high-capacity transmission corridors are in various stages of implementation, taking care of past under investments in grid.

Strong renewable energy capacity additions to also drive transmission capacity

Power generation in India is dominated by coal-based generation, contributing to ~50% of the total installed capacity in India. Further, with ~212 GW installed capacity; the coal-based generation contributes to around 3/4th of total electricity generation in India. However, there has been a staggering growth in installed capacity of Renewable energy sources from 63 GW in fiscal 2012 to 109 GW in fiscal 2019, further reaching to ~172 GW (including large hydro) in March 2023.

Figure 52: Increase in share of renewable energy sources

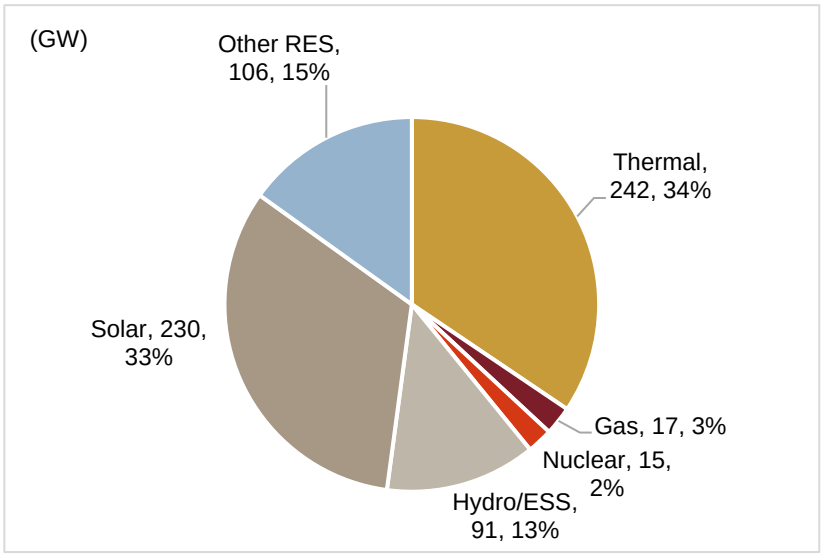


Total installed capacity: 356 GW	Total installed capacity: 416 GW

Source: CEA, CRISIL Consulting

Furthermore, central government has planned to achieve 500 GW capacity from non-fossil fuel-based energy sources by 2030. Solar and wind will pay a more role in achieving the said target. The share of renewable energy (incl. hydro and energy storage) in the installed capacity mix is expected to reach ~60% in fiscal 2028 from ~38% in fiscal 2023.

Figure 53: Expected installed capacity base in fiscal 2028 (in GW)



Source: CTUIL ISTS Rolling plan 2027-28 Report; CRISIL Consulting

Such multi fold expansion plans also require large scale development in transmission sector. This is mainly because large scale grid connected solar and wind plants are usually located in the far-flung areas, where there is limited existing transmission infrastructure. Moreover, renewable energy is not well distributed across states and is in-firm in nature. Robust transmission planning is required to optimize the high costs, utilization levels and losses associated with transmission system to transmit the power generated to load centers is critical.

For enabling growth of RE capacity, areas which have high solar and wind energy potential, needs to be connected to ISTS, so that the power generated could be evacuated to the load centres. As the gestation period of wind and solar based electricity generation projects is much less than the gestation period of transmission system, it needs

to be planned. As a major step towards achievement of the goal of 500 GW RE capacity, ISTS network has been planned for the projected RE capacity addition by the year 2030.

The RE installed capacity target of 175 GW by the year 2022 comprises of 66.5 GW RE capacity to be connected to ISTS network. Transmission system for integration of 66.5 GW RE capacity has already been planned. Part of the transmission system has been commissioned and the rest is under various stages of implementation/bidding.

In addition to the 66.5 GW RE capacity, transmission system has been planned for 236.6 GW (55.1 GW+181.5 GW) RE capacity.

Transmission system for 55.1 GW RE capacity has already been planned and status of the transmission schemes is given below:

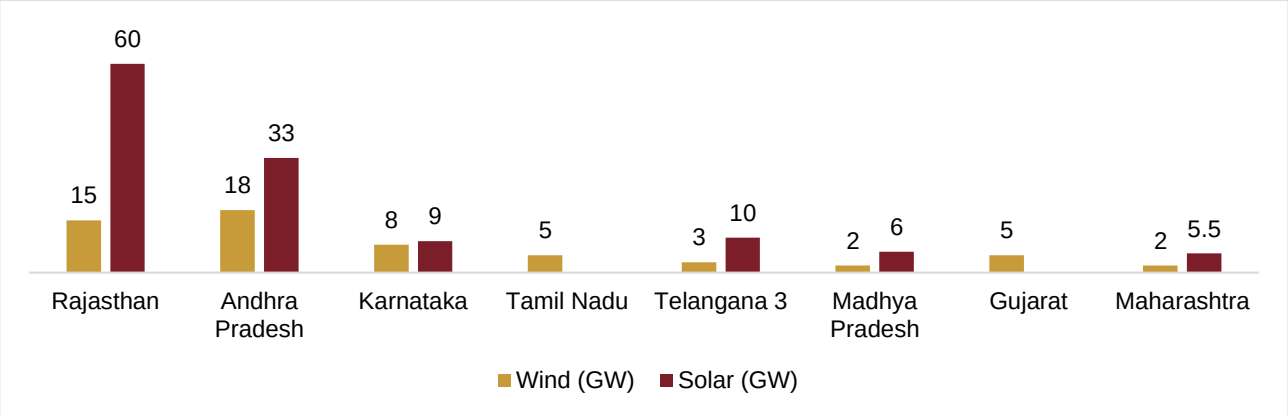
Table 28: Status of transmission schemes

Transmission scheme	RE capacity (GW)	Status of Transmission Scheme
Transmission schemes for 20 GW RE capacity in Rajasthan under Phase III	14	Transmission schemes are under bidding.
	6	The transmission scheme comprises of 6000 MW, +800 kV HVDC system between Bhadla-III and Fatehpur. The scheme has been recommended by NCT in its 9th meeting held on 28.09.2022. Subsequent activities are in progress for initiating bidding of the scheme.
Transmission scheme for 13 GW Leh RE park	13	The transmission scheme comprises of + 350 kV, 5000 MW VSC based HVDC link from Pang to Kaithal. Scheme allocated to Powergrid in January 2022, for implementation through RTM route.
Transmission scheme for 880 MW Kaza Solar Park, Himachal Pradesh	0.88	Transmission system planned. To be taken up for implementation in matching timeframe of RE Generation
Transmission scheme for additional 17.2 GW RE capacity from Khav-da and 4 GW RE capacity from Dholera, Gujarat	21.2	Transmission system planned. To be taken up for implementation in matching timeframe of RE Generation
Total	**55.08**	

Source: CEA

MNRE/SECI have identified REZs totaling 181.5 GW for likely benefits by the year 2030. These REZ's are located in eight states as detailed below:

Figure 54: Potential RE zones identified by MNRE/SECI (GW)



Source: CEA: Transmission System for Integration of over 500 GW RE Capacity by 2030

Out of 181.5 GW RE capacity, 56 GW RE capacity is likely to be commissioned by March 2025, 62.1 GW RE capacity is likely to be commissioned by December 2027 and 63.4 GW RE capacity is likely to be commissioned by December 2030.

Upgradation of existing lines critical to meet rising power demand in an economical way

India has ~4.71 lakh ckm of transmission network as on April 2023 of which most of the lines are using the Aluminium core steel reinforced (ACSR) conductor. This type of conductor is having lower current carrying capacity and lower withstand temperature (85 ^{o}C) capacity as compared to other latest available technology and substitutes such as ACCC (Aluminium Conductor Composite Core), CCC (Copper clad composite conductors) which are High tension low sag conductors (HTLS). Further these lines have lower efficiency and higher T&D losses. As per World Bank study, T&D losses costs the Indian economy ~1%-1.5% of its GDP, hence CEA in its recent revisions of the National transmission planning has embodied the new technological advancements.

Wherever transmission constraints are felt and enhancement in power transmission capacity in existing corridor becomes necessity, alternative means such as use of higher size conductor, voltage increase technologies, circuit addition, HVDC, dynamic line rating etc. need to be explored. One such emerging technology is the use of new generation High Performance Conductors (HPC), which include High Temperature (HT) conductors and High Temperature Low Sag (HTLS) conductors, and these conductors have been proven successful globally.

Both upgradation and re-conductoring of lines is economically viable as it can augment capacity without the need for heavy investments. Further, upgradation of transmission lines will not result in right of way (RoW) issues as newer technology conductors can easily replace the existing transmission line without modifying or reinforcing the existing lattice. Upgrading transmission network to a higher voltage i.e., from 400 kV capacity to 765 kV capacity increases the power handling capacity of the system four-fold. Other benefits of replacing old conductors with high-capacity new conductors include reduction in losses. Moreover, the gestation period of for upgrading a line is much lesser as compared to erection of a completely new line. Power transmission lines have reaped huge benefits in terms of increased power transmission capacity with such Upgradation efforts.

Use of latest technologies and substitutes such as ACCC, CCC, has already been deployed to reduce line loss and improve power transfer capability of the line.

Improving power scenario and measures to stabilize grid to lead to transmission corridors to neighbouring countries

Power deficit in India has been on a declining trajectory with energy deficit shrinking to 0.5% for fiscal 2023 as compared 3.6% in fiscal 2015. Thus, with healthy availability of power, India is evaluating opportunities to tap neighbouring countries for better integration and synergies.

India and its neighboring countries are interlinking the electricity transmission systems allowing surplus power to be exported to other grid while simultaneously importing large hydro based power from Nepal and Bhutan. Further, India is evaluating to build a platform to establish power exchange beyond its shores, which will act as a neutral and robust price discovery platform to create an orderly marketplace for all buyers and sellers for neighbouring Asian countries.

In order to ensure effective utilisation of regional resources, India is actively planning to inter-connect the national grid with neighbouring countries like Nepal, Bhutan, Sri Lanka and Bangladesh. Nepal is radially connected with India through 11, 33 and 132 kV lines. India and Bhutan have transmission lines of 400, 220 and 132 kV to import ~2,850 MW of power. Further, for transfer of power from upcoming hydroelectric projects in Bhutan, India is implementing two cross-border inter-connection lines of 400 kV each. Between India and Bangladesh, 400 kV DC line connecting Baharampur (India) to Bheramara (Bangladesh) and 765 kV DC line connecting Katihar (India) to Parbotipur (Bangladesh) along with 500 MW HVDC back-to-back terminal at Parbotipur are planned. A feasibility study has been carried out for two 500 MW bi-pole lines between Madurai (India) and New Anuradhapura (Sri Lanka) including submarine cable for the sea portion. Implementation of these transmission projects is expected to support investments in T&D segments over the next six years.

India is linked to its neighboring countries through a network of electrical interconnections, with a total power transfer capacity of approximately 4,230 MW.
Some of the key inter country projects include:

Table 29: Key inter-country power transmission projects

Sl. No.	Name of transmission line	Length (ckm) in Indian territory	Executing Agency	Completion Target
India-Nepal				
1	400 kV DC Muzzafarpur (I) - Dhalkebar (N) by CPTC/NEA	173	CPTC/NEA	Indian portion of the line was ready for charging in Dec'19. However, line was charged and synchronized at rated voltage on 11-11-2020 after readiness of Nepal end.
2	400 kV DC Gorakhpur (New) (I) - New Butwal (N)	240	Planned	NIT has been floated for the Transmission packages on 08-07-2022
India-Bhutan				
1	400KV D/C Jigmeling - Alipurduar line (Q) (india Side)	326	PGCIL	Commissioned in Jun'21.
India- Bangladesh				
1	400 kV DC Baharampura (I) - Bheramara (B)-2nd link by PGCIL / BPDB	172	PGCIL	1st ckt synchronised with Bangladesh bay June'21. 2nd ckt synchronised with Bangladesh in Oct'21

Source: CEA; CRISIL Consulting

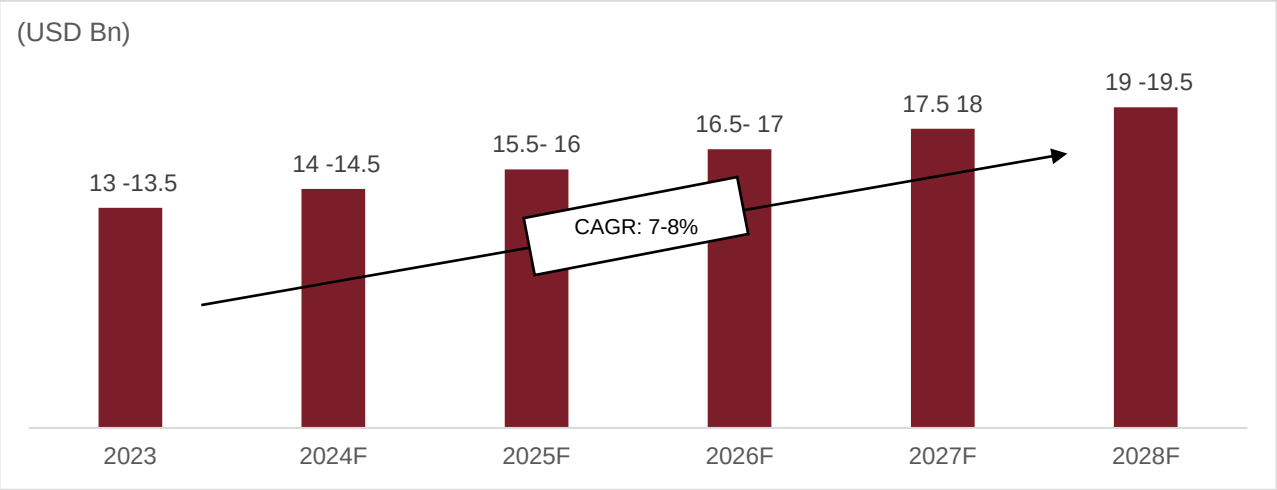
Strong government support to also drive transmission investments

Government support for power transmission is expected to continue. In the past, it has supported the transmission segment through several measures – increasing the concession period of a transmission asset, relaxation of norms to speed up project construction and implementation of UDAY scheme to boost power demand, which in turn, will eventually result in rise in transmission requirements.

3.6 Estimated market size in EPC business of T&D sector

With significant investments expected in the T&D sector in India from fiscal 2024 – 2028, the market for EPC for T&D will also improve. EPC involves engineering, procurement and construction of a project. The cost breakup of a T&D infrastructure including EPC vary depending on size, complexity, no. of lines, substations, location, topography of land and prevailing market conditions. Generally, equipment costs account for ~50-60% of total cost. Design and engineering contributes to around 5-10% of the total cost. Civil construction including labor, material and erection work account for around 15-20% of the total cost. Apart from these costs, other costs such as land acquisition, administrative expenses, project management, approvals/clearance, compensations contributes to 15-20% of the total cost. Considering the expected investment in T&D segment, Indian T&D EPC market is estimated at around USD19-19.5 Bn in 2028. The Indian T&D EPC market is expected to experience significant growth in the coming years driven by increasing electricity demand, government initiatives, strong thrust on sustainability and rising adoption of smart grid technologies.

Figure 55: Expected T&D EPC Market for India



Source: Industry; CRISIL Consulting

3.7 Key technology trends

To meet the long-term power transfer requirement by fiscal 2027 and beyond as well as for the optimal utilization of right of way, large power evacuation corridors are needed to be planned, which requires advancements in transmission voltage, conductor technology, substation equipment and infrastructure etc. Further, due to large geographical expanse of India and strongly growing power consumption need, there is requirement for transfer of large quantum of power from various generation complexes in Chhattisgarh, Jharkhand, Orissa to load centers in Northern and Western regions. Hence PGCIL has successfully tested evacuation at higher voltage of 1200 KV. In a joint initiative taken by PGCIL, CPRI and Equipment Manufacturers, a 1200 kV testing station and an experimental line at Bina in Madhya Pradesh is already set up. Power flow commenced in 2016. However, major limitations in erection of an ultra-high voltage lines are transportation of large equipment's to remote places, dielectric design and short circuit withstand capability.

On the conductor front there have been many advancements such as usage of high temperature low sag, high surge impedance loading (HSIL), and gas insulated line conductors. These conductors have been used in recent 132 kV lines bid out by the Odisha power Transmission Corporation limited, 400 kV Meerut- Kaithal D/C line and in the Naptha- Jhakri hydro project. Usage of these conductors increases the transfer capability of the transmission line and simultaneously reduce the line losses. HSIL conductors help to protect the transmission lines from lightning strikes.

Further due to growing urbanization and high real estate prices in cities, newer technology-based Gas insulated switchgear (GIS) substations are used, which not only reduces the space requirement by also cuts down on the maintenance and improves reliability. Modern substations are also using highly automated components with digital communication facilities, to increase the reliability of operations and reduce system downtime. With the advent of smart grid networking infrastructure and communication solutions synchronous digital hierarchy is utilized to communicate between substations, which not only helps in quick addressal of the fault but also helps in maintaining the grid frequency.

There have also been new innovative techniques used in the construction of transmission lines. For instance, there have been use of Light Detection and Ranging (LIDAR) technology, which uses laser distance measuring technology to conduct topographic mapping with the help of aircrafts. Further, helicopters are used for stringing (heli stringing) of transmission lines. A helicopter pulls the rope through stringing wheels, which are attached to each arm of structure. Conductor is then pulled back through the stringing wheels using a machine located on the ground. Then the stringing wheels are removed from each arm while attachments including dampeners are used to minimize the vibration on the conductor. Other newer technologies which help in automated inspection and maintenance planning such as drones are used to monitor lines spread over long distances. Further preventive

maintenance of transmission lines is also done by modern equipment's which includes thermo vision scanning, punctured insulator detector, corona measurement devices etc.

Digital Substation: Use of technology to improve performance and reliability. These use various technologies such as digital communication networks, digital protection and control devices, digital sensors etc. This has provided a paradigm shift in the way the control & protection system are tested and maintained. Digital substations offer several benefits over traditional substations, including improved reliability, increased efficiency, improved monitoring and control, reduced O&M Costs, helps in advanced diagnostics and improvement in overall availability of the system.

Advanced monitoring and control systems: Advanced monitoring and control systems are used to monitor the performance of power transmission systems and to control the flow of power. These systems use a variety of sensors and software to collect data and make decisions about how to operate the grid.

Cybersecurity: Cybersecurity is a critical issue for the power transmission industry. As the grid becomes more digital, it is vulnerable to cyberattacks. Utilities are investing in cybersecurity measures to protect their systems from attack.

3.8 State level substations and investment plans in transmission segment

The government has set a goal of achieving nearly 500 GW of installed capacity from renewable energy sources by 2030. As a result, power generation companies are seeking to establish capacities based on renewable energy. However, to link these generation capacities to the main grid, substantial investments will be necessary to develop the required transmission evacuation system. In response to this situation, the CEA has identified an additional investment of around Rs 2.4 lakh crore for the ISTS.

PGCIL's capital expenditure is regarded as a key indicator of the country's transmission capital expenditure. The annual capital expenditure made by PGCIL witnessed a steady rise, reaching Rs 25,791 crore in FY2018 from Rs 12,100 crore in FY11. This increase was mainly driven by the addition of thermal-based generation capacities. However, over the past five years, the annual capital expenditure has gradually declined to Rs 9,212 crore in FY23. This reduction can be attributed to the completion of a significant portion of the planned inter-regional transmission capacity related to thermal projects.

In terms of energy supplied in the country in FY21, top 5 states viz. Maharashtra, Gujarat, Uttar Pradesh, Tamil Nadu, and Rajasthan account for 49% of the total gross input energy in million units.

Gujarat

Gujarat Energy Transmission Corporation Ltd (GETCO) is a State Transmission Utility for Gujarat with a transmission network of 70,378 ckm as of FY22.

Table 30: Transmission Network of GETCO as of FY22

Sr No	Voltage class	Substation (Nos)	Transmission lines (ckm)	Transformation capacity (MVA)
1	400 kV	20	6,722	20,765
2	220 kV	115	21,410	46,355
3	132 kV	57	5,773	11,675
4	66 kV and 33 kV	2,054	36,473	68,356
	Total	**2,246**	**70,378**	**1,47,151**

Source: Network Planning Report – GETCO, CRISIL Consulting

Some of the transmission lines and substations commissioned in FY22 include:

Table 31: Transmission lines commissioned in FY22 in Gujarat

Sr No	Voltage class	Transmission line	Length (ckm)
1.	400 kV	LILO of 400 kV D/C Mundra - Hadala line at 400 kV Halvad substation	89
2.	400 kV	400 kV D/C Soja – Zerda line (Package-1 : Soja to AP-76/0 - 66.828 KM)	134
3.	400 kV	400kV D/C Wanakbori-Soja line (Package-2)	94
4.	400 kV	LILO of both circuits of 400kV D/C Fedra (Pachchham) – Dholera SIR 'AA' line to Dholera Solar Park	39
5.	220 kV	220 kV D/C Mitha - Katosan TSS Line	33
6.	220 kV	220 kV D/C Raghanesda - Vav (Khimanvas) Line	73
7.	220 kV	LILO of 220 kV Vadavi - Chhatral Line at 220kV Santej substation	51
8.	220 kV	220kV D/C Halvad - Sadla Line	76
9.	220 kV	LILO of both circuits of 220kV D/C Kansari - Deodar Line at 220kV Bhildi substation	10
10.	220 kV	400kv D/C Fedra (Pachchham) - Dholera 'AA' Line	66
11.	220 kV	LILO of both circuits of 220kv D/C Otha - Sagapara Line at 220kV Talaja (Shelavadar) substation	40
12.	220 kV	220kv D/C Amreli - Babara Line	53
13.	220 kV	LILO of one circuit of 220kv D/C Hadala - Sartanpar Line at proposed 220kv Ghiyavad substation	17
14.	220 kV	220kv D/C Kapadwanj - Mehmdabad TSS (NHSRCL) Line	93
15.	132 kV	LILO of both circuits of 132kv D/C Jasdan - Theolia Line At 220kv Babara substation	18
16.	132 kV	LILO of both circuits of 132kv D/C Sikarpur - Samakhiyali Line at 220kv Vondh substation	16
17.	66 kV	Lines connected with new substations, link lines, R&M and Deposit Work	1,715

Source: Network Planning Report – GETCO, CRISIL Consulting

Table 32: Substation addition in FY22 in Gujarat

Sr No	Voltage class	DGVNL	MGVNL	UGVNL	PGVNL	Total (Nos)
1.	400 kV	-	-	-	2	2
2.	220 kV	-	-	2	1	3
3.	132 kV	-	-	-	-	-
4.	66 kV	12	7	13	33	65
	Total	**12**	**7**	**15**	**36**	**70**

Source: Network Planning Report – GETCO, CRISIL Consulting

Table 33:Substation augmentation in FY22 in Gujarat

Sr No	Voltage class	Capacity addition in MVA	Capacity addition in Nos
1.	400/220 kV	-	-
2.	220/132 kV	50	1
3.	220/66 kV	370	3
4.	132/66 kV	360	6
5.	132/11 kV	-	-
6.	66/22/11 kV	1,015	101
	Total	**1,795**	**111**

Source: Network Planning Report – GETCO, CRISIL Consulting

Table 34: Network of ISTS Transmission System (PGCIL) in Gujarat

Sr No	Voltage class	Substations	Transformation capacity (MVA)	Transmission Line Network (CKm)
1.	765 kV	3	9,000	1,771
2.	400 kV	6	9,465	8,316
3.	220 kV	-	-	1,472
	Total	**9**	**18,465**	**11,559**

Source: Network Planning Report – GETCO, CRISIL Consulting

Table 35: Network system of Torrent Power in Gujarat

Sr. No	Voltage Class	Substation (Nos)			Transformation capacity (MVA)			Transmission Line Network (ckm)		
		TPL Ahm	TPL Surat	TPL Dahej	TPL Ahm	TPL Surat	TPL Dahej	TPL Ahm	TPL Surat	TPL Dahej
1.	400 kV	2	-	-	2,205	-	-	469	-	-
2.	220 kV	1	4	1	900	1,480	150	25	258	6
3.	132 kV	18	-	-	4,395	-	-	278	-	-
4.	66 kV	-	13	-	183	1,280	-	30	-	-
	Total	**21**	**17**	**1**	**7,683**	**2,720**	**150**	**802**	**258**	**6**

Source: Network Planning Report – GETCO, CRISIL Consulting

Table 36:Transmission Plan of GETCO Network for upto year – 2026 & onwards

Voltage class	As of FY22	FY23	FY24	FY25	FY26	FY27 onwards	Total
400 kV	20	3	1	2	4	2	12
220 kV	115	9	7	11	7	7	41
132 kV	57	1	-	-	-	-	1
66 kV	2,054	87	92	87	89	91	446
Total	**2,246**	**100**	**100**	**100**	**100**	**100**	**500**

Source: Network Planning Report – GETCO, CRISIL Consulting

Table 37:Year wise Transformation Capacity (in MVA) to be added up to year 2026 & onwards in Gujarat

Voltage class	FY23	FY24	FY25	FY26	FY27 onwards	Total
400 kV	3,000	1,000	2,000	4,000	2,000	12,000
220 kV	2,860	2,560	4,160	3,820	3,480	16,880
132 kV	200	-	-	-	-	200
66 kV	2,610	2,760	2,640	2,670	2,730	13,410
Total	**8,670**	**6,320**	**8,800**	**10,490**	**8,210**	**42,490**

Source: Network Planning Report – GETCO, CRISIL Consulting

The main objective of the Green Energy Corridor Project is to integrate electricity generated from renewable sources like solar and wind into the traditional power grid, ensuring synchronization between the two. In Gujarat, the project includes approximately 1888 CKm transmission lines and substations of a total capacity of 7980 MVA costing Rs. 1,962 Crores for Renewable Energy evacuation. Under the Kisan Suryoday Yojana, the Government of Gujarat has announced to provide Rs. 3500 Crore towards strengthening of transmission network by the year 2023, for providing day-time power supply to agriculture sector.

For FY24, as per the tariff orders, GETCO has a total planned capex of Rs. 3,447 Crore of which Rs. 898 Crore are for ~62 substations and Rs. 1,378 Crore for 763 transmission lines.

Rajasthan

Rajasthan Rajya Vidyut Prasaran Nigam Limited (RVPN) is a State Transmission Utility for Rajasthan

Table 38:Transmission Network of RVPN as of June 2023

Sr No	Voltage class	Substation (Nos)	Transmission lines (CKm)	Transformation capacity (MVA)
1.	765 kV	2	425	9,000
2.	400 kV	16	6,899	14,495
3.	220 kV	127	16,178	33,075
4.	132 kV	460	18,900	36,061
Total		**607**	**42,403**	**92,631**

Source: RVPN, CRISIL Consulting

RVPN has set out financial and physical targets for investment in transmission works for FY23 (Revised) and FY24 (Proposed)

Table 39:Financial targets FY23 (Revised) and FY24 (Proposed) in Rajasthan

Sr No	Head	Plan Outlay FY23 (Rs. Cr.) (Revised)	Plan Outlay FY24 (Rs. Cr.) (Proposed)
1.	Generation (Shared generating projects)	50	70
2.	Transmission works with SLDC	1,148	3,000
3.	Works as per requirement of Ind AS	70	70
Total		**1,268**	**3,140**

Source: RVPN, CRISIL Consulting

Table 40:Physical targets FY23 (Revised) and FY24 (Proposed) in Rajasthan

Sr No	Voltage	Substation (Nos)		Transformation capacity (MVA)		Transmission lines (CKm)	
		FY23	FY24	FY23	FY24	FY23	FY24
1.	765 kV	-	-	1,500	-	-	-
2.	400 kV	-	-	-	-	491	-
3.	220 kV	1	1	160	200	56	29
4.	132 kV	26	14	770	497	532	350
5.	Augmentation 400/220/132 kV	-	-	1,500	2,450	-	-

Source: RVPN, CRISIL Consulting

As per the tariff orders of RVPN, the Commission has approved the capex of Rs. 689 Crore for FY24 as against Rs. 1,147 Crore in FY23 for transmission works.

Maharashtra

Maharashtra State Electricity Transmission Company Limited (MAHATRANSCO or MSETCL) is one of the largest electric power transmission utilities for evacuation and transmission of electricity from its point of generation to the point of distribution across state of Maharashtra. The transmission network is of 50,631 CKm and 728 substations as of FY23.

Table 41:Transmission infrastructure of MAHATRANSCO as of FY23

Voltage	EHV Substation (Nos)	Transformation capacity (MVA)	EHV Lines (ckm)
765 kV	1	3,000	-
HVDC	2	3,582	1,504
400 kV	33	33,548	8,464
220 kV	250	60,090	19,366
132 kV	356	31,005	18,209
110 kV	40	2,480	1,788
100 kV	39	2,823	706
66 kV	7	171	595
Total	**728**	**136,698**	**50,631**

Source: MSETCL, CRISIL Consulting

MSETCL has a transmission system capable of handling about 21,000 MW of power. It has an infrastructure plan of Rs. 16,185 Crore

Table 42:Substations Plan of MSETCL Network from FY19 to FY24 (Nos)

Voltage class	FY19	FY20	FY21	FY22	FY23	FY24	Total (Nos)
400 kV	4	-	2	1	-	1	**8**
220 kV	10	10	9	11	7	2	**49**
132 kV	4	7	8	9	6	1	**35**
110 kV	-	-	-	-	2	-	**2**
100 kV	-	1	-	2	-	-	**3**
HVDC	-	-	-	-	-	2	**2**
Total	**18**	**18**	**19**	**23**	**15**	**6**	**99**

Source: STU Five Year Transmission Plan – MSETCL, CRISIL Consulting

Table 43:Transmission Plan of MSETCL Network from FY19 to FY24 (ckm)

Voltage	FY19	FY20	FY21	FY22	FY23	FY24	Total (CKm)
765 kV	-	-	-	-	-	20	20
400 kV	451	181	31	172	70	40	945
220 kV	819	834	994	759	472	394	4,272
132 kV	1,104	1,386	1,192	1,114	960	796	6,552
110 kV	-	71	52	90	295	-	508
100 kV	35	22	-	68	20	6	151
Total	**2,409**	**2,494**	**2,269**	**2,203**	**1,817**	**1,256**	**12,448**

Source: STU Five Year Transmission Plan – MSETCL, CRISIL Consulting

Table 44:Transformation capacity Plan of MSETCL Network from FY19 to FY24 (MVA)

Voltage	FY19	FY20	FY21	FY22	FY23	FY24	Total (MVA)
400 kV	975	1,760	1,250	555	0	0	**4,540**
220 kV	1,575	2,400	4,050	400	0	0	**8,425**
132 kV	50	125	325	0	0	0	**500**
110 kV	0	25	25	0	0	0	**50**
100 kV	0	0	0	0	0	0	**0**
Total	**2,600**	**4,310**	**5,650**	**955**	**0**	**0**	**13,515**

Source: STU Five Year Transmission Plan – MSETCL, CRISIL Consulting

Uttar Pradesh

UP Power Transmission Corporation Limited (UPPTCL) was incorporated in 2006 to undertake transmission activities in Uttar Pradesh.

Table 45:Transmission infrastructure of UPPTCL as of FY23

Voltage	EHV Substation (Nos)	Transformation capacity (MVA)	EHV Lines (CKm)
765 kV	2	6,000	1,511
400 kV	27	25,165	6,923
220 kV	152	56,900	14,973
132 kV	463	61,194	27,508
Total (A)	**644**	**149,259**	**50,916**
TBCB			
765 kV	4	10,000	915
400 kV	10	12,120	1,318
220 kV	0	2120	77
132 kV	0	0	176
Total (B)	**14**	**24,240**	**2,486**
Total (A+B)	**658**	**173,499**	**53,402**

Source: UPPTCL, CRISIL Consulting

As per the tariff orders of UPPTCL, proposed capital expenditure is of Rs. 4,945 crore calculated based on the expected expenditure projected towards the ongoing projects / schemes and those towards the new projects to be undertaken in FY 2023-24.

Table 46:Sources of capital expenditure of UPPTCL for FY24

Sources of capital expenditure	FY 2023-24 (Rs Crore)
Grant towards the Green Energy Corridor	719
Consumer Contribution/ Grant	619
Debt	2,525
Equity	1,082
Total	**4,945**

Source: UPPTCL tariff order, CRISIL Consulting

UPPTCL has also submitted capital investment plan for the MYT control period FY21 to FY25.

Table 47:Transmission network of UPPTCL (Ckm) till FY25

Voltage	FY21	FY22	FY23	FY24	FY25
132 kV	27,310	29,565	31,189	31,912	32,756
220 kV	14,754	18,234	19,461	20,128	20,591
400 kV	7,765	9,103	9,557	10.057	10,317
765 kV	1,942	2,312	2,607	2,822	2,822
Total	**51,771**	**59,213**	**62,813**	**64,919**	**66,487**

Source: UPPTCL Business Plan Order for The MYT Control Period FY21-FY25, CRISIL Consulting

Table 48:Transmission network of UPPTCL (SS) till FY25 (Nos)

Voltage	FY21	FY22	FY23	FY24	FY25
132 kV	455	473	495	507	524
220 kV	141	167	183	193	202
400 kV	29	35	38	39	41
765 kV	2	4	5	6	6
Total	**627**	**679**	**721**	**745**	**773**

Source: UPPTCL Business Plan Order for The MYT Control Period FY21-FY25, CRISIL Consulting

Table 49:Transformation capacity of UPPTCL (MVA) till FY25

Voltage	FY21	FY22	FY23	FY24	FY25
132 kV	56,994	59,886	63,852	66,720	69,589
220 kV	52,740	63,529	69,205	74,185	78,045
400 kV	28,250	38,562	41,512	43,402	45,722
765 kV	7,500	13,500	18,000	20,820	20,820
Total	**145,484**	**175,477**	**192,569**	**205,127**	**214,176**

Source: UPPTCL Business Plan Order for The MYT Control Period FY21-FY25, CRISIL Consulting

The shares of 132KV, 220KV, 400KV and 765 KV will increase from 39.18%, 36.25%, 19.42% & 5.16% respectively in 2020-21 to 32.49%, 36.44%, 21.35% & 49.72% respectively in 2024-25. This shift indicates a

notable increase in the transformation capacity (MVA) of the 400KV and 765KV categories, thereby contributing to a reduction in transmission loss.

UPPTCL has also provided substations and transmission lines under Green Energy Corridor-II (GEC-II) scheme

Table 50:Number of substations under GEC-II scheme

Voltage	FY21	FY22	FY23	FY24	FY25	Total (Nos)
132 kV	0	8	0	2	0	10
220 kV	0	7	4	2	0	13
400 kV	0	1	1	0	0	2
765 kV	0	0	1	1	0	2
Total	**0**	**16**	**6**	**5**	**0**	**27**

Source: UPPTCL Business Plan Order for The MYT Control Period FY21-FY25, CRISIL Consulting

Table 51:Number of transmission lines under GEC-II scheme

Voltage	FY21	FY22	FY23	FY24	FY25	Total (Ckm)
132 kV	0	192	0	71	0	263
220 kV	0	334	273	122	0	729
400 kV	0	25	335	0	0	360
765 kV	0	0	185	215	0	400
Total	**0**	**551**	**793**	**408**	**0**	**1,752**

Source: UPPTCL Business Plan Order for The MYT Control Period FY21-FY25, CRISIL Consulting

Table 52: Sources of capital expenditure of UPPTCL for FY24 (Rs Crore)

Sources of capital expenditure	FY21	FY22	FY23	FY24	FY25
New/Ongoing projects	3,436	4,351	4,214	1,734	1,621
Green Energy Corridor (Solar Power)	335	1,476	1,584	1,007	610
Augmentation	594	225	377	388	360
System Strengthening (Line & Bays)	359	264	250	300	350
Addition of Capacitor/Reactor	87	75	100	100	100
Total	**4,810**	**6,393**	**6,525**	**3,529**	**3,041**
Through Tariff Based Competitive Bidding (TBCB)	2,952	3,317	0	0	0

Source: UPPTCL tariff order, CRISIL Consulting

Tamil Nadu

The Tamil Nadu Transmission Corporation Limited is an electric power transmission system operator owned by Government of Tamil Nadu. It was established in November 2010, because of restructuring the Tamil Nadu Electricity Board. It is a subsidiary of TNEB Limited.

The transmission sector of TANTRANSCO comprises the Extra High Tension (EHT) lines spanning a total length of 34,275 kilometres, along with a total of 998 substations. 95 substations in and around Chennai have been equipped with SCADA (Supervisory Control and Data Acquisition) technology and have been integrated into the Chennai Distribution and Control Center (DCC). TANTRANSCO operates one State Load Dispatch Centre in Chennai and three Sub Load Dispatch Centres in Chennai, Madurai, and Erode.

Table 53: Transmission infrastructure of TANTRANSCO as of FY22

Voltage	Substation (Nos)	Transmission Lines (CKm)
400 kV	16	4,591
230 kV	115	11,271
110 kV	980	20,788
66 kV	3	683
Total	**1,114**	**37,333**

Source: TANTRANSCO tariff order, CRISIL Consulting

As per the tariff orders, for the period FY23-27, TANTRANSCO has an approved capital expenditure of Rs. 12,680 crore as follows:

Table 54:Capital Expenditure submitted approved by the Commission for TANTRANSCO

Sources of capital expenditure	FY23	FY24	FY25	FY26	FY27
Transmission related	2,352	2,645	2,330	2,453	2,900

Source: TANTRANSCO tariff order, CRISIL Consulting

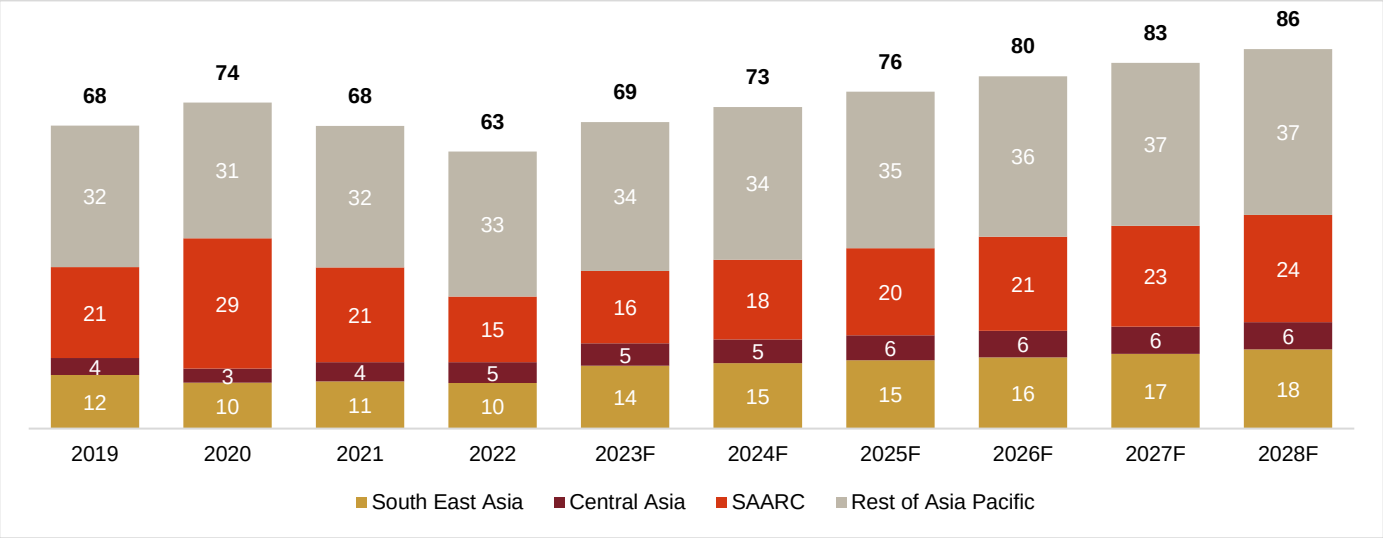
The Union Minister for New & Renewable Energy and Power has announced the approval of a project under Green Energy Corridor Phase-II. This project aims to establish 624 kilometers of transmission lines and substations with a capacity of 2200 MVA by the fiscal year 2025-26. The primary objective is to facilitate the evacuation of renewable energy power, enabling approximately 4000 MW capacity in the state of Tamil Nadu. The Ministry of New & Renewable Energy has given its approval, and the estimated cost of the project is Rs. 719.76 crore, with the central government offering a grant of Rs. 237.52 crore, covering 33% of the project cost. The responsibility for implementing the project lies with the state agency TANTRANSCO.

In addition to this, under Green Energy Corridor Phase-I, TANTRANSCO has already completed the sanctioned project, which included the installation of 1068 kilometers of transmission lines and substations with a capacity of 1910 MVA. This project was completed on 31 October 2022, and the Ministry has released a grant of Rs. 524.30 crore to TANTRANSCO for its successful execution.

3.9 Country-wise/Region wise review and outlook on transmission sector

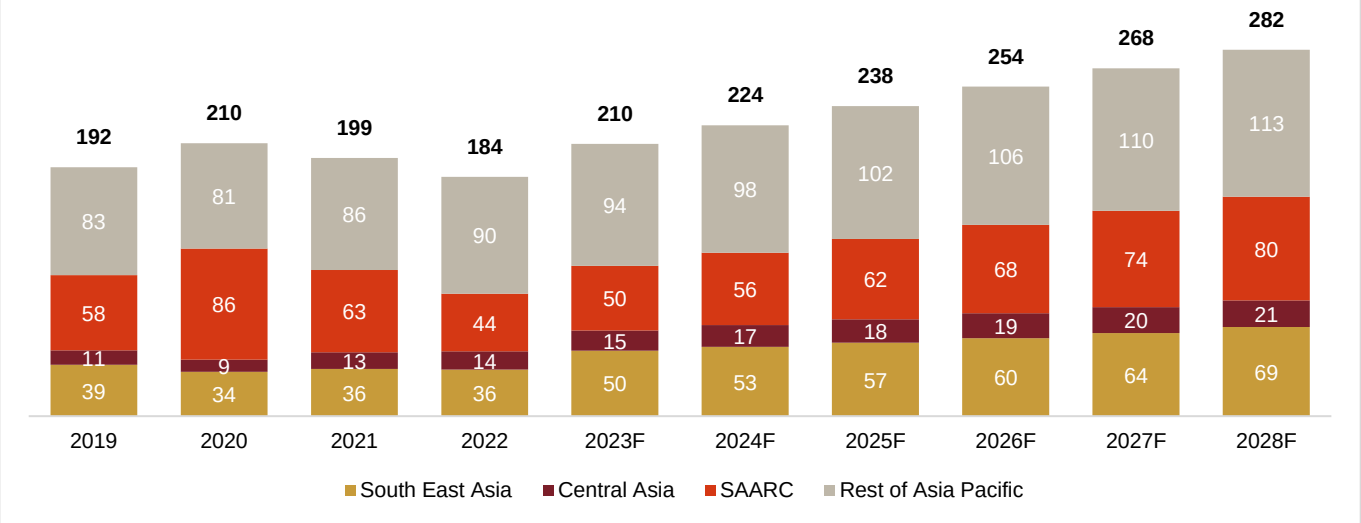
3.9.1 Asia Pacific

Figure 56:Asia Pacific transmission lines y-o-y additions forecast (‘000 ckm)



Source: Global Market Insights, CRISIL Consulting

Figure 57: Asia Pacific transmission lines y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

Table 55: Asia Pacific voltage-wise transmission lines y-o-y additions forecast (‘000 ckm and GVA)

Voltage	Transmission Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
> 132 kV - 220 kV	(‘000 ckm)	**40**	**43**	**39**	**36**	**39**	**41**	**43**	**45**	**47**	**49**
	GVA	**107**	118	108	100	113	121	129	137	145	153
> 220 kV - 660 kV	(‘000 ckm)	**19**	20	19	19	22	23	24	25	26	27
	GVA	**58**	60	60	61	71	76	80	85	89	94
>660 kV	(‘000 ckm)	**9**	10	10	8	8	9	9	10	10	11
	GVA	**26**	32	31	24	26	28	30	32	34	36
Total	**(‘000 ckm)**	**68**	**74**	**68**	**63**	**69**	**73**	**76**	**80**	**83**	**86**
	GVA	**192**	**210**	**199**	**184**	**210**	**224**	**239**	**254**	**268**	**282**

Source: Global Market Insights, CRISIL Consulting

Table 56: South-East Asia voltage-wise transmission lines y-o-y additions forecast ('000 ckm and GVA)

Voltage	Transmission Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
> 132 kV - 220 kV	('000 ckm)	9	8	7	7	9	10	10	11	11	12
	GVA	28	27	24	25	32	34	36	38	41	43
> 220 kV - 660 kV	('000 ckm)	3	2	3	3	5	5	5	6	6	6
	GVA	12	7	12	11	18	19	21	22	23	25
>660 kV	('000 ckm)	-	-	-	-	-	-	-	-	-	-
	GVA	-	-	-	-	-	-	-	-	-	-
Total	**('000 ckm)**	12	10	11	10	14	15	15	16	17	18
	GVA	40	34	36	36	51	53	57	60	64	69

Source: Global Market Insights, CRISIL Consulting

Table 57: Central Asia voltage-wise transmission lines y-o-y additions forecast ('000 ckm and GVA)

Voltage	Transmission Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
> 132 kV - 220 kV	('000 ckm)	2	2	2	2	3	3	3	3	3	3
	GVA	5	5	6	7	8	8	9	10	10	10
> 220 kV - 660 kV	('000 ckm)	2	2	2	2	2	3	3	3	3	3
	GVA	6	5	7	7	8	9	9	10	10	10
>660 kV	('000 ckm)	-	-	-	-	-	-	-	-	-	-
	GVA	-	-	-	-	-	-	-	-	-	-
Total	**('000 ckm)**	4	3	4	5	5	5	6	6	6	6
	GVA	11	9	13	14	15	17	18	19	20	21

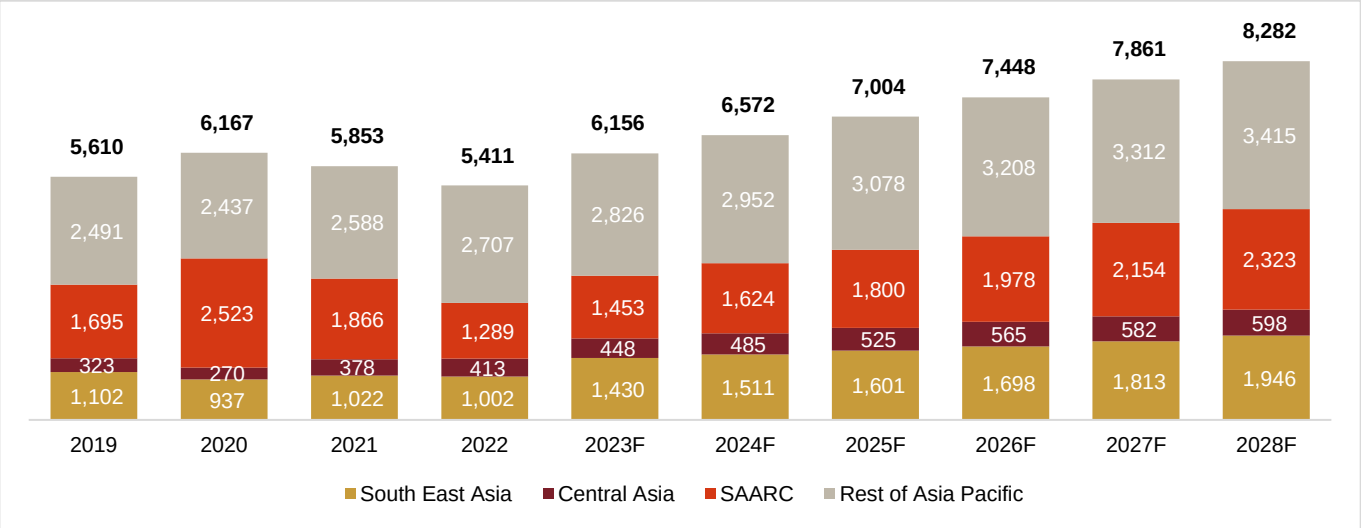
Source: Global Market Insights, CRISIL Consulting

Table 58: SAARC voltage-wise transmission lines y-o-y additions forecast ('000 ckm and GVA)

Voltage	Transmission Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
> 132 kV - 220 kV	('000 ckm)	13	18	13	9	10	11	12	13	14	15
	GVA	35	48	37	26	30	33	37	41	44	48
> 220 kV - 660 kV	('000 ckm)	4	7	4	4	4	5	5	5	6	6
	GVA	13	22	13	13	14	15	17	18	20	21
>660 kV	('000 ckm)	3	5	4	2	2	2	2	3	3	3
	GVA	10	16	13	6	6	7	8	9	10	11
Total	**('000 ckm)**	21	29	21	15	16	18	20	21	23	24
	GVA	58	86	63	44	50	56	62	68	74	80

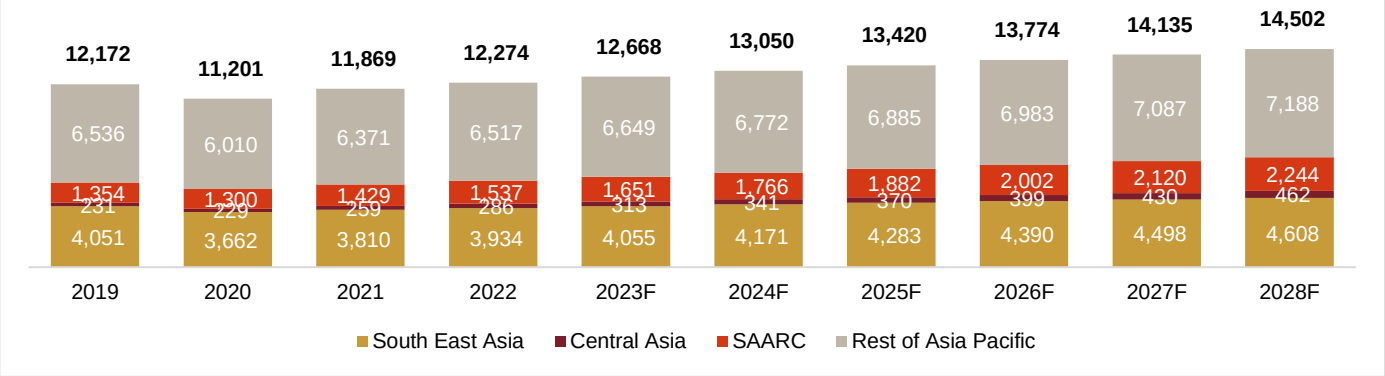
Source: Global Market Insights, CRISIL Consulting

Figure 58: Asia Pacific transmission lines y-o-y investment forecast (USD million)



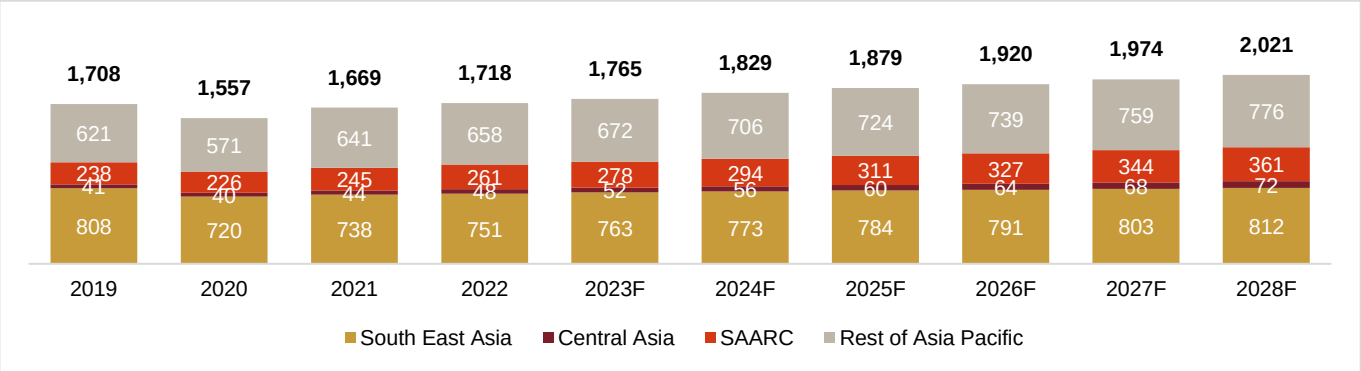
Source: Global Market Insights, CRISIL Consulting

Figure 59: Asia Pacific substation y-o-y additions forecast (Nos)



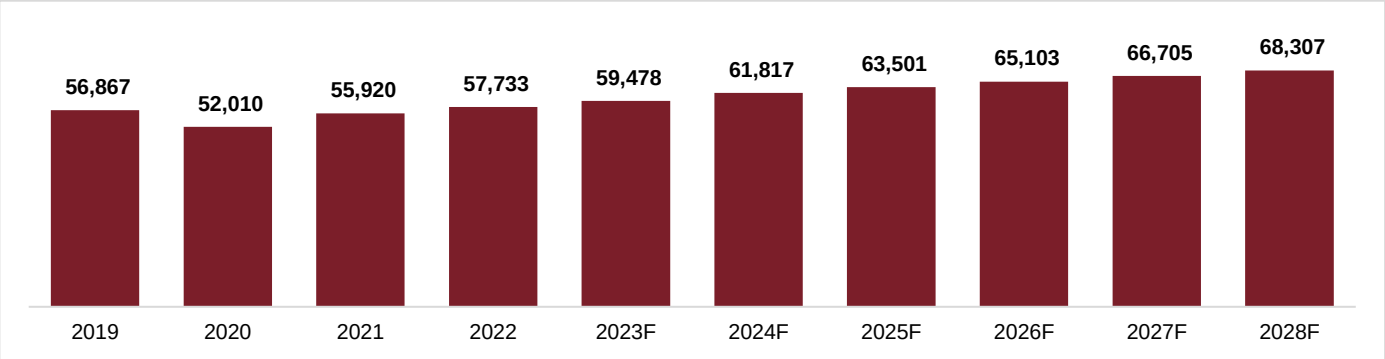
Source: Global Market Insights, CRISIL Consulting

Figure 60: Asia Pacific substation y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

Figure 61: Asia Pacific substation y-o-y investment forecast (USD million)



Source: Global Market Insights, CRISIL Consulting

Key Drivers for Power Transmission Market in Asia Pacific

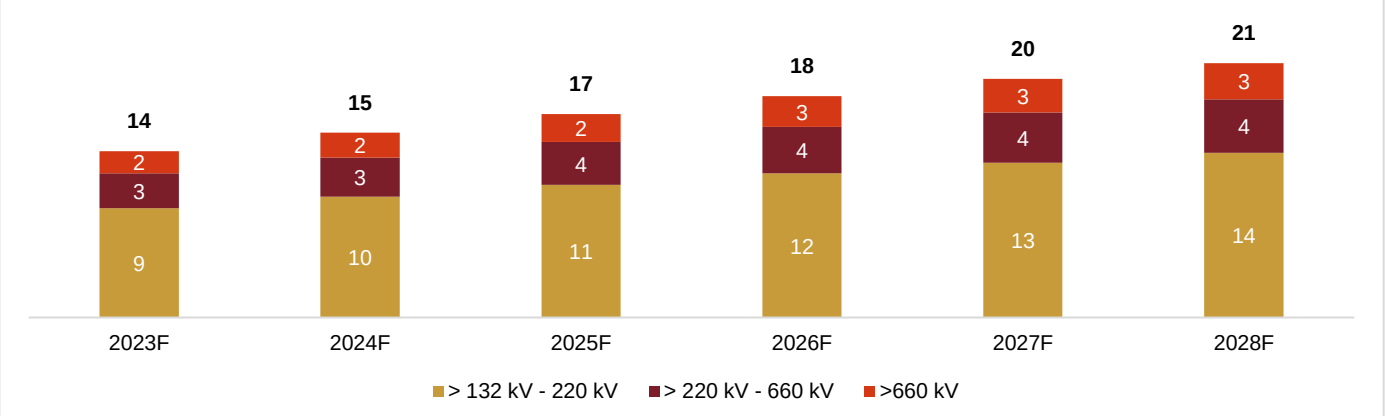
The market trend of increasing transmission & distribution lines across the globe has been characterized by significant growth & development along with certain key factors including the rising electricity demand, renewable energy integration, interconnection projects, government initiatives & investments, and technological advancements, among others. Regions including Asia Pacific and Africa have experienced robust economic growth and rapid urbanization, leading to the increasing demand for electricity.

China is planning to invest over $1 trillion in new transmission lines by 2025. India is planning to invest over $200 billion in new transmission lines by 2027. In Philippines, the Department of Energy (DOE) and the National Transmission Corp. (TransCo) are targeting to complete by end-2023 a smart and green grid plan aimed at ensuring the seamless integration of additional renewable energy capacity to the grid in the coming years. Electricity Generating Authority of Thailand (EGAT) has planned no. of transmission system development and expansion projects for bulk power supply, power purchase from IPPs, transmission system renovation and expansion etc. for a green energy future. Vietnam's National Power Transmission Corp. (EVNNPT) has started eleven 220-500kV transmission power grid projects and energized 11 projects. vietnam's Ministry of Industry and Trade has proposed that a new public-private partnership bill have provisions allowing private investments in transmission lines and substations connecting power plants with the national grid.

In recent years, India, Indonesia, and China have witnessed largescale investments from leading manufacturers across the globe. The growing demand for manufactured products coupled with the rapid expansion of manufacturing units is compelling industry participants to expand & upgrade operations across the region.

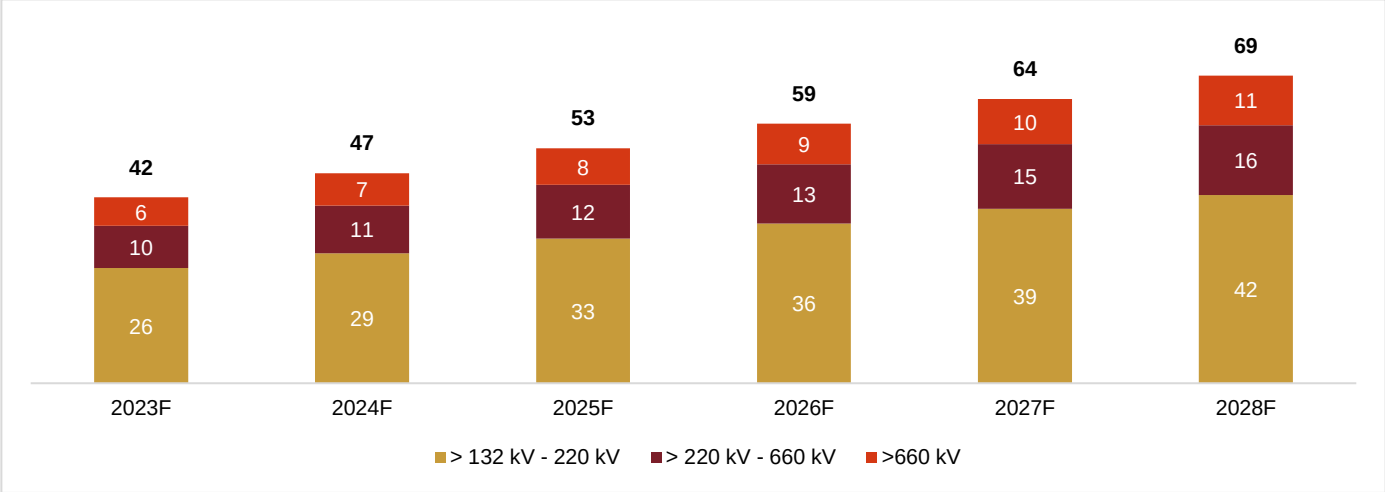
3.9.2 India

Figure 62: India voltage-wise transmission lines y-o-y additions forecast ('000 ckm)



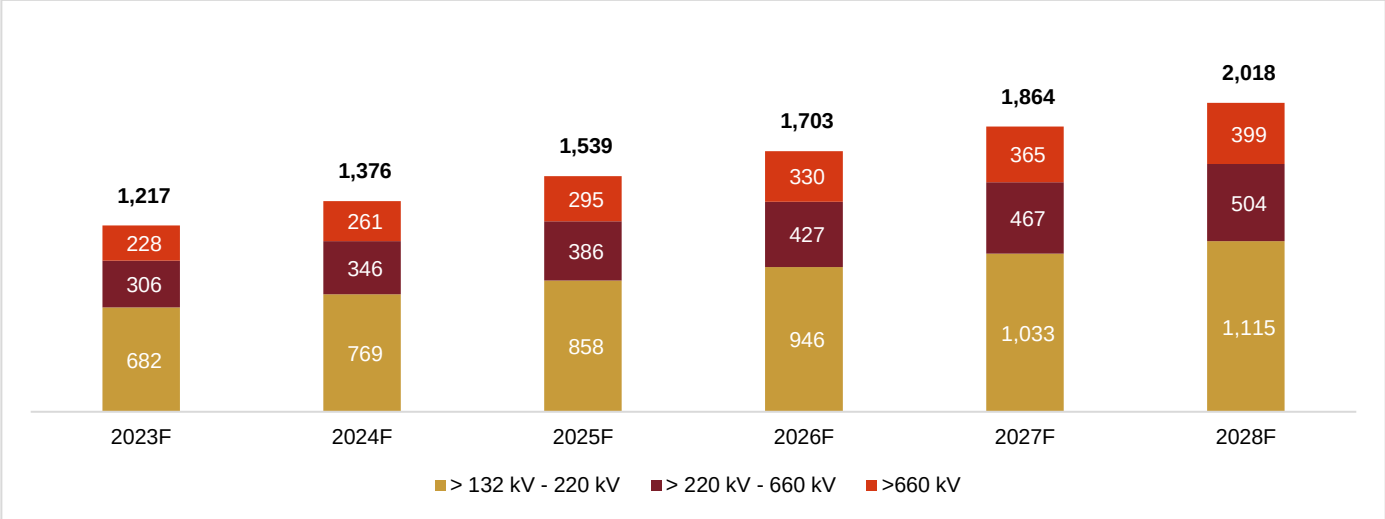
Source: Global Market Insights, CRISIL Consulting

Figure 63: India voltage-wise transmission lines y-o-y additions forecast (GVA)



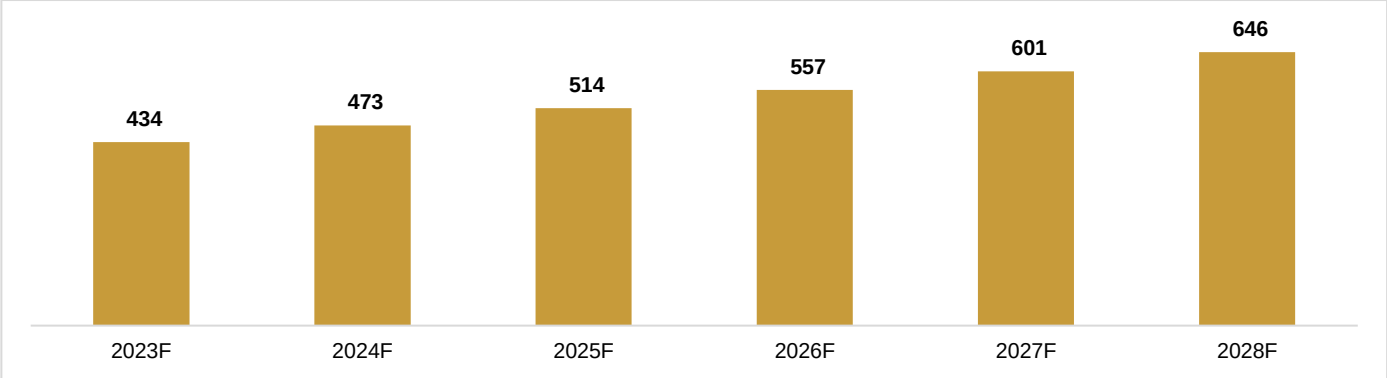
Source: Global Market Insights, CRISIL Consulting

Figure 64: India voltage-wise transmission lines y-o-y investment forecast (USD million)



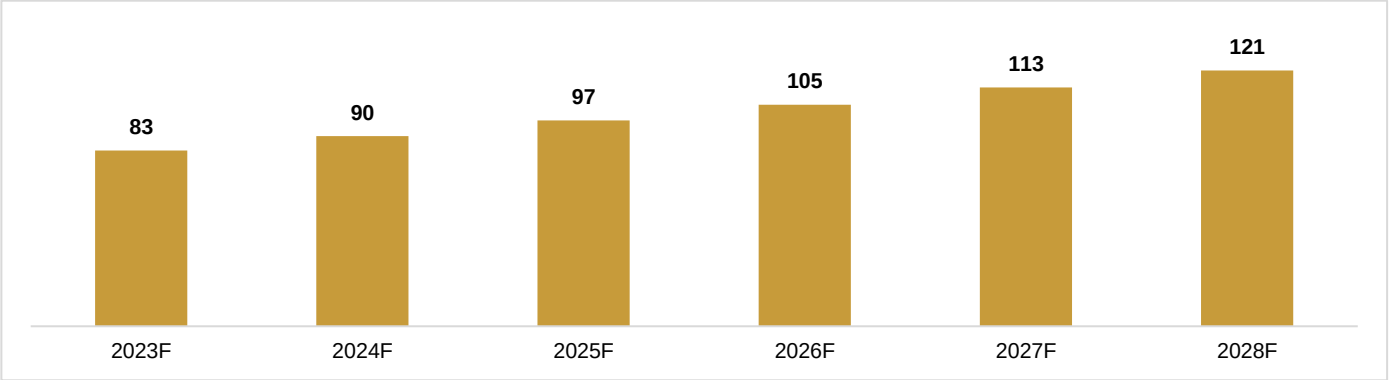
Source: Global Market Insights, CRISIL Consulting

Figure 65: India substation y-o-y additions forecast (Nos)



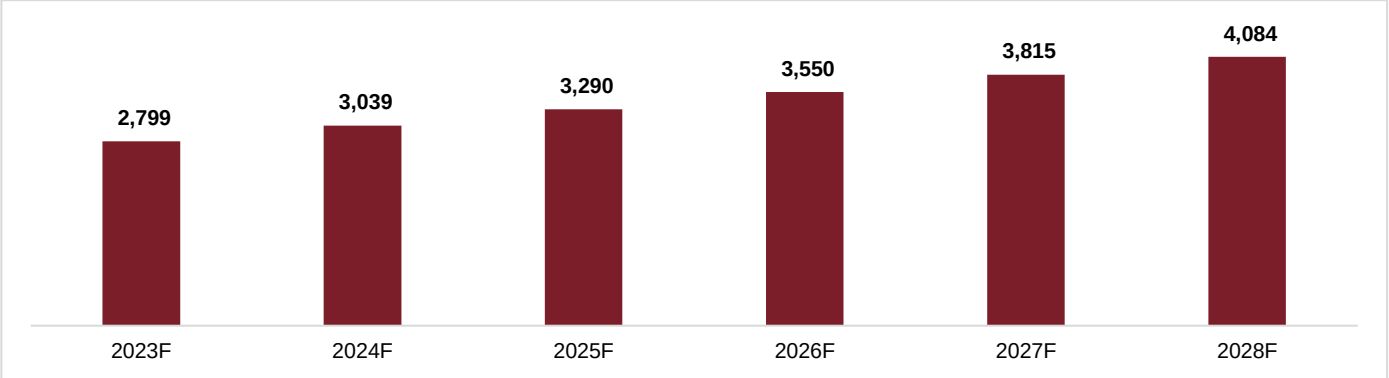
Source: Global Market Insights, CRISIL Consulting

Figure 66: India substation y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

Figure 67: India substation y-o-y investment forecast (USD million)



Source: Global Market Insights, CRISIL Consulting

Key Drivers for Power Transmission Market in India

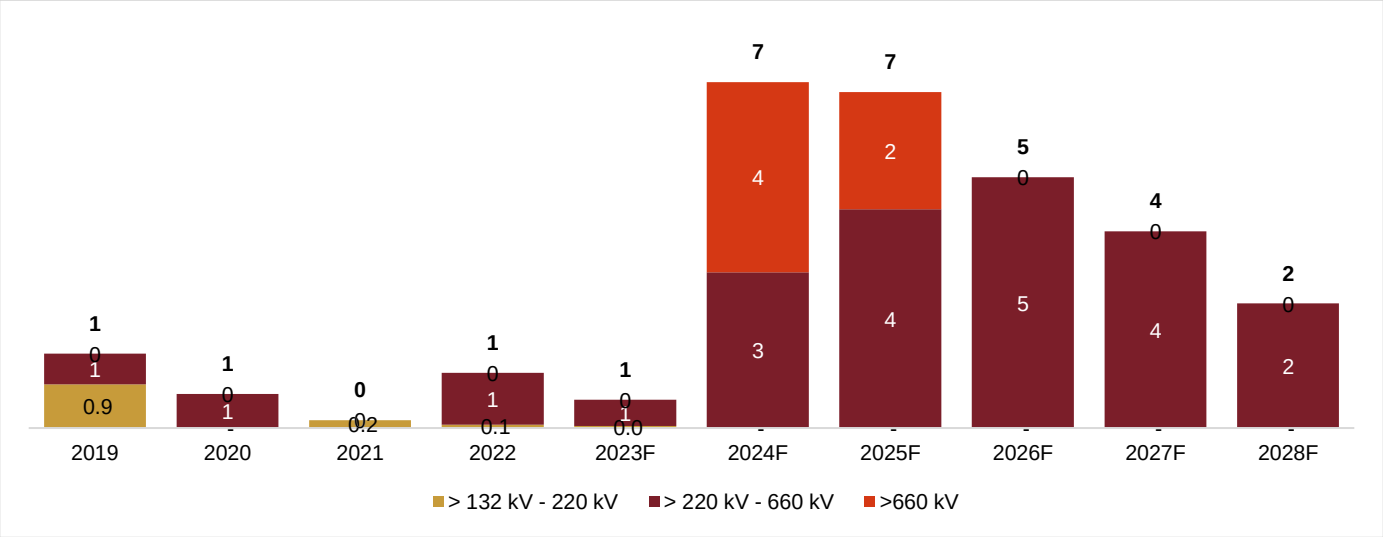
The power transmission sector in the country has grown steadily in recent years, mainly due to the rising demand for electricity and the increasing capacity of power generation plants, particularly renewable energy plants. A major factor driving the further expansion of the grid is the need to evacuate electricity from upcoming renewable energy projects. Green energy corridors and a transmission system for renewable energy zones are already being built to make it easier to integrate renewable energy into the grid.

Report on “Transmission System for Integration of over 500 GW RE Capacity by 2030” published by CEA portrays the broad transmission system roadmap for reliable integration of 537 GW RE capacity by the year 2030.

The length of the transmission lines and sub-station capacity planned under ISTS for integration of additional wind and solar capacity by 2030 has been estimated as 50,890 ckm and 433,575 MVA respectively at an estimated cost of Rs 244,200 crores.

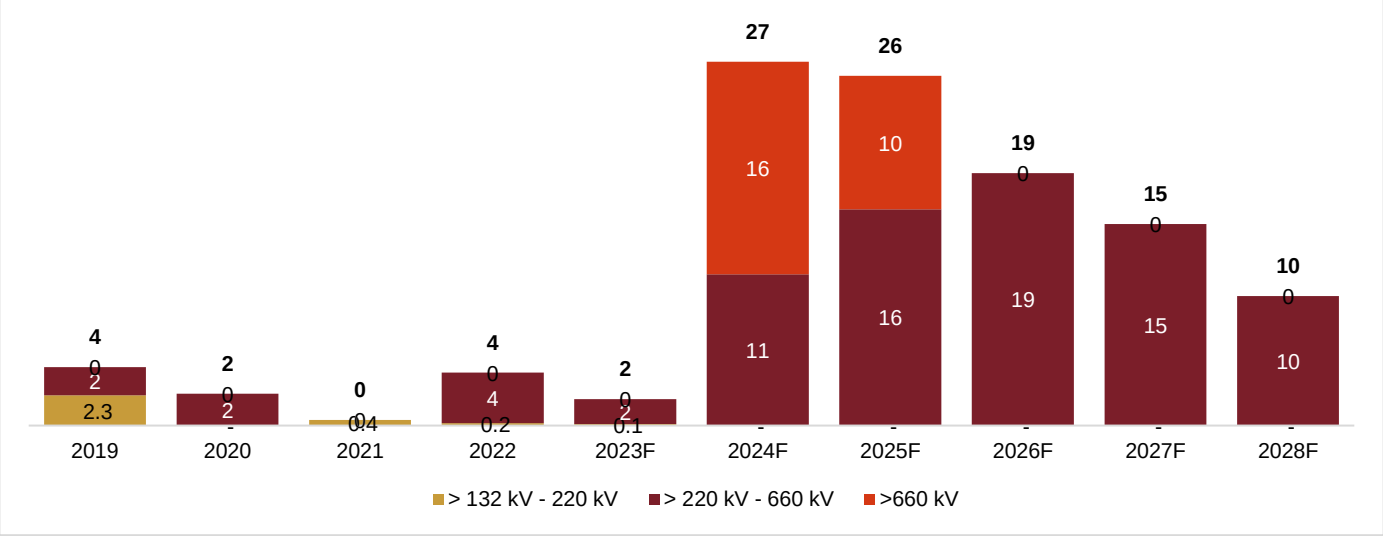
3.9.3 USA

Figure 68: USA voltage-wise transmission lines y-o-y additions forecast ('000 ckm)



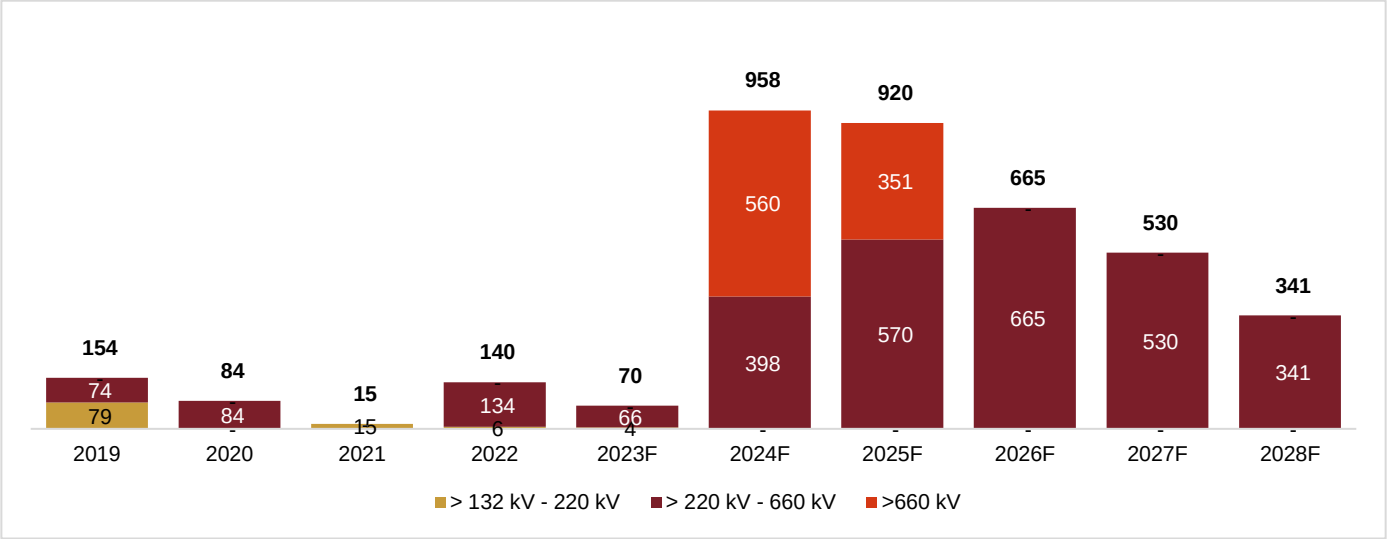
Source: Global Market Insights, CRISIL Consulting

Figure 69: USA voltage-wise transmission lines y-o-y additions forecast (GVA)



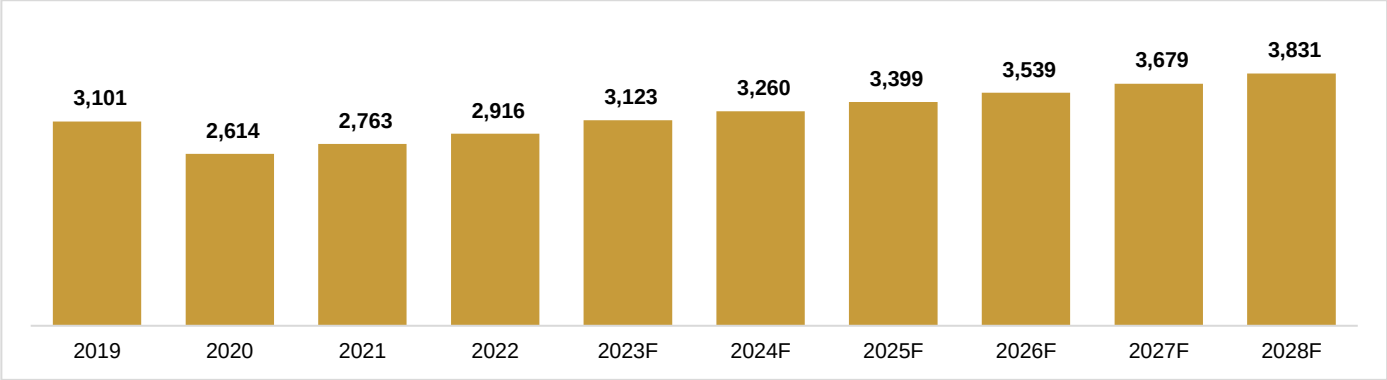
Source: Global Market Insights, CRISIL Consulting

Figure 70: USA voltage-wise transmission lines y-o-y investment forecast (USD million)



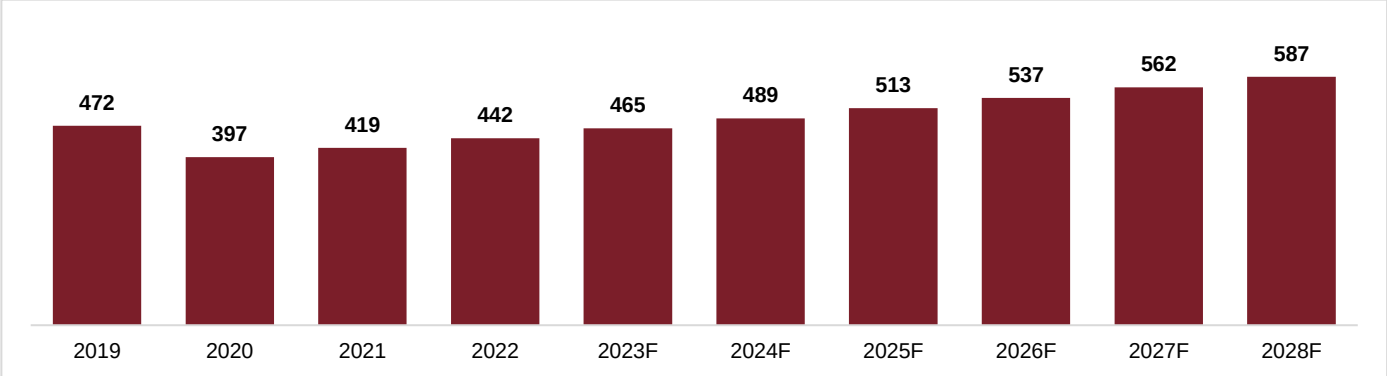
Source: Global Market Insights, CRISIL Consulting

Figure 71: USA substation y-o-y additions forecast (Nos)



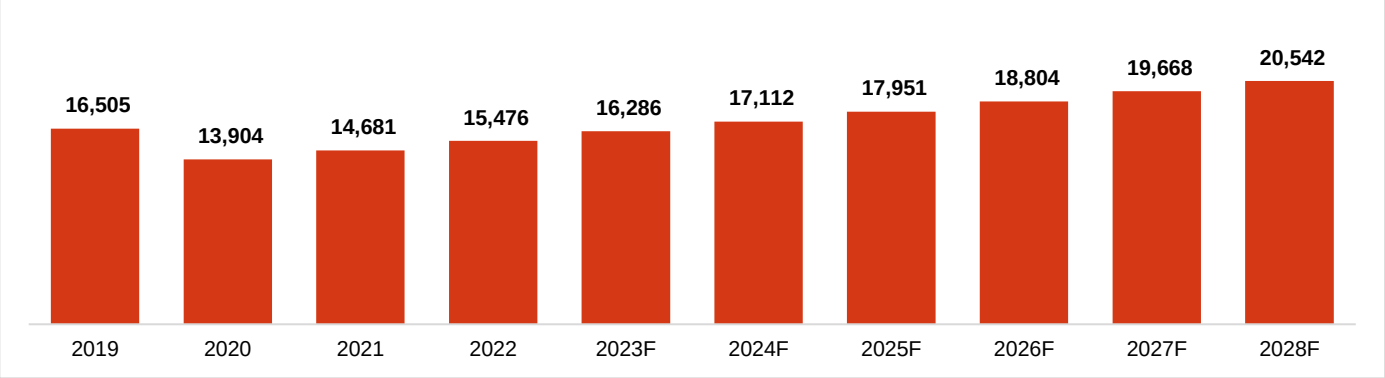
Source: Global Market Insights, CRISIL Consulting

Figure 72: USA substation y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

Figure 73: USA substation y-o-y investment forecast (USD million)



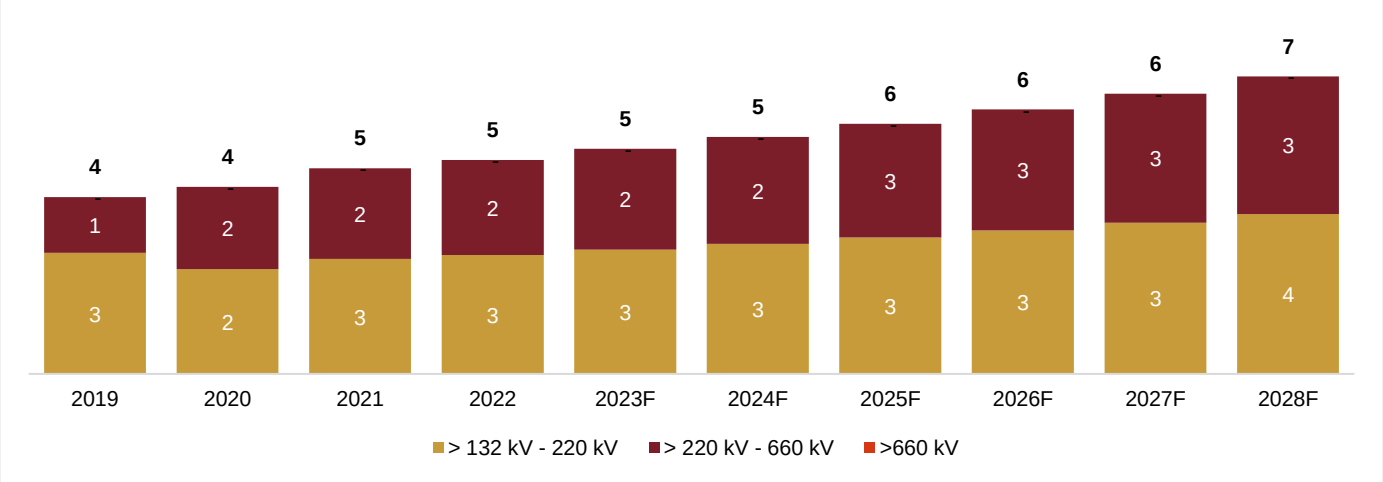
Source: Global Market Insights, CRISIL Consulting

Key Drivers for Power Transmission Market in US

The power transmission market in the USA is expected to grow significantly in the coming years due to increased focus on renewable energy and increased demand of electricity. As part of the President's Investing in America agenda, the U.S. Department of Energy (DOE) has announced up to a $1.3 billion commitment in three transmission lines crossing six states. This will advance transformative projects aimed at adding 3.5 gigawatts (GW) of additional grid capacity throughout the United States. The Transmission Facilitation Program is a $2.5 billion revolving fund to help overcome the financial hurdles associated with building new, large-scale transmission lines, upgrading existing transmission lines, and connecting microgrids in Hawaii, Alaska, and U.S. territories. Some of the key projects include Cross-Tie 500kV Transmission Line (Nevada, Utah) is a proposed 214-mile,1500 MW transmission line connecting existing transmission systems in Utah and Nevada, Southline Transmission Project (Arizona, New Mexico) is a proposed 175-mile, 748 MW transmission line from Hidalgo County, New Mexico to Pima County, Arizona and Twin States Clean Energy Link (New Hampshire, Vermont) is a proposed 1,200 MW high-voltage direct current (HVDC) bidirectional line that will expand the capacity of the New England electric grid.

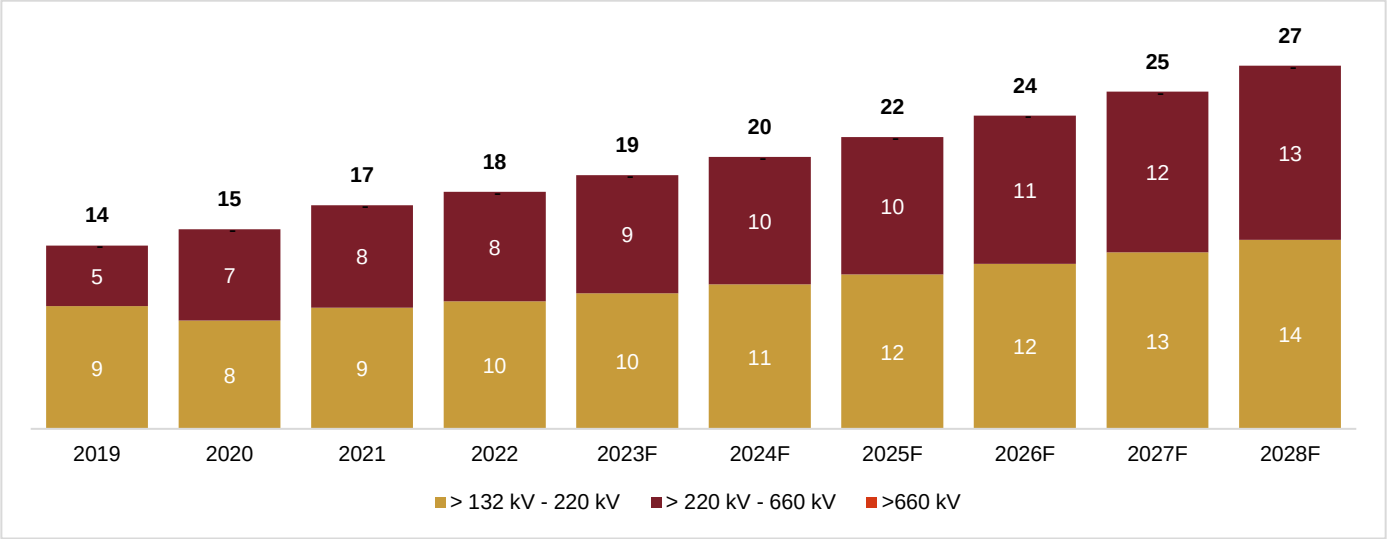
3.9.4 Oceania

Figure 74: Oceania voltage-wise transmission lines y-o-y additions forecast ('000 ckm)



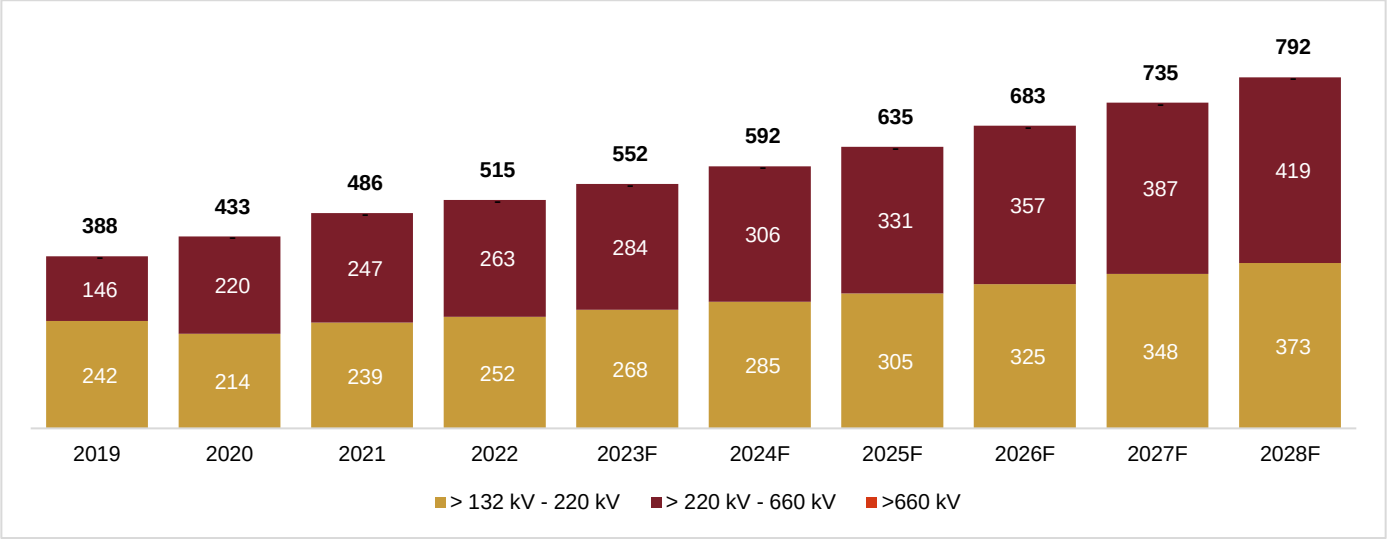
Source: Global Market Insights, CRISIL Consulting

Figure 75: Oceania voltage-wise transmission lines y-o-y additions forecast (GVA)



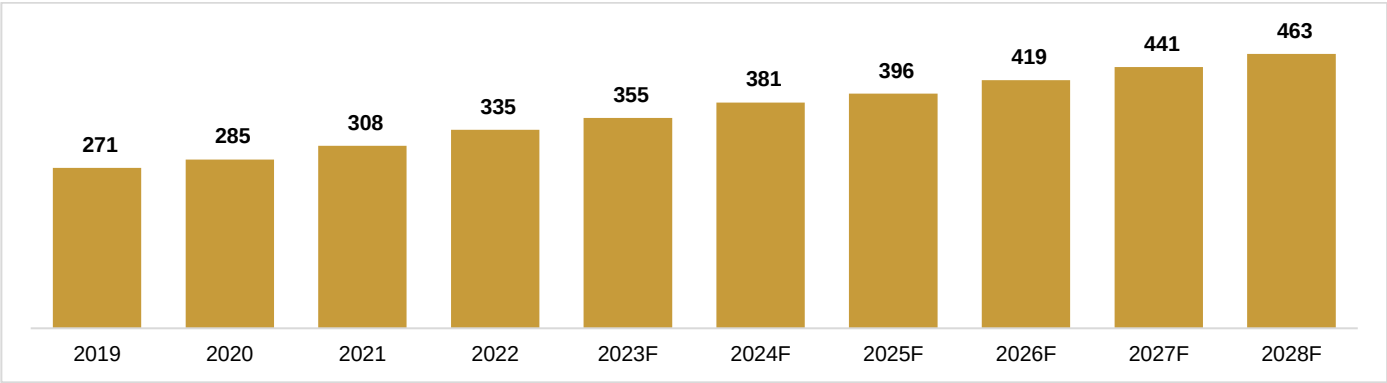
Source: Global Market Insights, CRISIL Consulting

Figure 76: Oceania voltage-wise transmission lines y-o-y investment forecast (USD million)



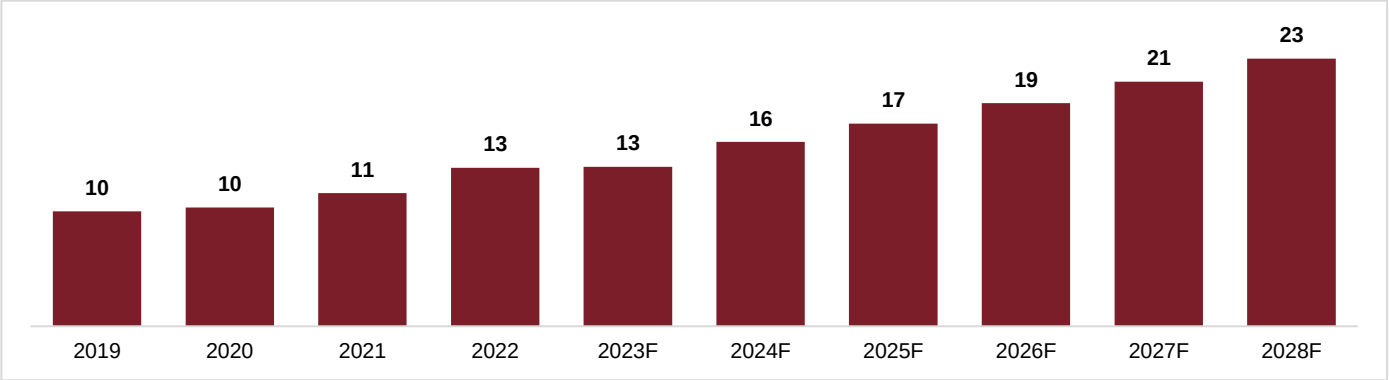
Source: Global Market Insights, CRISIL Consulting

Figure 77: Oceania substation y-o-y additions forecast (Nos)



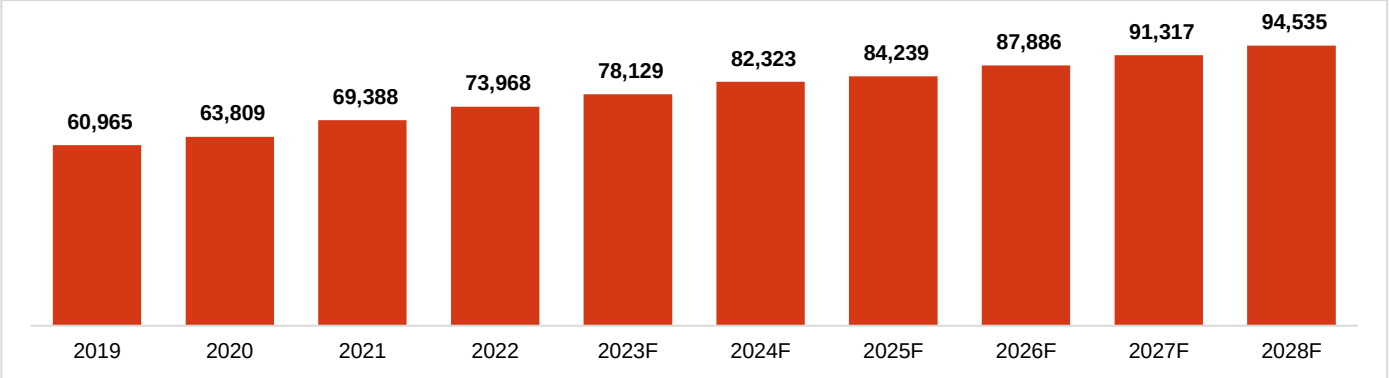
Source: Global Market Insights, CRISIL Consulting

Figure 78: Oceania substation y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

Figure 79: Oceania substation y-o-y investment forecast (USD million)



Source: Global Market Insights, CRISIL Consulting

Key Drivers for Power Transmission Market in Oceania

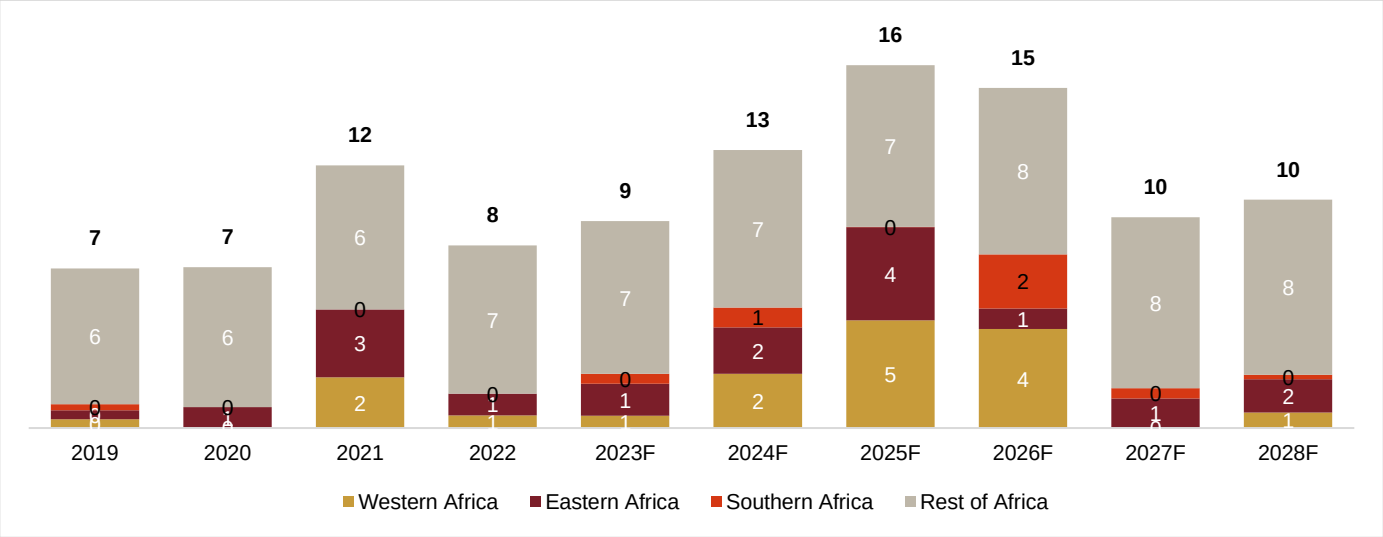
Some of the key projects announces in Oceania region include:

Australia: Transgrid will invest in batteries, energy storage, and 2,500 kilometers of new transmission lines to ensure the grid can operate securely with up to 100% instantaneous renewable energy. The Capacity Investment Scheme (CIS) will support the development of grid-scale dispatchable renewable generation and storage to ensure more reliable and affordable electricity for Australia's homes and businesses. It will unlock around $10 billion of investment and add 6GW to support grid reliability and security.

New Zealand: In Transpower's Net Zero Grid Pathways project, the company submitted a proposal to the Commerce Commission for approval of NZD 400 million for upgrades to the existing grid under a first phase over 2023-2035, while a second post-2030 phase would focus on new grid lines to accommodate load growth (at a still to-be-determined cost)**.**

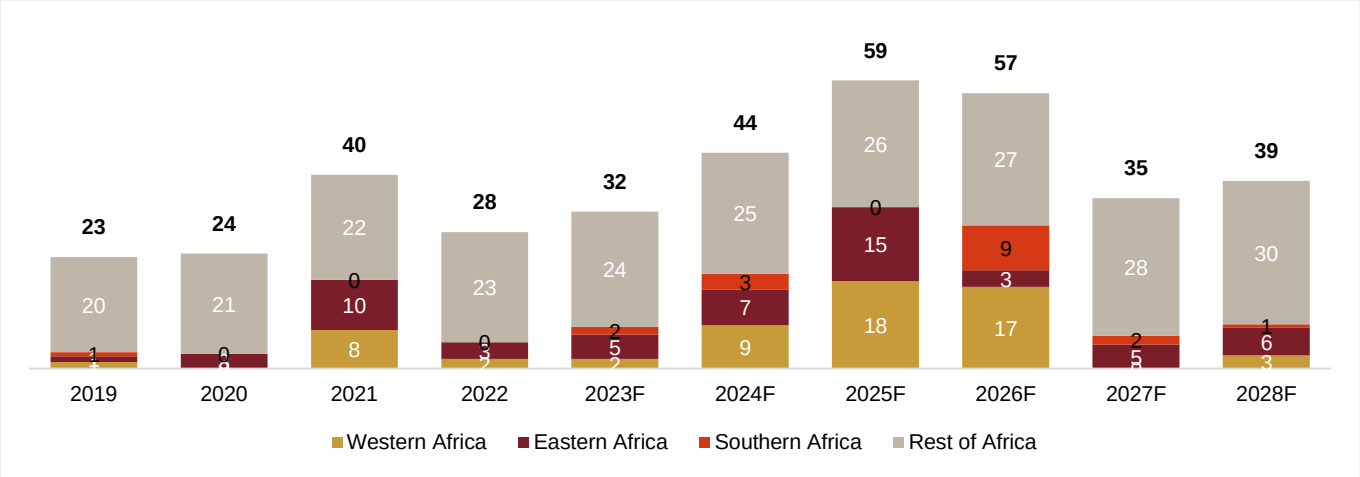
3.9.5 Africa

Figure 80: Africa transmission lines y-o-y additions forecast ('000 ckm)



Source: Global Market Insights, CRISIL Consulting

Figure 81: Africa transmission lines y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

Table 59: Africa voltage-wise transmission lines y-o-y additions forecast ('000 ckm and GVA)

Voltage	Transmission Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
> 132 kV - 220 kV	('000 ckm)	**4**	**3**	**4**	**3**	**4**	**4**	**4**	**3**	**4**	**4**
	GVA	**11**	10	12	10	12	13	15	11	13	14
> 220 kV - 660 kV	('000 ckm)	**4**	4	8	5	6	9	12	12	6	6
	GVA	**12**	13	28	18	21	31	45	45	22	25
>660 kV	('000 ckm)	**-**	-	-	-	-	-	-	-	-	-
	GVA	**-**	-	-	-	-	-	-	-	-	-
Total	**('000 ckm)**	7	**7**	**12**	**8**	**10**	**13**	**16**	**15**	**10**	**10**
	GVA	23	**24**	**40**	**28**	**32**	**45**	**59**	**57**	**35**	**39**

Source: Global Market Insights, CRISIL Consulting

Table 60: Western Africa voltage-wise transmission lines y-o-y additions forecast ('000 ckm and GVA)

Voltage	Transmission Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
> 132 kV - 220 kV	('000 ckm)	-	-	-	-	-	-	-	-	-	-
	GVA	-	-	-	-	-	-	-	-	-	-
> 220 kV - 660 kV	('000 ckm)	0	-	2	1	1	3	5	5	-	1
	GVA	1	-	8	2	2	9	18	17	-	3
>660 kV	('000 ckm)	-	-	-	-	-	-	-	-	-	-
	GVA	-	-	-	-	-	-	-	-	-	-
Total	**('000 ckm)**	**0**	**-**	**2**	**1**	**1**	**3**	**5**	**5**	**-**	**1**
	GVA	**1**	**-**	**8**	**2**	**2**	**9**	**18**	**17**	**-**	**3**

Source: Global Market Insights, CRISIL Consulting

Table 61: Eastern Africa voltage-wise transmission lines y-o-y additions forecast ('000 ckm and GVA)

Voltage	Transmission Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
> 132 kV - 220 kV	('000 ckm)	0	0	1	0	1	1	1	-	0	1
	GVA	1	1	2	1	2	3	4	-	1	2
> 220 kV - 660 kV	('000 ckm)	-	1	2	1	1	1	3	1	1	1
	GVA	-	2	8	3	3	5	12	4	4	4
>660 kV	('000 ckm)	-	-	-	-	-	-	-	-	-	-
	GVA	-	-	-	-	-	-	-	-	-	-
Total	**('000 ckm)**	**0**	**1**	**3**	**1**	**1**	**2**	**4**	**1**	**1**	**2**
	GVA	**1**	**3**	**10**	**3**	**5**	**7**	**15**	**4**	**5**	**6**

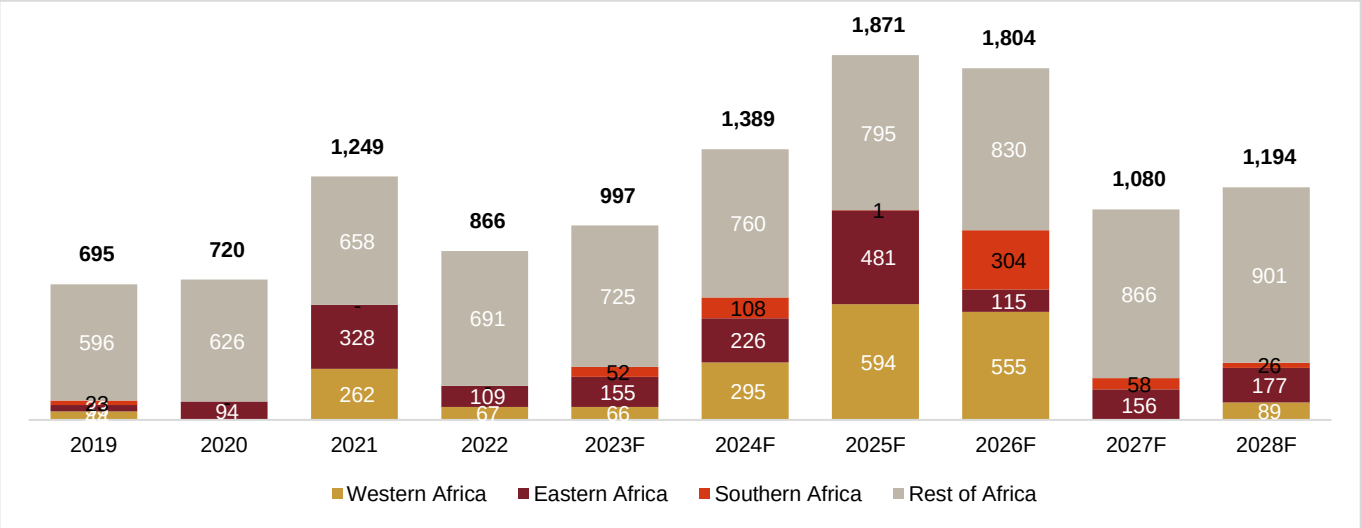
Source: Global Market Insights, CRISIL Consulting

Table 62: Southern Africa (excl. South Africa) voltage-wise transmission lines y-o-y additions forecast ('000 ckm and GVA)

Voltage	Transmission Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
> 132 kV - 220 kV	('000 ckm)	0	-	-	-	-	-	-	-	-	-
	GVA	1	-	-	-	-	-	-	-	-	-
> 220 kV - 660 kV	('000 ckm)	-	-	-	-	0	1	0	2	1	0
	GVA	-	-	-	-	2	3	0	9	2	1
>660 kV	('000 ckm)	-	-	-	-	-	-	-	-	-	-
	GVA	-	-	-	-	-	-	-	-	-	-
Total	**('000 ckm)**	**0**	**-**	**-**	**-**	**0**	**1**	**0**	**2**	**1**	**0**
	GVA	**1**	**-**	**-**	**-**	**2**	**3**	**0**	**9**	**2**	**1**

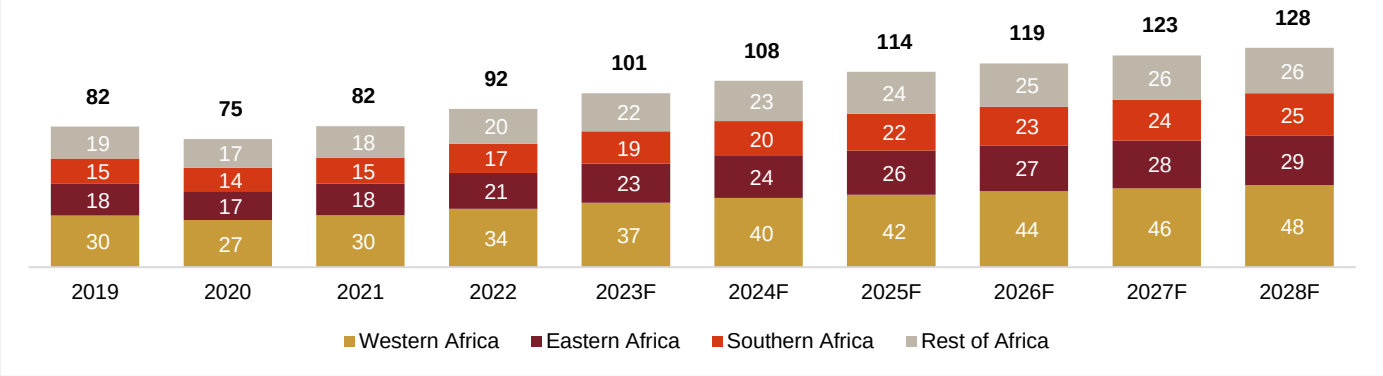
Source: Global Market Insights, CRISIL Consulting

Figure 82: Africa transmission lines y-o-y investment forecast (USD million)



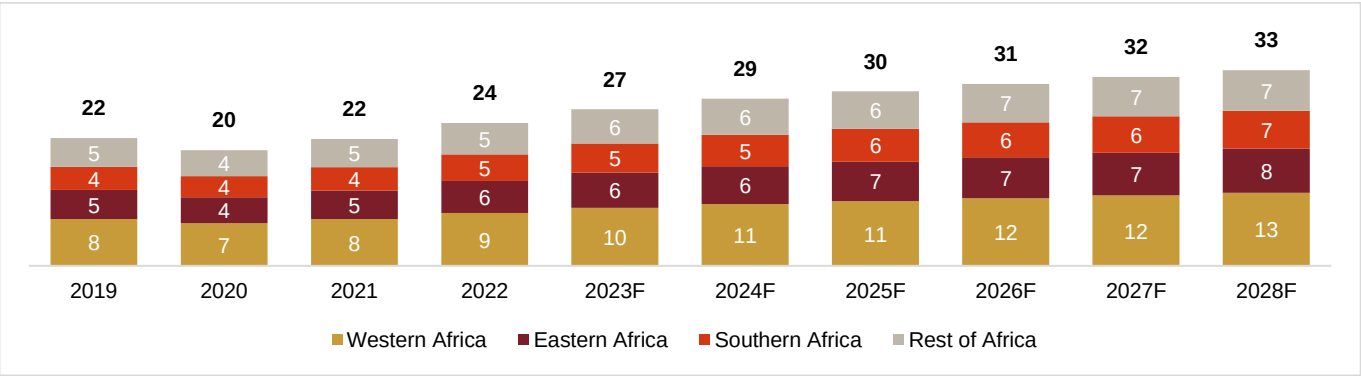
Source: Global Market Insights, CRISIL Consulting

Figure 83: Africa substation y-o-y additions forecast (Nos)



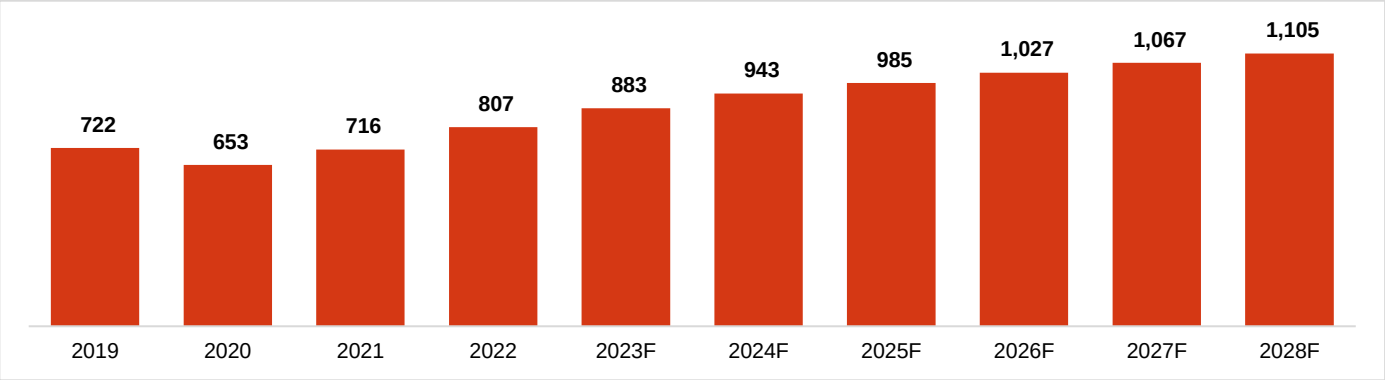
Source: Global Market Insights, CRISIL Consulting

Figure 84: Africa substation y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

Figure 85: Africa substation y-o-y investment forecast (USD million)



Source: Global Market Insights, CRISIL Consulting

Key Drivers for Power Transmission Market in Africa

Lack of access to electricity across the African region has influenced public & private investments in the deployment of new transmission & distribution networks across the region. For instance, as per the Africa Energy Outlook 2022 report by the International Energy Agency, at present, 43% of the total population or over 600 million people in the African region, especially in the sub-Saharan Africa region, lack access to electricity, which displays the critical need for electrical infrastructure in Africa. Increasing government initiatives toward energy efficiency and grid resilience coupled with rising Public- Private Partnerships (PPPs) are further slated to complement the business scenario over the projected timeline. For instance, in February 2023, the Government of Kenya entered into a Public-Private Partnership (PPP) with Power Grid Corporation of India Limited to build a 237 km transmission line under the pan-African investment firm, Africa50. This line will lead to the formation of Kenya's first privately-owned electricity transmission line, which will be built on an investment of approximately USD 298 million.

3.9.6 Latin America

Latin America and the Caribbean (LAC) is a vast and diverse region encompassing approximately 8% of the world's population and contributing around 7% to global GDP. LAC boasts a remarkably high urbanization rate of 82%, with most cities and economic activity concentrated along its extensive coastline. LAC countries are responsible for about 6% of total global energy supply, demand and related emissions. With over 60% of its electricity generated from renewables, primarily hydropower (45%), LAC's power sector stands out as one of the least carbon-intensive globally. Renewables present a big opportunity for the region. Endowed with rich renewable energy resources, LAC boasts extensive coastlines suitable for wind power, ample sunshine for solar energy, substantial geothermal potential along the Andes, and mighty rivers for hydropower. Harnessing the full potential of LAC's renewable energy resources necessitates transporting renewable power over vast distances and challenging terrains, connecting the most promising renewable resource locations to population and economic hubs. LAC needs to add new grid transmission lines and ensuring adequate systems flexibility in power systems as the use of variable renewables generation increases.

Power sector investment in LAC is expected to increase to meet rising electricity demand and to modernise and expand grid infrastructure. As per IEA, under Stated Policies Scenario, the investments in grids likely to increase % of total power sector investment in 2022 to around 35% in 2050 and spending well over triples from 2022 levels to around USD 30 billion by 2050. The need to satisfy growing electricity demand, incorporate renewable energy capacity, and upgrade existing grid infrastructure, including through digitalization, is driving investments in the power sector. The accelerating electricity demand and the rising penetration of renewable energy sources necessitate a significant augmentation of the supporting grids. Under Stated Policies Scenario, IEA expected that the electricity network in LAC to expand from around 9 million km of lines and cables in 2022 to 10 million km in

2030 and 13.6 million km in 2050. The expanded network is expected to enhance grid reliability, promote regional integration, and empower grids to support energy transformations across Latin America and the Caribbean. Countries like Colombia, Brazil, Peru, and Chile have effectively attracted private sector investment in transmission grids by employing a business model similar to the IPP model used for generation, with significant support from national and international development finance institutions.

3.9.7 Europe

Successful implementation of the European Green Deal and REPowerEU will require a comprehensive strategy that encompasses increasing the share of renewable energy in the energy portfolio, addressing the rising electricity demand driven by electrification across various industries, expanding the penetration of grid-connected distributed energy resources, and promoting greater customer engagement, including through demand response mechanisms. T&D infrastructure will serve as a critical market enabler for the transformative changes envisioned by the European Green Deal and REPowerEU. To effectively reach the European Green Deal goals, T&D networks need to be significantly expanded for effective grid integration, system adequacy, cross-border energy flows and support sector integration including EVs. Harnessing the power of digitalization, evident in automation systems, smart meters, and other smart grid technologies, is crucial for enhancing grid management capabilities and unlocking new service opportunities. Addressing these critical challenges will demand significant investments at both the national and EU levels.

As per IEA, cumulative renewable electricity capacity in Europe is expected to increase nearly 60% (+425 GW) between 2022 and 2027, more than twice as much as in the previous five-year period (2016-2021). Solar PV leads growth, followed by onshore wind, offshore wind, bioenergy and hydropower. Europe's renewable capacity expansion is limited by three main challenges: inadequate support schemes; lengthy and complex permitting procedures; and the slow pace of T&D network upgrades.

In 2022, EU countries approved a European Commission proposal to provide €1.037 billion in funding for five cross-border infrastructure projects under the Connecting Europe Facility (CEF) for trans-European energy networks. CEF will provide financial support to 4 projects for construction and 1 study. Well-integrated energy infrastructure networks are necessary for the energy transition, as they facilitate the integration of renewable energy, enhance security of supply and help keep energy prices in check

a. **EuroAsia interconnector** (€657 million): Interconnects the transmission networks of Cyprus and Greece, 898km of undersea cables
b. **Baltic Synchronisation Project Phase II** (€170 million): Grid reinforcement in Poland and upgrading the transmission infrastructure in Lithuania, Latvia and Estonia
c. **Aurora line** (€127 million): Third transmission line between Sweden and Finland
d. **Chiren expansion** (€78 million): Capacity increase of a gas storage facility in Bulgaria
e. **Northern Lights Phase II** (€4 million): Expansion of the CO2 transport and temporary storage capacity in Norway

The European Commission presented the EU action plan "Digitalisation of the energy system" at the end of 2022. The Commission expects about EUR 584 billion (USD 633 billion) of investments in the European electricity grid by 2030, of which EUR 170 billion (USD 184 billion) would be for digitalisation (smart meters, automated grid management, digital technologies for metering and improvement on the field operations).

European Commission has estimated that about **€584 billion of electricity infrastructure investments** are needed between 2020 and 2030, in particular in the distribution grid, to reach the 'Fit for 55'

and REPowerEU objectives for renewables and energy efficiency. Investments in digital solutions such as grid optimisation at distribution level will help reduce further capital expenditure on enhancing the existing grid infrastructure.

India has been a preferred choice for supply of transmission lines and towers due to following reasons:

Cost advantage: cost advantage over other countries due to low labor costs, abundant raw materials, and a well-developed manufacturing sector.

Better Quality: High-quality products meeting meet international standards due to use of advanced manufacturing processes and quality control measures.

Reliability: Indian manufacturers have a good reputation for being reliable and meeting delivery deadlines.

Flexibility: Indian manufacturers are flexible and can adapt to meet the specific needs of their customers**.**

Stable geo-political situation: India has been politically stable country

Additionally due to the strategic location, India has become a preferred choice for supply of transmission lines and towers. Being centrally located in Asia, it becomes easy to ship products to different countries. Indian transportation network is also well developed making it easy to transport products to ports. As a result of these factors, India has been able to export transmission towers to a number of countries including Middle East, Africa and South-East Asia.

3.10 Overview of HTLS and GAP conductors

HTLS conductors, or high-temperature low-sag conductors, are a type of overhead power line conductor that can withstand higher operating temperatures than conventional conductors. This allows them to carry more current and transmit more power, which can be beneficial in areas with high demand or where there are restrictions on the height of transmission towers. HTLS conductors are typically made of a steel core surrounded by an outer layer of high-temperature resistant aluminum alloy. The aluminum alloy is often modified with zirconium or other elements to improve its strength and conductivity at high temperatures. HTLS conductors are available in a variety of types, each with their own advantages and disadvantages. Some of the most common types of HTLS conductors include:

- **TACIR (Thermally Upgraded Aluminum Conductor Steel Reinforced):** This type of conductor is made of a steel core surrounded by an outer layer of high-temperature resistant aluminum alloy. The aluminum alloy is often modified with zirconium or other elements to improve its strength and conductivity at high temperatures. TACIR conductors can operate at temperatures up to 250°C.
- **GTACSR (Galvanized Thermally Upgraded Aluminum Conductor Steel Reinforced):** This type of conductor is similar to TACIR, but it has a galvanized steel core. This makes it more resistant to corrosion, which can extend its lifespan. GTACSR conductors can also operate at temperatures up to 250°C.
- **ZTACIR (Zirconium Thermally Upgraded Aluminum Conductor Steel Reinforced):** This type of conductor is made with a zirconium-modified aluminum alloy. This gives it even better strength and conductivity at high temperatures than TACSR or GTACSR conductors. ZTACIR conductors can operate at temperatures up to 300°C.
- **ACSS (Aluminum Conductor Steel-Cored Stressed):** This type of conductor is made with a steel core surrounded by an outer layer of aluminum strands. The aluminum strands are stressed to improve their strength and conductivity. ACSS conductors can operate at temperatures up to 200°C.

HTLS conductors are a relatively new technology, but they are becoming increasingly popular as the demand for electricity grows. They offer a number of advantages over conventional conductors, including:

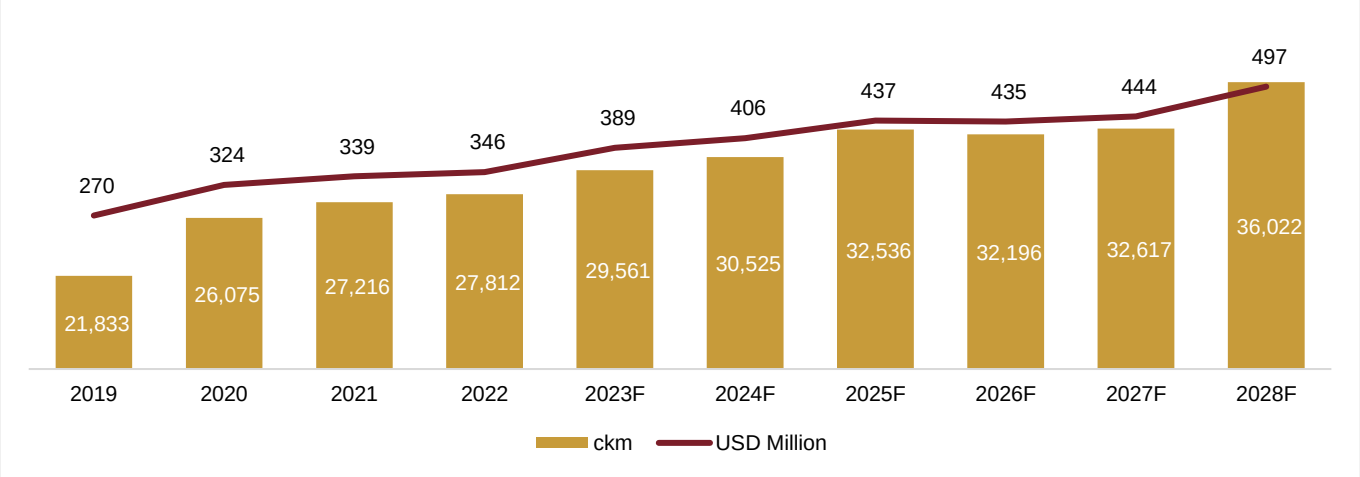
- **Increased capacity:** HTLS conductors can carry more current than conventional conductors, which allows them to transmit more power.
- **Reduced sag:** HTLS conductors sag less than conventional conductors at high temperatures, which can help to improve clearances and reduce the need for taller towers.
- **Longer lifespan:** HTLS conductors are more resistant to corrosion and wear than conventional conductors, which can extend their lifespan.

A gap conductor is a type of high-temperature low-sag (HTLS) conductor that is made of a steel core surrounded by an outer layer of thermal-resistant aluminum alloy wires. The gap between the steel core and the aluminum alloy wires is filled with a high-temperature resistant grease. This gap allows the steel core to move freely, which gives the conductor its special characteristics.

Conventional conductors continue to dominate the power T&D lines market as these conductors including aluminum conductor steel reinforced (ACSR) and all aluminum conductor (AAC), have been the standard choice for decades due to their proven reliability, widespread availability, and cost-effectiveness. These conductors have a well-established track record in power transmission networks and are widely used in various voltage classes and geographical regions. Although they may have lower ampacity compared to HTCs, their simplicity and familiarity make them a preferred option for many utilities and transmission companies. In addition, the replacement of existing conventional conductors with HTCs requires substantial investment and planning, which may deter some organizations from immediate adoption. However, as the need for higher power transfer capabilities and increased efficiency continues to grow, conventional conductors are witnessing gradual improvements and innovations to address some of their limitations. As the market evolves, a balance between the adoption of advanced HTCs and the continued use of conventional conductors is expected to shape the power transmission landscape in the coming years.

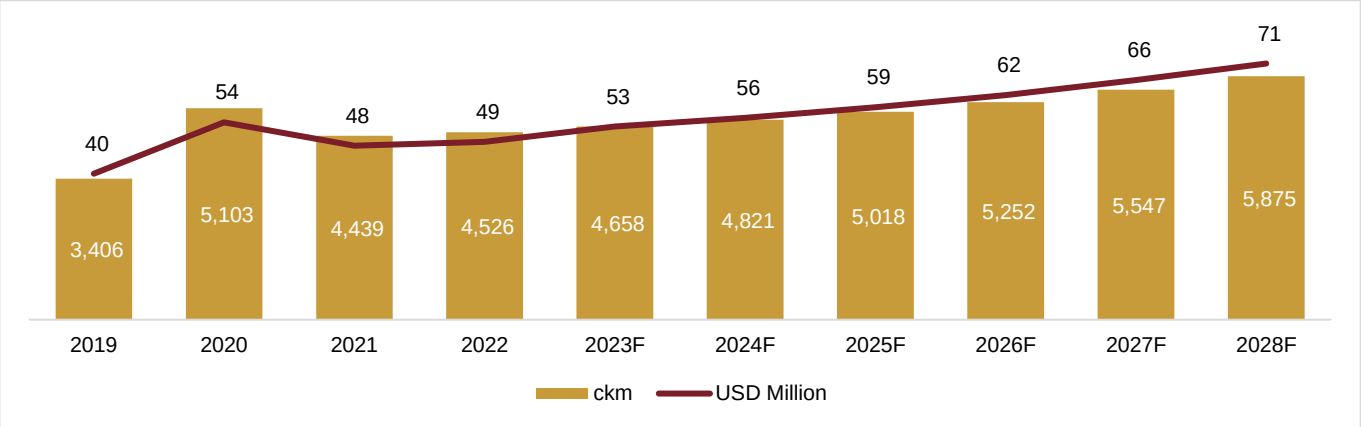
The market trend for High-Temperature Conductors (HTCs) has been experiencing significant growth and interest in recent years. As electricity demand continues to rise and power transmission networks face increasing challenges, there is a growing need for conductors that can handle higher electrical loads and offer enhanced efficiency. HTCs, such as aluminum conductor steel reinforced (ACSR) with aluminum-steel composite cores or advanced materials like aluminum conductor composite core (ACCC), are gaining popularity due to their ability to reduce sagging and increase ampacity. These conductors enable transmission lines to carry more power over longer distances, leading to improved grid reliability and performance. Moreover, as the world transitions to a cleaner and more sustainable energy mix, HTCs play a crucial role in supporting the integration of renewable energy sources into the grid, ensuring efficient power transfer from remote generation sites to population centers. Governments and utilities are increasingly investing in upgrading transmission infrastructure with HTCs, making it one of the key drivers of innovation and modernization in the power T&D industry.

Figure 86: Global HTLS forecast FY19-FY28 (length and investments)



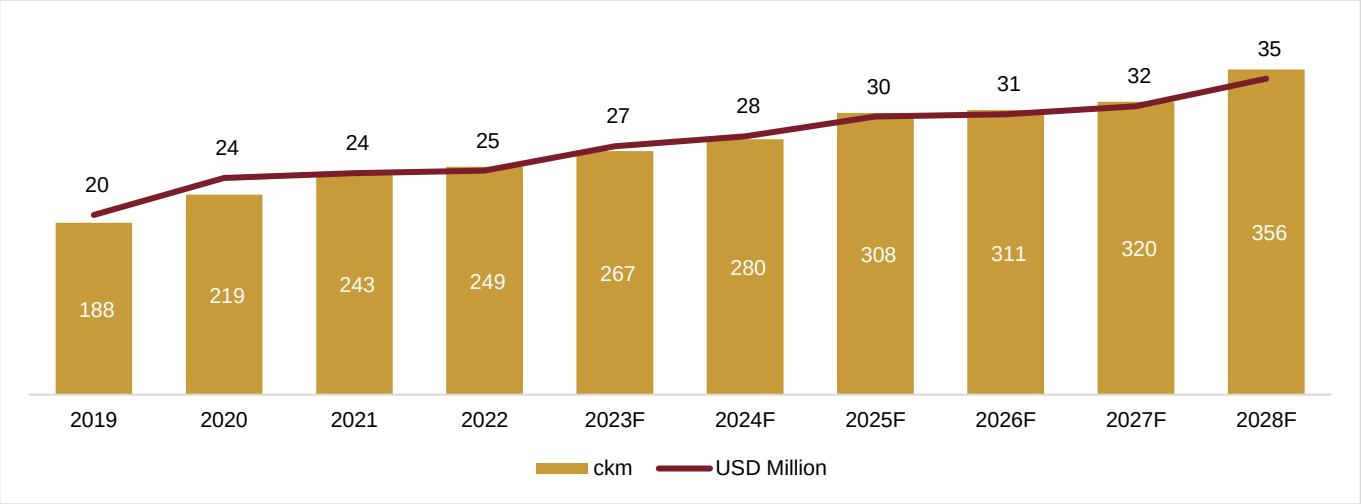
Source: Global Market Insights, CRISIL Consulting

Figure 87: Indian HTLS forecast FY19-FY28 (length and investments)



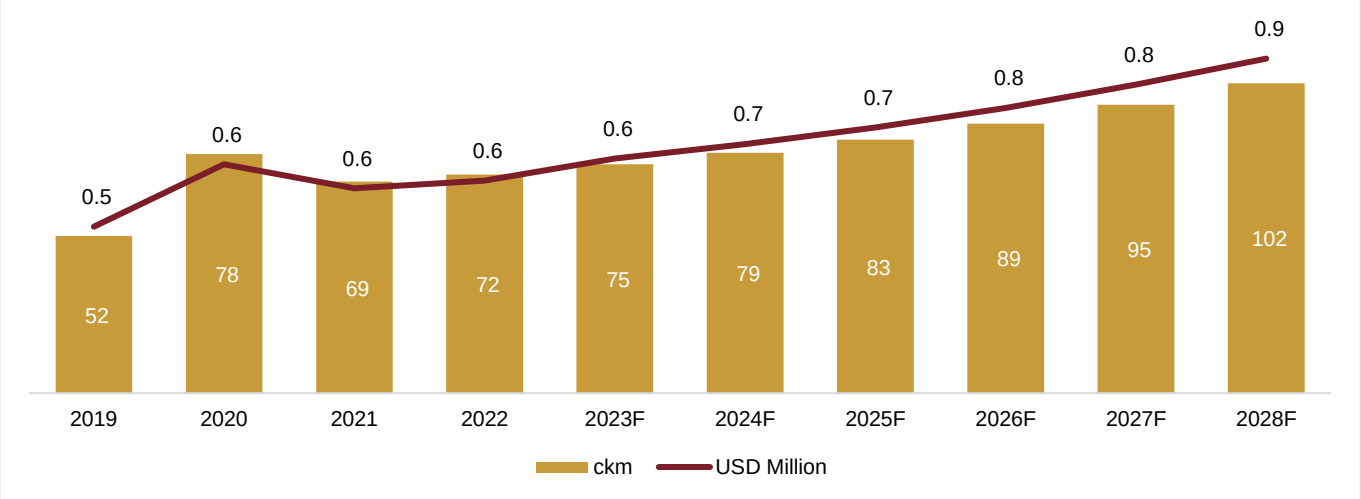
Source: Global Market Insights, CRISIL Consulting

Figure 88: Global GAP conductors forecast FY19-FY28 (length and investments)



Source: Global Market Insights, CRISIL Consulting

Figure 89: Indian GAP conductors forecast FY19-FY28 (length and investments)



Source: Global Market Insights, CRISIL Consulting

3.11 Major upcoming transmission lines and sub-station projects

Table 63: Key investments and projects in the power sector

Region	Name of project	kV	ckm	Commissioning year	Sponsor/Contractor	Total investment (USD million)
USA	Northland Reliability Project	345	515	2030	Minnesota Power Great River Energy	970
	Twin States Clean Energy Link, US	345	679	2026	National Grid Citizens Energy Corporation IBEW Northeastern Vermont Development Association (NVDA)	2,000
	SunZia Southwest Transmission Project	520	1,609	2026	SunZia Transmission, LLC Pattern Energy	8,000
	Hartburg – Sabine Junction Line	500	119	2023	Entergy Texas	115
	Champlain Hudson Power Express (CHPE) Project	400	1,091	2026	Blackstone Inc	6,000
	TransWest Express Project	600	2,350	2025	TransWest Express LLC.	3,000
	Clean Path New York (Clean Path NY) Project	400	563	2027	Clean Path NY	3,500
	North Plains Connector Line Transmission Project	600	1,240	2029	Grid United ALLETE Minnesota Power	2,500
Africa	Line for 4 Western Countries	330	1750	TBD	Transmission Company of Nigeria (TCN) Western Africa Power Pool (WAPP)	570
	Côte d'Ivoire-Liberia	225	1,300	2026	West African Power Pool (WAPP)	509
	N'Zérékoré - Fomi - Bamako section	225	1,428	2026	West African Power Pool (WAPP)	396
	WAPP North Core Interconnection	330	1,750	2024	West African Power Pool (WAPP)	624
	Manantali – Bamako (Kati) double-circuit line in Mali	225	558	2023	West African Power Pool (WAPP)	381
	Kyaka – Masaka Line, Tanzania	400	60	2025	Tanzania Electric Supply Co Ltd (TANESCO)	12
	Mirama / Kikagati / Nsongezi Transmission Line	132	74	2024	Uganda Electricity Transmission Company Ltd. (UETCL)	33
	Tanzania-Zambia interconnection	400	1,240	2024	Tanzania Electric Supply Company Ltd.	605
	Baynes Hydro Power Project 400 KV Transmission	400	900	2024	National electric power utility in Namibia) Electric power transmission company in Angola)	1,370
Asia Pacific	Transmission System Improvement Project in Western and Southern Regions to Enhance System Security (TIWS)	500	2,192	2025	-	1,000
	Power Southern Region to Enhance System Security (TILS)	500	1,400	2026	-	1,000
	Rehabilitation of OHTL Akmolinskye MES branch, Vostochnye MES branch, Severnye MES branch and	220-500	8,400	2019-2028	-	130

Region	Name of project	kV	ckm	Commissioning year	Sponsor/Contractor	Total investment (USD million)
	Tsentralnye MES branch of KEGOC, stage II & stage III.					
	Nura – Zhezkazgan Line, Kazakhstan	500	1,100	2021-2025	-	70

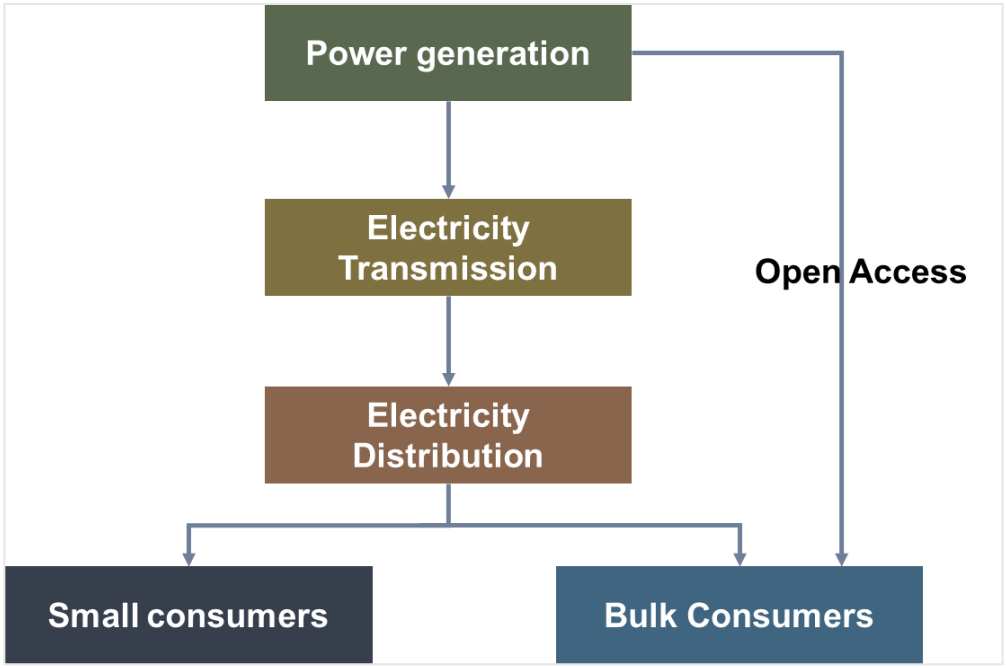
Source: Global Market Insights, CRISIL Consulting

4 Overview of power distribution sector

4.1 Regulatory overview - India

The Government of India facilitates efforts of states to provide power to consumers in an improved manner. Electricity is a concurrent subject & responsibility of distribution rests with states. The Electricity Act, 1910 regulated India's power sector for almost a century. Post-independence, the Electricity (Supply) Act 1948 was introduced. Post 1991, various changes have been introduced for transforming power sector in India. Earlier, State Electricity Boards (SEBs) were largely responsible for power supply with few private sector licensees in urban areas like Mumbai, Delhi, Kolkata etc. In 1998, Central Government introduced Electricity Regulatory Commissions Act, 1998 wherein responsibility of tariff setting vested with regulatory commissions. However, enactment of the Electricity Act 2003 brought major reforms in power sector. The Act de-licensed power generation and also made provision of private transmission licenses and the distribution licensee. Thus, power T&D activity became licensed activity. The SEBs were also unbundled into three separate business segment of generation, T&D segments.

Figure 90: Power sector in India



Source: Industry, CRISIL Consulting

The distribution sector consists of power distribution companies (discoms) responsible for the supply and distribution of energy to consumers such as industrial, commercial, agricultural, domestic, etc. At a national level, MoP and MNRE are responsible for policy making whereas state-level policies are framed by energy/power departments of respective State Governments/ Union Territories. At the state-level, State Electricity Regulatory Commissions (SERCs) are responsible for framing Regulations for power generation, electricity transmission and distribution. Most of the regulations are largely inspired by Centre-level policies/regulations with SERCs modifying them considering state-level issues and prevailing conditions. Some of the key distribution regulations are discussed below:

- State Grid Code Regulations: A single set of technical and commercial regulations, encompassing all the utilities connected to/or using Intra State Transmission System (InSTS) and governing the relationship between various users of InSTS, SLDC (State Load Dispatch Center) and RLDC (Regional Load Dispatch Center).

- Electricity Supply Code and Standards of Performance for Distribution Licensees Regulations: Regulations that govern the distribution of electricity of India by laying down guidelines and standards to be followed by all discoms in order to ensure reliable and efficient supply of electricity to consumers.
- Consumer Grievance Redressal Forum & Electricity Ombudsman Regulations: The CGRF & EO provide a mechanism for consumers to resolve their complaints about electricity supply and ensure the protection of consumers' rights by facilitating fair treatment by discoms.
- General Conditions of Distribution License Regulations: The GCDLR lays down the roles and responsibilities of distribution licensees, the standards of performance that they are required to meet, and the procedure for dealing with consumer complaints. They also specify the financial and technical requirements that distribution licensees must meet to be granted a license.
- Trading License Conditions Regulations: A trading license allows an entity to buy and sell electricity in the wholesale market. These regulations lay down the requirements that the entity must meet to acquire a trading license, as well as the obligations that they must comply with once they have been granted the license.
- Distribution Open Access Regulations: The DOA enables consumers to purchase electricity from sources other than their distribution licensee, such as power exchanges or renewable energy generators, thus giving consumers additional flexibility in sourcing their electricity supply and promoting competition in the electricity market. It includes procedures for consumers to obtain OA to the distribution grid, the charges they must pay, and the rights and obligations of the consumers as well as distribution licensees.
- Multi Year Tariff Regulations: MYT regulations give clarity to transmission licensees, distribution licensees, generating companies, consumers, and other stakeholders with regards to the principles governing determination of revenue requirement and tariffs in each state. They usually cover a period of 3-5 years and are based on factors such as cost of power generation, cost of transmission and distribution, and expected electricity demand. The regulations also include provisions for adjusting tariffs in case of changes in any of these factors.
- Terms and Conditions for Determination of Renewable Energy Tariff Regulations: These provide developers with an estimated tariff that will cover their costs and enable them to make a suitable return on investment, while ensuring that consumers benefit from lower cost of RE power. They generally cover a period of 25 years where the tariff is determined on a levelized basis and can be adjusted periodically to reflect changes in the cost of RE technology, financing cost, and expected demand for RE power.
- Renewable Purchase Obligation Regulations: Entities are required to purchase a certain share of electricity from RE sources, as a percentage of the total consumption of electricity. The total purchase obligation (including solar, wind, hydro and other) as laid down by the Ministry of Power is 27.08% in FY2023-24 and has been set at 43.33% for FY2029-30.
- Forecasting, Scheduling and Deviation Settlement for Solar and Wind Generation Regulations: Solar and wind generators are required to submit day-ahead forecasts of their generation, while specifying the procedures for scheduling and dispatching solar and wind generation. The regulations set out the rules for dealing with contingencies from weather change or deviations from forecasts, by means of penalties for generators that go over and under their targets.
- Net Metering for Roof-top Solar PV Systems Regulations: Net metering allows consumers with rooftop solar PV systems to offset their electricity consumption with their own generation by crediting consumers for the excess electricity they generate and consume and billing them only for the net amount of electricity imported from the grid. Net metering was capped at 10kW in December 2020 which was amended to 500 kW in June 2021.

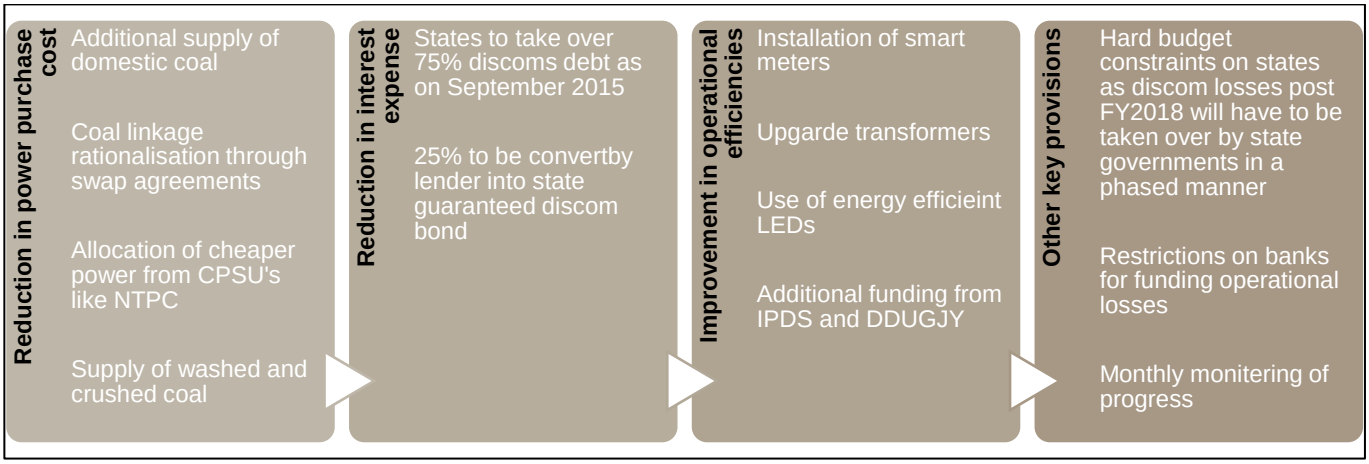
4.1.1 Ujwal DISCOM Assurance Yojana (UDAY)

Distribution is the final and critical link in the power sector value chain. However, the financial position of the distribution sector has significantly deteriorated over the past decade owing to irregular tariff hikes, high aggregate technical and commercial (AT&C) losses, and delays in subsidy payments by state governments. This has adversely impacted power offtake by discoms and led to delays in payments to generation companies. Both the

financial and operational performance of discoms started to improve post implementation of Ujwal DISCOM Assurance Yojana (UDAY), but the situation reversed and worsened again once the scheme ended in March 2019.

Under the UDAY scheme, states took over 75% of discom debt as on September 30, 2015, over a period of two years – 50% in fiscal 2016 and 25% in fiscal 2017. The balance 25% was to be converted by lenders into loans or bonds at an interest rate not more than the banks' base rate plus 10 basis points. Alternatively, this debt could be fully/partly issued by the discoms as state guaranteed bonds at prevailing market rates, which were to be equal to or less than the banks' base rate plus 10 bps. The scheme envisaged reduction of the cost of power through measures such as additional supply of domestic coal (at notified prices), coal linkage rationalization through swap agreements, supply of washed and crushed coal, and supply of cheaper power from NTPC and other central public sector units (as part of central allocation of power to states), if available through a higher plant load factor. Implementation was mixed with policy-level support but limited traction on the ground. While coal linkage rationalization under the SHAKTI scheme did benefit several projects, and domestic supply also improved, the effect has been temporary or partial.

Figure 91: Synopsis of UDAY scheme



Source: CRISIL Consulting

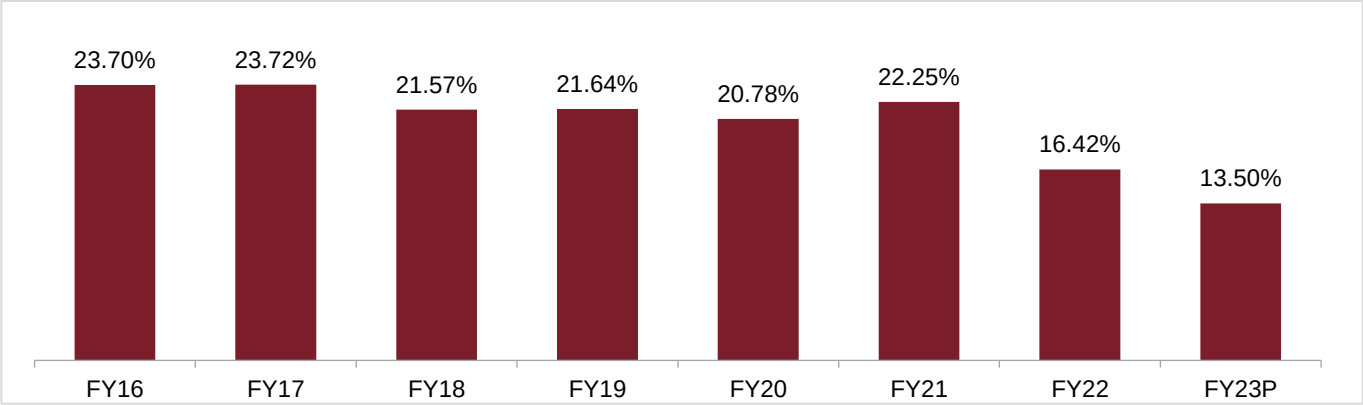
Improvements in operational efficiency

Operational efficiency improvements were planned through smart metering, upgradation of infrastructure (including transformers), and use of energy-efficient LED bulbs, pumps, and other heavy electric equipment. Through GoI schemes such as Integrated Power Development Scheme (IPDS) and Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), additional/priority funding (depending on achievement of operational milestones) was being made available to target reduction in AT&C losses. However, the earlier target of 15% by the end of fiscal 2019 from ~23.7% in fiscal 2016 was not achieved.

AT&C losses reduced to 16.4% in fiscal 2022, significantly lower than 20.8% in fiscal 2020 and 22.3% in fiscal 2021. AT&C losses were considerably high in fiscal 2021, as COVID-19 adversely impacted both billing and collection efficiencies. However, AT&C losses reduced by ~3% even when compared with the pre-pandemic level (fiscal 2020). The AT&C loss further reduced to 13.5% in fiscal 2023 as per the provisional data compiled by MoP.

The AT&C loss trend indicates that the improvement was driven by collection efficiency, which improved from 93.1% in fiscal 2020 to 97.2% in fiscal 2022. On the other hand, billing efficiency remained unchanged at 85.9% during the period.

Figure 92: AT&C loss trajectory (%)

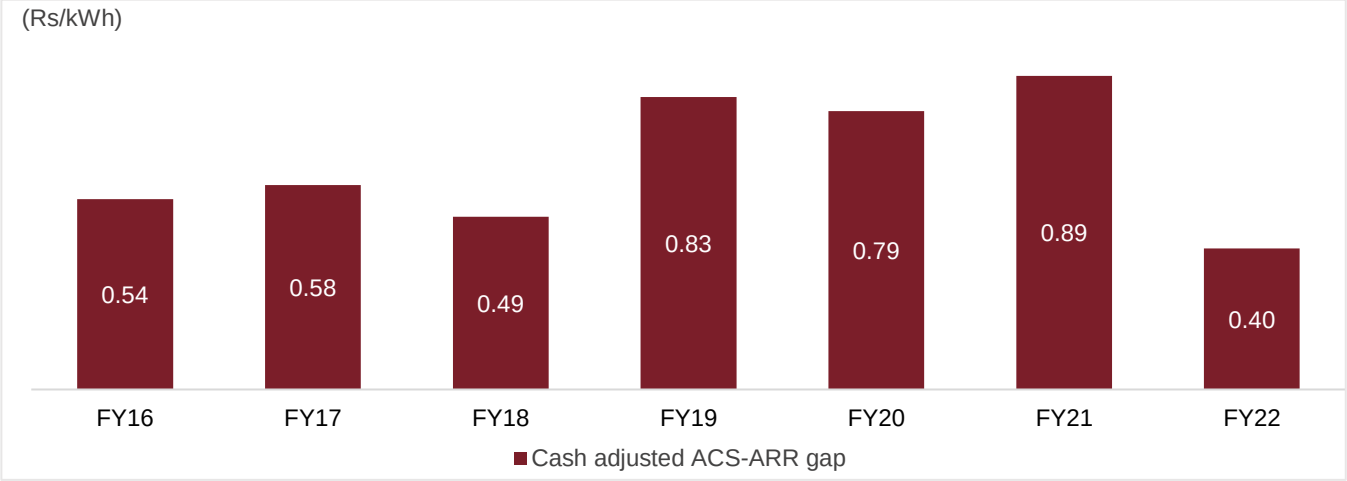


P: Provisional

Source: PFC, CRISIL Consulting

The average cost of supply (ACS) and average revenue realized (ARR) gap for the states narrowed to Rs 0.49 per kWh in fiscal 2018 from Rs 0.58 per kWh in fiscal 2017 but expanded to Rs 0.83 per kWh at the end of fiscal 2019, indicating reversal of some of the gains achieved through reduction in power purchase costs, interest burden and AT&C losses over the past three years. The cash-adjusted ACS-ARR gap stood at Rs 0.79 per unit as of March 2020 and widened further to Rs 0.89 per unit as of March 2021, indicating further deterioration in discoms' financial profiles. However, the gap narrowed to Rs 0.40 per unit as of March 2022, reflecting improved financial conditions of reporting discoms.

Figure 93: ACS-ARR gap



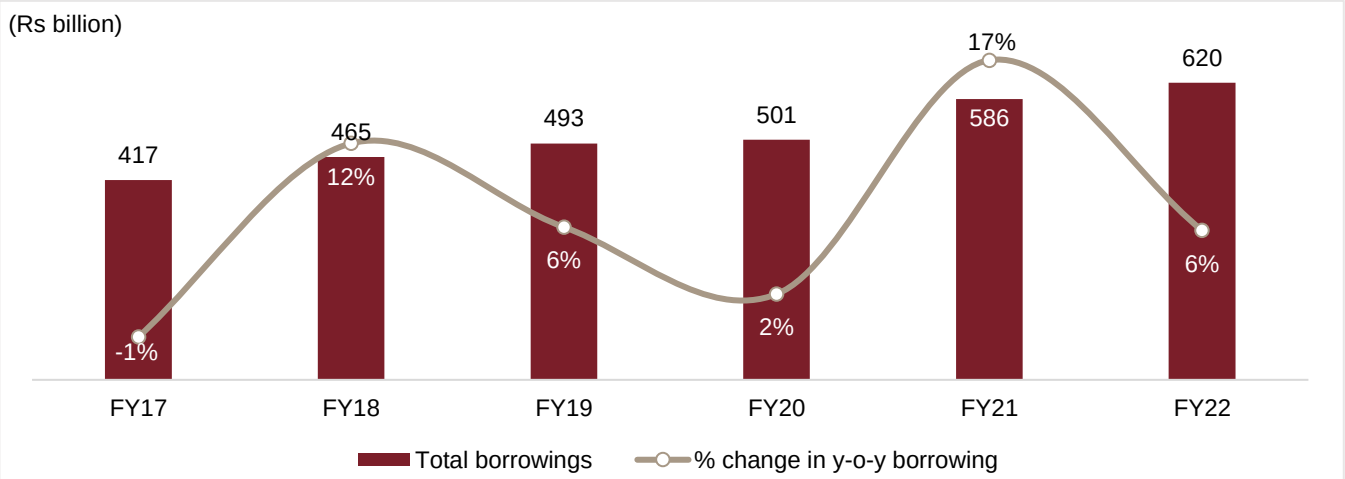
PFC has not provided figures for FY23

Source: PFC, CRISIL Consulting

The power distribution sector suffers from high trade payables with days payable averaging 160 days nationally, as opposed to the benchmark of 45 days specified in LPS Rules, 2022. With the sector making losses and facing liquidity crunch, reducing trade payables remains challenging.

Due to operational inefficiencies and financial losses incurred over the years, state discoms have accumulated a significant debt burden. After completion of UDAY scheme, discoms' debt rose over fiscals 2020 and 2021 as revenues fell on account of weak power demand. Total debt of state discoms increased 24% from Rs 5.01 trillion in fiscal 2020 to Rs 6.20 trillion in fiscal 2022. If current fiscal and operational issues persist, CRISIL Consulting expects total debt across state discoms to increase to Rs 9-10 trillion by fiscal 2027.

Figure 94: Total borrowings for discoms



Source: MoP, PFC, CRISIL Consulting

4.1.2 Other distribution reforms planned by the government to revive the sector

The government plans to implement several policies to resolve the issues of the distribution segment, as it impacts the entire value chain. Key announcements pertaining to this are as follows:

- *Rs 3 trillion RDSS aiming to improve operational and financial parameters of discoms* — In Union Budget 2021-22, the GoI announced the Revamped Distribution Sector Scheme (RDSS) with an outlay of Rs 3.04 trillion, partly funded by the GoI to the tune of Rs 976 billion, aimed at reducing financial stress across discoms. The package, slated to be distributed over the next five years, will subsume other schemes (DDUJY and IPDS) under its ambit. As has been the case with the Atmanirbhar Bharat discom liquidity package, PFC and REC will be the key nodal lenders for disbursal of funds to discoms. The GoI has laid down the guidelines and criteria for availing funding under the scheme, which aims to improve operational efficiency, distribution infrastructure, and governance and compliance standards of state discoms. The key criteria proposed in the scheme are explained below.

Figure 95: Key criteria of RDSS

Parameter	Target/objective under RLRDS	Current status	Potential and Impact
ACS-ARR	National target of zero by fiscal 2025	Avg. ACS-ARR gap has increased from Rs 0.55 per unit in fiscal 2017 to Rs 0.77 per unit in fiscal 2022 due to worsening in fiscal 2021. Exception states were Gujarat, UP, Rajasthan, Andhra Pradesh and Maharashtra, which saw ACS ARR reduction in fiscal 2022 over fiscal 2017	Stringent cost-cutting through shift towards cheaper sources of power such as RE, efficient management of operating costs, capital support through equity infusion and access to low-cost debt is required to be combined with timely tariff hikes in order to achieve the target. Weaker states are likely to remain laggards, however efficient states such as Gujarat Maharashtra and Andhra Pradesh could lead the pack, offsetting performance of weak states.
AT&C losses	National target of 12-15% by fiscal 2025	AT&C losses of states under consideration reduced from 23.2% in fiscal 2017 to 20.7% in fiscal 2022, incentivized by UDAY reforms and improvement in billing and collection efficiency. However, certain states such as Telangana, and Madhya Pradesh have seen an increase in losses. The losses for these states after increasing to 24.2% in fiscal 2021 due to pandemic impact on collection efficiency in fiscal 2021, are likely to moderate to 13-14% by fiscal 2027.	Improvement in billing efficiency through strengthening of distribution network, installation of smart meters, and theft reduction, as well as increase in collection efficiency through pro-consumer payment mechanisms, incentivising timely payments, and improving collection systems could be instrumental in meeting the target. Weaker states such as Uttar Pradesh, Bihar, Madhya Pradesh and Andhra Pradesh, will have to exhibit substantial improvement for achieving the target

Parameter	Target/objective under RLRDS	Current status	Potential and Impact
Tariff Reforms	Cost-reflective tariff to ensure profitability	Historically, tariff hikes have not been in line with increase in power purchase costs (PPC), resulting in under-recovery of costs for state discoms and affecting their profitability.	Cost-reflective tariffs could ensure fair recovery of costs through increased revenue, resulting in improved profitability. However, higher tariffs could translate to increased cost burden on consumers, particularly industrial and commercial categories that are already paying higher tariffs due to cross-subsidisation.
Direct Benefit Transfer (DBT)	Direct transfer of the subsidy to end-consumers	Currently, subsidy is transferred by state governments to respective discoms for power supplied to subsidised consumer categories, typically agri. consumers, with subsidy received-to-booked ratio at 99% in FY22 for states under consideration. However, certain states such as Madhya Pradesh, Karnataka and Telangana are known to have weaker performance than peers. The ratio is expected to remain stable at over 99% considering RDSS mandate of compulsory payment of pending subsidy.	DBT is expected to shift financial burden from discoms to consumers and state governments, with subsidised consumers having to pay designated tariffs, even as state govt. has to make timely direct transfers to concerned consumers. However, states with weaker finances could falter in payments, which could trigger defaults by subsidised consumers, thereby impacting collection efficiency and profitability of respective discoms.
Working capital rationalization	Payables days to Creditors for the year under evaluation to be equal to or less than the projected trajectory	Payables to power gencos remain abysmally high due to weak financial position of state discoms, largely on account of stretched receivables from consumers, particularly economically weaker sections and government departments. Funds disbursed under Atmanirbhar Bharat discom liquidity package have aided repayments to gencos in fiscal 2021 and fiscal 2022, however payables persist at alarmingly high levels.	Timely payments by consumers are essential to improve liquidity position of state discoms', which, in turn, can reduce payables days, thereby improving working capital cycle. Increasing collection efficiency and successful implementation of DBT could be crucial for the same.

Parameter	Target/objective under RLRDS	Current status	Potential and Impact
Hours of Supply (Rural)	Govt. aiming for 24*7 power for all under a parallel program	Rural areas received power supply for an average ~20 hours daily across India as of June 2022.	Reducing leakages in distribution network through timely infrastructure upgrades as well as improving billing and collection efficiency in rural consumers could facilitate achievement of the target.
DT metering and Smart metering	Non-Agri. and Agri. DT metering to be completed by June 2023 and March 2025 respectively Smart metering to be completed by March 2025	DT metering in urban and rural areas has reached 95% and 68% as of July 2021, whereas smart metering has reached ~10%.	100% DT metering and smart metering could enable accurate and timely tracking of power consumed, thereby increasing billing efficiency of discoms, consequently reducing their AT&C losses
Corporate Governance and Compliance	Discoms to publish audited annual accounts by December-end of following fiscal year for the first two years of the scheme, and by September-end from third year onwards Tariff orders to be issued by SERCs by April 1 of new fiscal year	Audited annual accounts are typically published by state discoms after a lag of at least 12 months, whereas tariff orders are issued by SERCs 4-8 months after commencement of a new fiscal year.	Timely filing of tariff orders and annual accounts could ensure efficient implementation of new tariff schedule as well as improve overall governance standards and compliance of discoms.

Source: Ministry of Power, CRISIL Consulting

- Electricity Act 2003: The Act consolidated laws relating to generation, transmission, distribution, trading and use of electricity and promoted measures conducive to development of the electricity industry. The Act introduced competition by unbundling State Electricity Boards into generation, transmission, and distribution companies, delicensing generation, facilitating open access, and enabling captive generation and introducing power trading. It increased transparency by establishment of Regulatory Commissions and national Appellate Tribunal. It aided cost recovery and commercial viability by introducing strict provisions to reduce power theft, ensuring competitive procurement, rationalization of tariffs, progressive reduction and elimination of subsidies, and providing push for 100% metering. It further promoted renewable energy by introducing RPOs.
- The letter of credit (LC) mechanism was also implemented in August 2019. This order mandated discoms to issue LCs or provide payments upfront before purchase of power. However, the success of this scheme has been limited so far, due to various loopholes utilised by discoms and the lower bargaining power of independent power producers (IPPs).
- In June 2022, the MoP notified Late Payment Surcharge and Related Matters Rules, 2022, to tackle the mounting payables to generation companies and transmission companies. The rules provisioned for converting discoms' outstanding dues to these companies into equated monthly instalments (EMIs) for gradual liquidation of these dues. Further, to promote timely payment of current power bills, the power supply would be regulated for discoms that fail to clear their bills one month after the due date of payment or two-and-a-half months after the presentation of the bill by the generating company.

4.2 Regulatory overview – Region wise

4.2.1 USA

The Federal Power Act (FPA) is the primary federal law that governs the electric power industry in US. It gives the Federal Energy Regulatory Commission (FERC) the authority to regulate the inter-state transmission of electricity, as well as the wholesale sale of electricity.

The Public Utility Holding Company Act of 1935 (PUHCA) was enacted to prevent the excessive concentration of power in the electric utility industry. It prevents holding companies from owning more than one utility in a given state and requires them to obtain approval from the Securities and Exchange Commission before making any major changes to their corporate structure.

The Energy Policy Act of 2005 made several changes to the regulatory landscape for the electric power industry. It gave the FERC the authority to order the construction of new transmission lines, and it also required states to open their retail electricity markets to competition.

In addition to these federal regulations, each state has its own set of regulations governing the power distribution sector. These regulations typically address issues such as tariff rates, service quality, and environmental compliance.

4.2.2 Asia Pacific

The Electricity Grid Code, 2019 of Bangladesh lays down certain key requirements for the distribution sector. Generators and consumers must meet certain technical requirements before they can connect to the distribution system. These requirements include the type of equipment that can be used, the voltage and current ratings, and the protection requirements. The distribution system must be operated and maintained in a safe and reliable manner. This includes the following procedures for switching and isolating equipment, and for responding to emergencies. Moreover, different parts of the system must be able to work together effectively by using common standards for communication and data exchange.

The Electricity Law of the People's Republic of China establishes the basic principles for the regulation of the electricity industry in China and establishes the National Energy Administration (NEA) as the main regulatory body for the power sector. The regulations on the Management of Power Supply provide detailed rules for the operation of the power distribution sector and cover key areas such as the licensing of power distribution companies, the quality of service, and the pricing of electricity. The regulations on the Protection of Electricity Facilities protect electricity facilities from damage or interference by setting out the responsibilities of power distribution companies to ensure the safety of their customers.

The Electric Utilities Industry Law of Japan established the Ministry of Economy, Trade and Industry (METI) as the main regulatory body for the power sector. The Electricity Business Act regulates the generation, transmission, and distribution of electricity in Japan and sets out the responsibilities of power companies to ensure the reliable and secure power supply.

4.2.3 Africa

The Energy Commission, a quasi-independent body established by the Energy Commission Act 1997 (Act 541) is the energy policy advisor & prepares energy policy recommendations for the Ministry of Energy in West Africa. The electricity sector was reformed in the mid-1990s to attract private sector investments toward electricity generation. The Electric Power Sector Reform Act entered into force in March 2005. It provides the legal framework for the reform of the sector, which includes the unbundling of Power Holding Company of Nigeria into six generation companies, one transmission company and eleven distribution companies. Part of the reform also includes the

establishment of the Nigerian Electricity Regulatory Commission (NERC) and the National Electricity Liability Management Company (NELMCO) Limited.

The East African Power Pool (EAPP) was formed in May 2003 and aimed at optimizing the usage of energy resources available in the region by working out regional investment schemes in power generation, T&D, taking into account the socio-economic and environmental aspects. The Power Africa's 2.0 strategy aims on power transmission, distribution and the enabling environment. This strategy helps identify potential gaps, vulnerabilities and opportunities in transmission infrastructure so that countries, development partners and the private sector can more effectively prioritize investments, optimize regional power costs, and avoid similar problems in the future.

The Regional Electricity Regulators Association of Southern Africa (RERA) which was formally launched in September 2002 aims at capacity building and information sharing, facilitation of electricity sector policy, legislation and regulations, and regional regulatory cooperation. The Southern African Power Pool (SAPP) created in 1995, is a specialized organization of Southern African Development Community with the objective to enhance energy supply inside the SADC (barring Mauritius), by coordinating public power framework tasks into a bound together power market. The SAPP coordinates the planning and operation of the electric power system among member utilities and provides a forum for regional solutions to electric energy problems.

4.3 Distribution investments of ~Rs 3.0-3.5 trillion expected over FY2024-28

Investments in distribution will be led primarily by spending under RDSS, bolstered by smart metering investments, leading to cumulative investment in distribution to the tune of ~Rs 3-3.5 trillion over the next five years. In the Union Budget 2021-22, the government announced a RDSS worth Rs 3.04 trillion for state discoms, to be allocated over the next five years.1.65 trillion worth of DPRs have been sanctioned by nodal agencies (PFC and REC) as of June 2022. While the amount is sanctioned, disbursement under the scheme will be contingent upon work undertaken that was proposed under DPR. Fulfilment of the conditions, which primarily involve operational efficiency parameters, strengthening of distribution infrastructure, and regulatory compliance, will entail significant investments in the distribution segment. A total of Rs 2.5 trillion was allocated for loss reduction and smart metering under RDSS, led by Uttar Pradesh, Maharashtra, Tamil Nadu and West Bengal. Investments in the segment are likely to gradually pick up post fiscal 2024 with central and state governments expected to provide the required funding support, led by a thrust on improving electricity access and providing 24x7 power to all. Investments in the segment are likely to gradually pick up fiscal 2024 onwards with central / state government(s) expected to provide the required funding support.

The Integrated Power Development Scheme (IPDS) was launched to strengthen the sub-transmission and distribution network in urban areas, metering of distribution transformers/feeders/consumers in urban areas and IT enablement of the distribution sector. The Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY), which was launched in December 2014, covers works related to strengthening of rural power infrastructure and aims at separation of agricultural and non-agricultural feeders, strengthening and augmentation of the T&D infrastructure in rural areas, including metering of transformers/feeders/consumers and boosting rural electrification, along with decentralized distributed generation. Moreover, several foreign institutions are expected to extend credit to the distribution sector. Asian Development Bank (ADB) approved a $48 million loan to finance the expansion and upgrading of the power distribution system in Assam. In December 2020, ADB approved a $190 million loan to Bangalore Electricity Supply Company Ltd. for modernizing the power distribution system in Bengaluru by converting 7,200 km of overhead distribution lines to underground cables with parallel installation of 2,800 km of fiber optic communication cables, to protect distribution lines from natural hazards and interference, thereby reducing technical and commercial losses significantly.

4.3.1 Present status of key discoms

State discoms, the major drivers of investments in the distribution space, have been under severe financial stress for the last few years due to collection inefficiencies and mounting receivables to power generation companies. Revenue dipped in fiscal 2021 due to fall in demand from high-paying industrial and commercial consumers on account of reduced economic activity as a fallout of the pandemic. The government's relief package worth Rs 1.35 trillion by Power Finance Corporation Ltd./ Rural Electrification Ltd. for clearing power generators' dues eased discoms' liquidity problems in the second half of the fiscal. However, the impact was short-lived with dues on the rise again post March 2021. The relief package is also expected to have worsened the debt profile of discoms, forcing them to curb investments over the medium term. Status of key discoms as of fiscal 2022 is given below-

Table 64: Status of discoms

	State	AT&C loss (%)	ACS-ARR gap (Rs/kWh)	State fiscal deficit (%)
Strong	Gujarat	12.4%	-0.22	1.5%
	Karnataka	14.7%	0.69	2.8%
Moderate	Andhra Pradesh	15.4%	0.15	3.2%
	Punjab	15.7%	-0.24	5.7%
	Haryana	19.0%	0.06	3.4%
	Chhattisgarh	19.5%	0.37	3.8%
	Maharashtra	21.2%	0.17	2.8%
	Uttar Pradesh	29.2%	-0.52	4.3%
Weak	Madhya Pradesh	17.2%	2.46	3.8%
	Jharkhand	17.5%	0.21	5.1%
	Telangana	22.0%	1.97	3.9%
	Bihar	23.5%	2.03	11.3%
	Tamil Nadu	31.8%	0.74	4.2%
	Rajasthan	33.7%	0.41	3.0%

Source: CRISIL Consulting

4.4 Key growth drivers in the distribution sector

Some of the key growth drivers for the distribution segment across regions are:

Increasing energy demand across developing region

Regions such as Asia Pacific and Africa have experienced robust economic growth and rapid urbanization, leading to the increasing demand for electricity. Governments and utilities are investing in the expansion and upgradation of transmission & distribution infrastructure to meet the growing energy needs. In addition, the lack of access to electricity across the African region has influenced public & private investments in the deployment of new networks across the region.

New electrification, refurbishment & retrofit of existing grid infrastructure

The industry is largely being driven by the modernization and revamping of the existing grid infrastructure across various countries & regions including the US and Africa. Rapid grid extension across national borders coupled with the rising tendency of trans-border electricity trading to accomplish electricity access in peri-urban & rural areas will propel product demand. Moreover, shifting focus toward the expansion of power grid networks to remote locations, followed by the continuous integration of sustainable grid infrastructure to ensure security supply will augment the business spectrum.

Growing renewable integration

A wide number of economies including the US, Africa & Asia Pacific have set ambitious targets for renewable energy adoption. The integration of renewable sources, such as solar, wind & hydroelectric power, requires the

development of efficient lines to transport clean energy from generation sites to consumption centers. In addition, favorable government incentives & reforms to support the adoption of renewable energy and consequently provide electricity access across rural areas will also considerably drive industry growth. The rapid expansion of renewable networks to cater to rural & remote areas with limited grid access coupled with growing investments by public & private players will further encourage the deployment of renewable energy.

Rising peak load demand

Developing economies across Asia Pacific have consistently been prone to power lags and frequent electricity failures. Rising investments to establish a sustainable electrical network coupled with favorable regulatory reforms pertaining to electrification across grid-isolated areas have been the prime regulatory & competitive focus in the region. The increasing peak load demand across the developed countries of the region is leading to concerns pertaining to grid stability and supply security. The ongoing measures to refurbish conventional grid infrastructure such as the rapid adoption of smart transmission & distribution technologies are augmenting investments and streamlining operational performance.

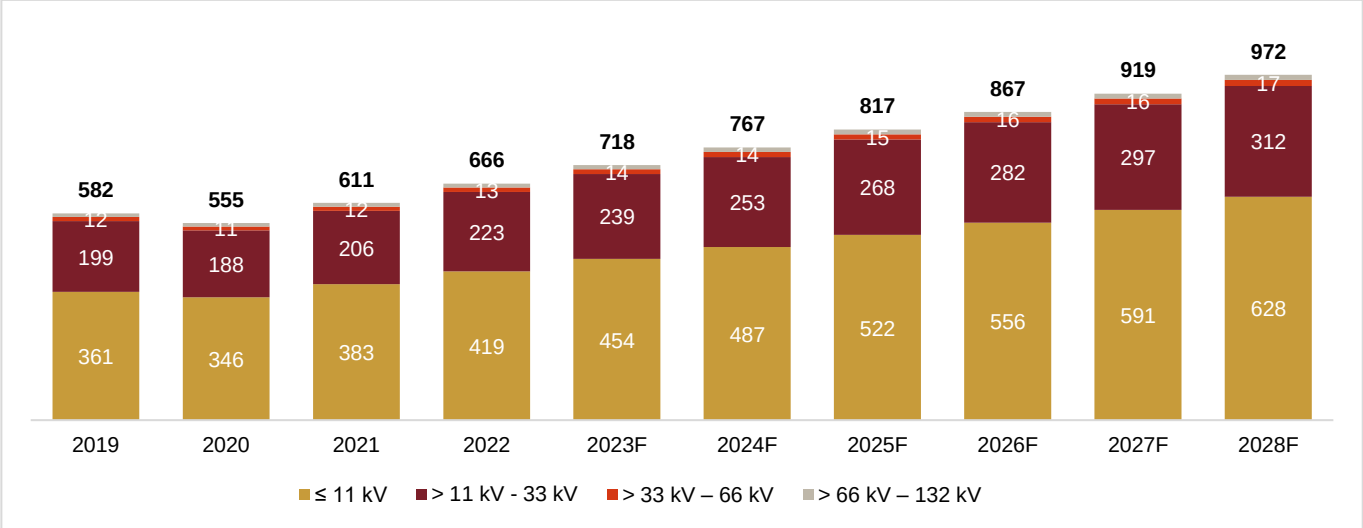
4.5 Country-wise/Region wise review and outlook on distribution sector

Developing economies have been actively expanding and modernizing their electric infrastructure to accommodate a growing demand for electricity and ensure a reliable supply. The combination of favorable industrial prospects and increasing energy needs has created opportunities for technological and industrial advancements in the power sector. This expansion is further supported by a legislative focus on promoting industrialization and commercialization, leading to a surge in the number of primary consumers, driving overall industry growth. In addition, the rising population in these economies has led to a growing penetration of residential consumers, leading to an increased demand for low-voltage (LV) connections. This trend is expected to stimulate further growth in the power industry as more households require electricity for various purposes. Overall, the integration of an efficient and ambient electricity supply is becoming crucial for meeting the energy needs of developing economies. As a result, the power industry is experiencing significant growth and expansion, driven by the increasing industrialization, commercialization, and urbanization in these regions. The continuous efforts to meet the rising demand for electricity and ensure a reliable energy supply are propelling the industry towards a dynamic and promising future.

The distribution lines market is expected to witness substantial growth due to the surging electricity demand, primarily driven by the rapid increase in the global population. As more people join the electrical grid, the need for efficient distribution lines to deliver electricity to homes, businesses, and industries becomes paramount. Furthermore, policy makers in various countries are increasingly focusing on electrifying remote and underserved areas, making electricity accessible to all. This concerted effort to expand electricity infrastructure and bring power to previously unreached regions is expected to further propel the growth of the distribution lines industry in the coming years. The combination of rising electricity demand and the drive to electrify remote areas creates a favorable environment for investment and innovation in the distribution lines market. To meet the growing needs of an expanding population and ensure equitable access to electricity, utilities and governments are likely to invest in upgrading and expanding distribution networks, thus driving the overall industry growth.

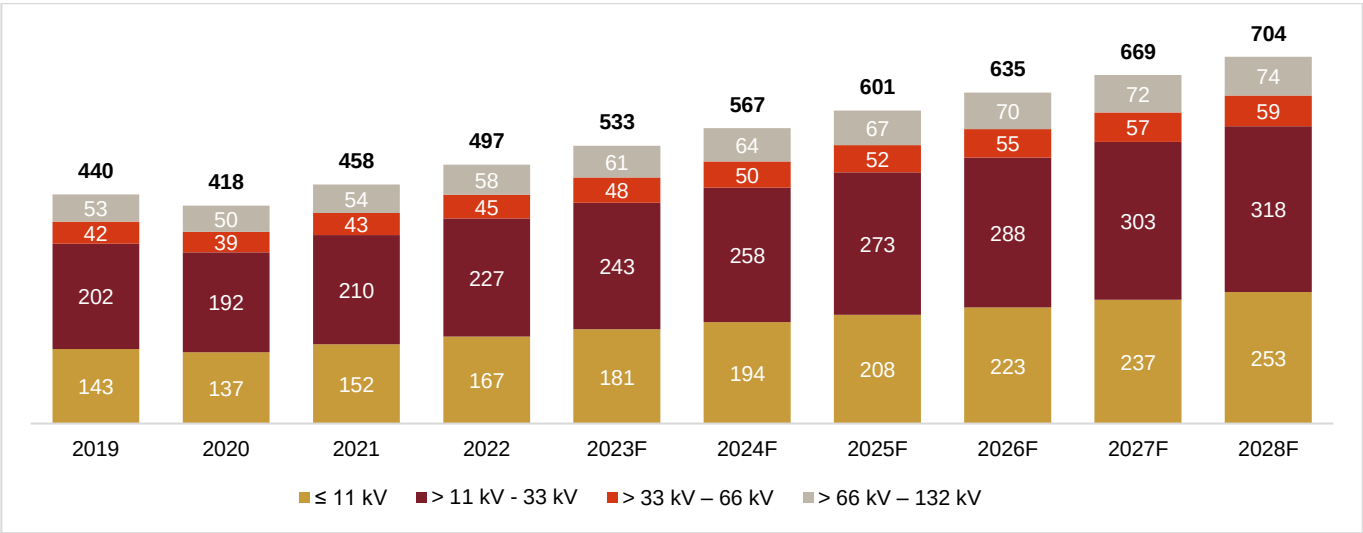
4.5.1 India

Figure 96: India voltage-wise distribution lines y-o-y additions forecast ('000 ckm)



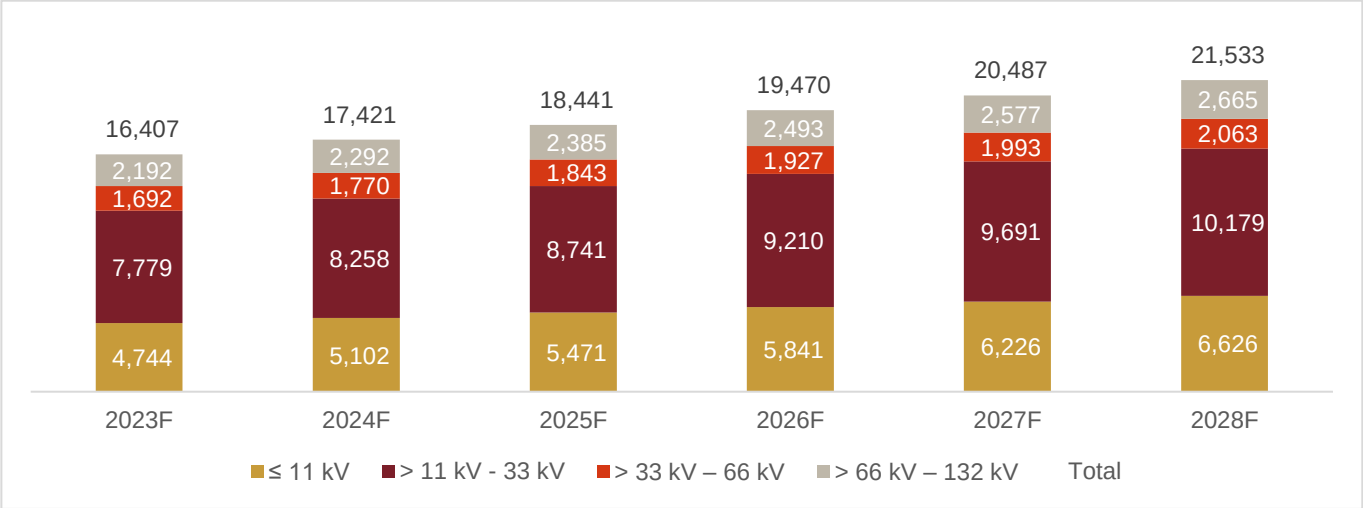
Source: Global Market Insights, CRISIL Consulting

Figure 97: India voltage-wise distribution lines y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

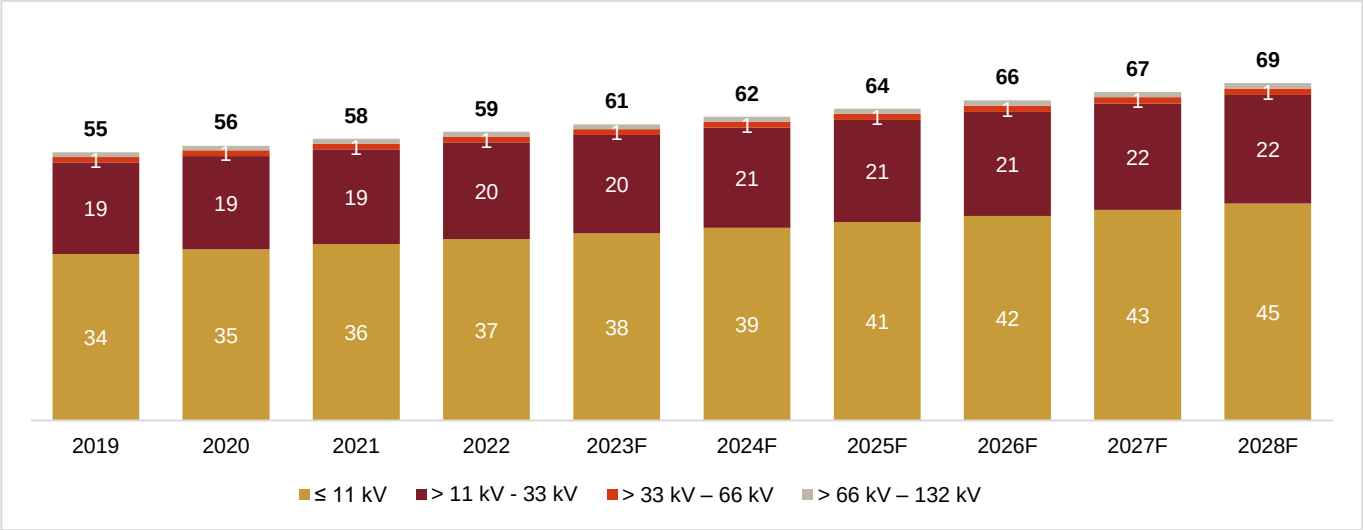
Figure 98: India voltage-wise distribution lines y-o-y investment forecast (USD million)



Source: Global Market Insights, CRISIL Consulting

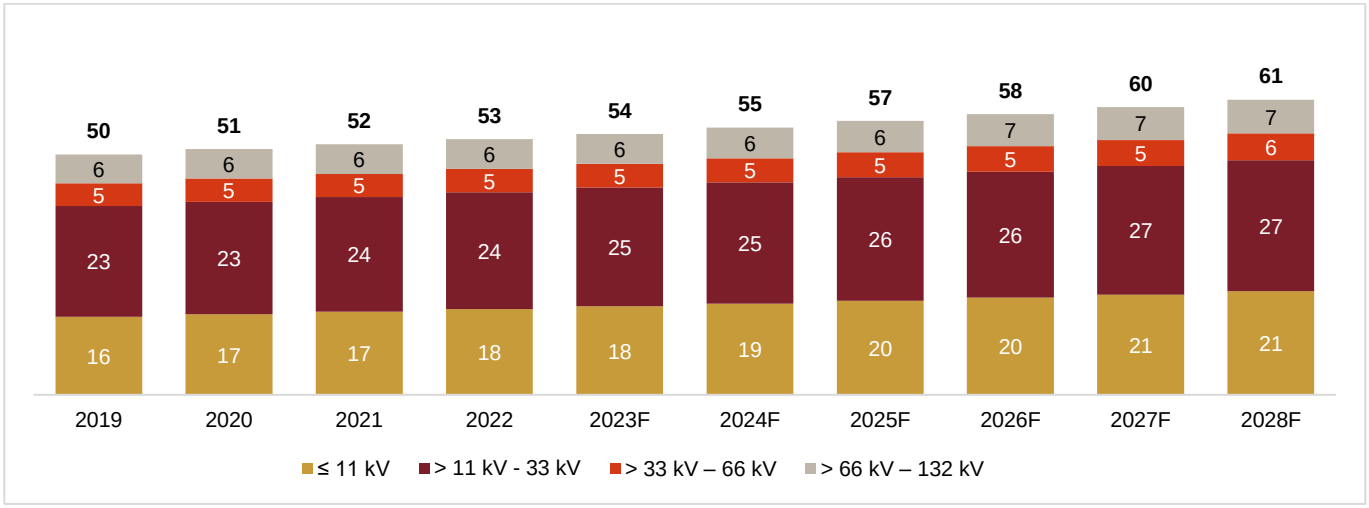
4.5.2 USA

Figure 99: USA voltage-wise distribution lines y-o-y additions forecast ('000 ckm)



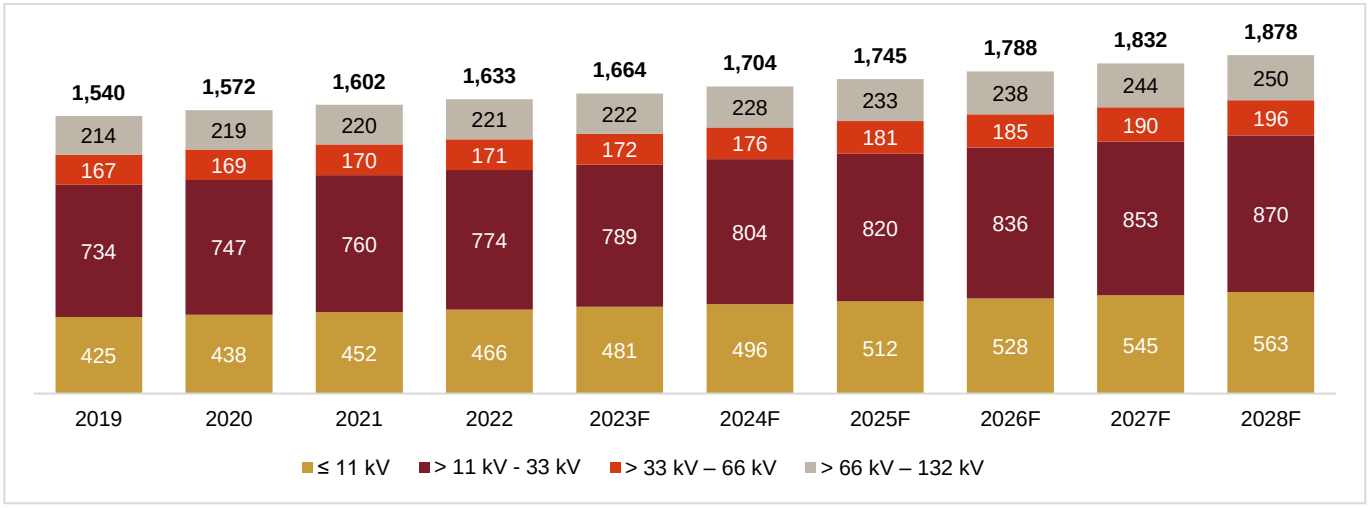
Source: Global Market Insights, CRISIL Consulting

Figure 100: USA voltage-wise distribution lines y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

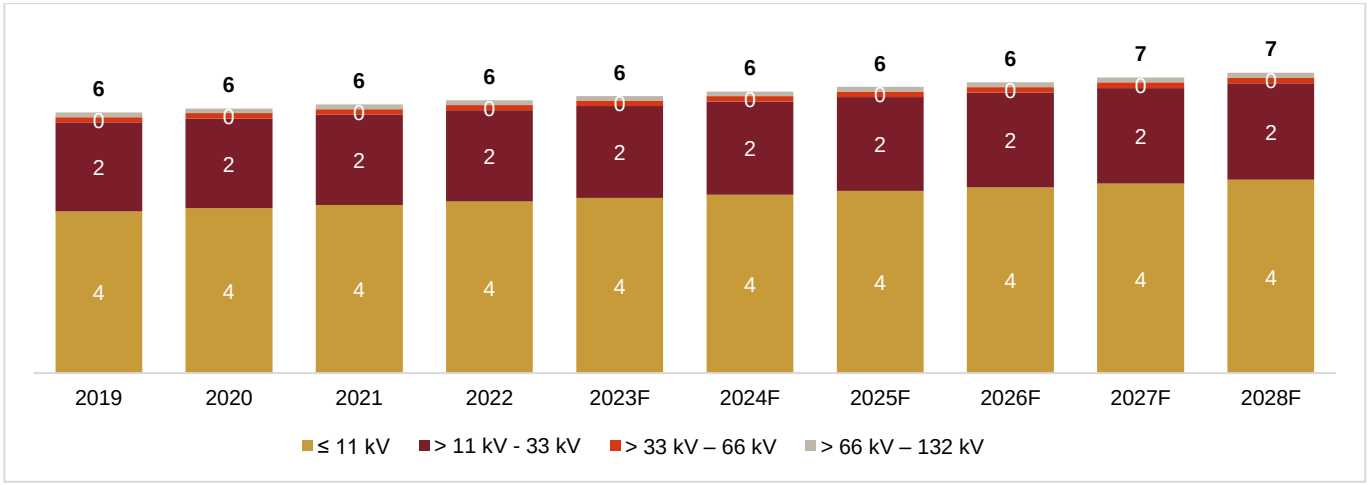
Figure 101: USA voltage-wise distribution lines y-o-y investment forecast (USD million)



Source: Global Market Insights, CRISIL Consulting

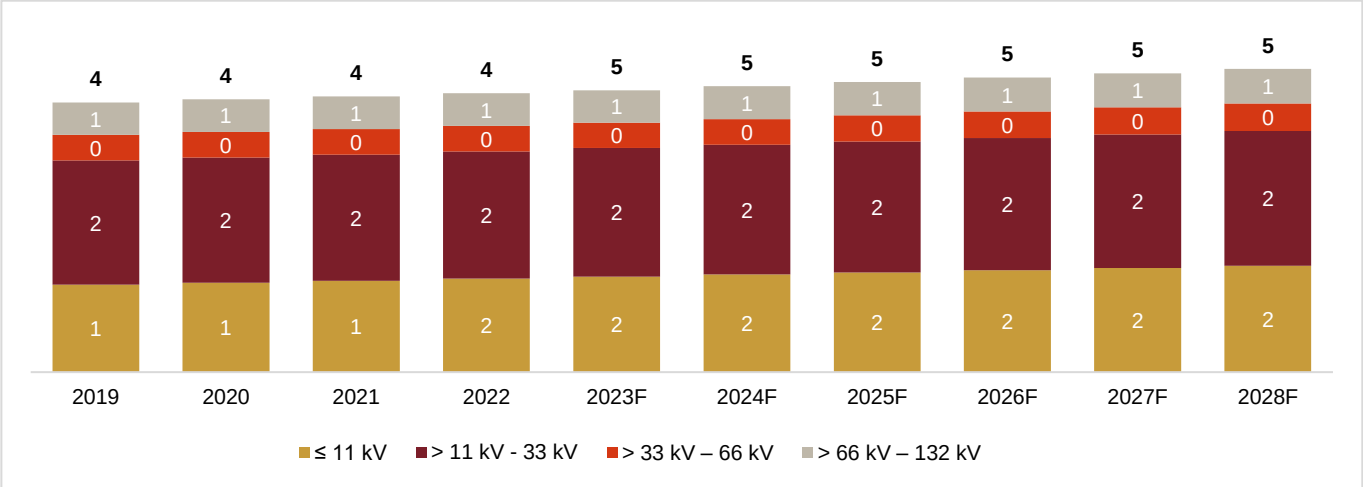
4.5.3 Oceania

Figure 102: Oceania voltage-wise distribution lines y-o-y additions forecast ('000 ckm)



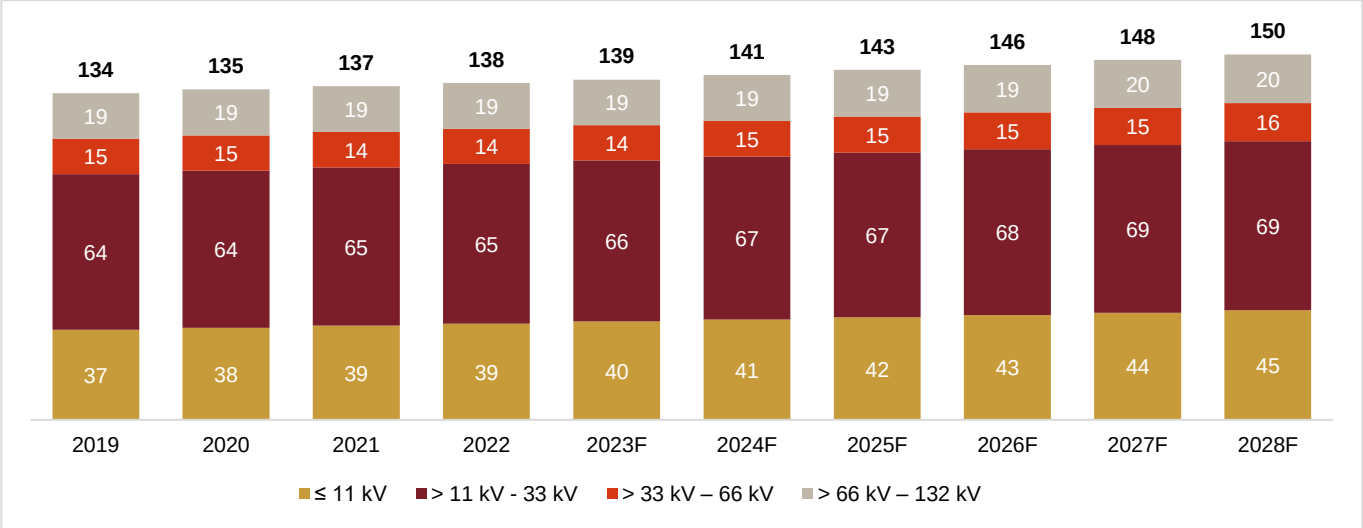
Source: Global Market Insights, CRISIL Consulting

Figure 103: Oceania voltage-wise distribution lines y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

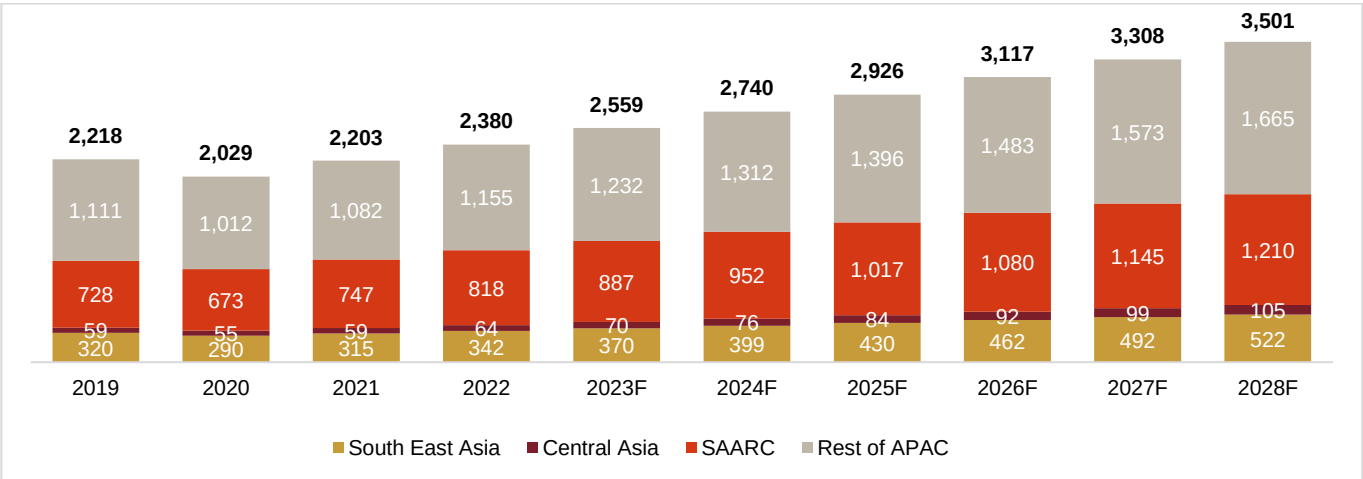
Figure 104: Oceania voltage-wise distribution lines y-o-y investment forecast (USD million)



Source: Global Market Insights, CRISIL Consulting

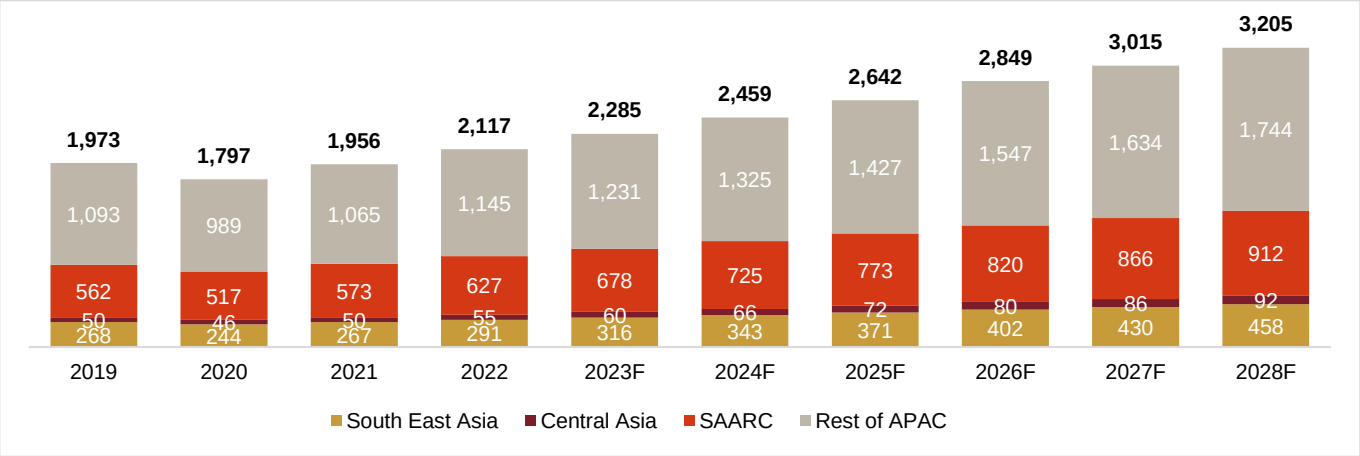
4.5.4 Asia Pacific

Figure 105: Asia Pacific distribution lines y-o-y additions forecast ('000 ckm)



Source: Global Market Insights, CRISIL Consulting

Figure 106: Asia Pacific distribution lines y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

Table 65: Asia Pacific voltage-wise distribution lines y-o-y additions forecast

Voltage	Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
≤ 11 kV	('000 ckm)	**1,304**	1,194	1,297	1,401	1,508	1,614	1,723	1,832	1,946	2,059
	(GVA)	**516**	473	515	557	601	644	689	734	781	828
> 11 kV - 33 kV	('000 ckm)	**760**	697	755	814	872	930	990	1,051	1,114	1,176
	(GVA)	**774**	709	769	829	888	948	1,009	1,071	1,136	1,199
> 33 kV - 66 kV	('000 ckm)	**65**	61	68	75	82	89	97	101	112	120
	(GVA)	**226**	213	236	260	285	311	339	351	390	420
> 66 kV - 132 kV	('000 ckm)	**89**	77	84	91	98	107	116	133	136	146
	(GVA)	**457**	401	436	472	512	556	605	694	709	759
Total	**('000 ckm)**	**2,218**	**2,030**	**2,204**	**2,380**	**2,559**	**2,740**	**2,926**	**3,117**	**3,308**	**3,501**
	(GVA)	**1,973**	**1,797**	**1,956**	**2,117**	**2,285**	**2,459**	**2,642**	**2,849**	**3,015**	**3,205**

Source: Global Market Insights, CRISIL Consulting

Table 66: South-East Asia voltage-wise distribution lines y-o-y additions forecast

Voltage	Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
≤ 11 kV	('000 ckm)	190	172	187	203	219	236	254	273	291	308
	(GVA)	75	68	74	81	87	94	102	109	117	124
> 11 kV - 33 kV	('000 ckm)	111	100	109	118	127	137	147	158	168	177
	(GVA)	113	102	111	120	130	140	150	161	171	181
> 33 kV - 66 kV	('000 ckm)	11	10	11	12	14	15	17	17	20	21
	(GVA)	37	34	38	43	48	53	59	61	69	74
> 66 kV - 132 kV	('000 ckm)	8	8	8	9	10	11	12	14	14	15
	(GVA)	43	40	44	48	52	56	61	71	74	79
Total	**('000 ckm)**	**320**	**290**	**315**	**342**	**370**	**399**	**430**	**462**	**492**	**522**
	(GVA)	**268**	**244**	**267**	**291**	**316**	**343**	**371**	**402**	**430**	**458**

Source: Global Market Insights, CRISIL Consulting

Table 67: Central Asia voltage-wise distribution lines y-o-y additions forecast

Voltage	Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
≤ 11 kV	('000 ckm)	35	33	35	38	42	45	49	54	58	62
	(GVA)	14	13	14	15	17	18	20	22	23	25
> 11 kV - 33 kV	('000 ckm)	21	19	21	22	24	26	29	31	34	36
	(GVA)	21	19	21	23	25	27	29	32	34	36
> 33 kV - 66	('000 ckm)	2	2	2	2	3	3	3	4	4	4

Voltage	Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
kV	(GVA)	7	7	7	8	9	10	11	12	14	15
> 66 kV - 132 kV	('000 ckm)	2	2	2	2	2	2	2	3	3	3
	(GVA)	8	8	8	9	10	11	12	14	15	16
Total	**('000 ckm)**	**59**	**55**	**59**	**64**	**70**	**76**	**84**	**92**	**99**	**105**
	(GVA)	**50**	**46**	**50**	**55**	**60**	**66**	**72**	**80**	**86**	**92**

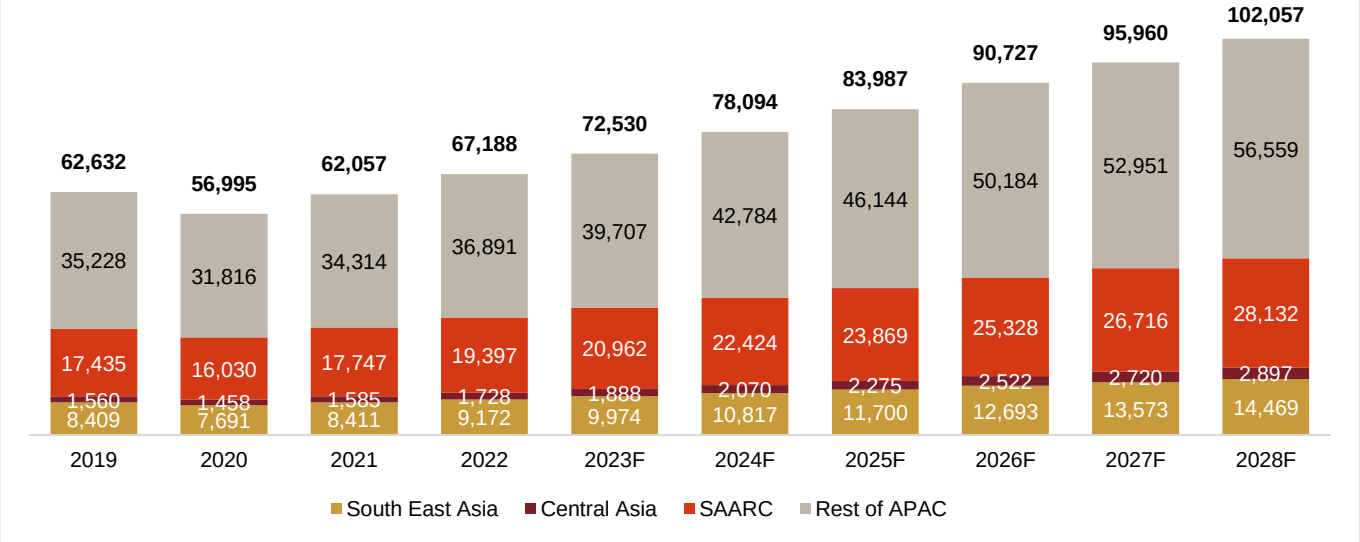
Source: Global Market Insights, CRISIL Consulting

Table 68: SAARC voltage-wise distribution lines y-o-y additions forecast

Voltage	Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
≤ 11 kV	('000 ckm)	448	416	463	509	554	597	640	682	725	769
	(GVA)	177	165	184	203	221	238	256	273	291	309
> 11 kV - 33 kV	('000 ckm)	250	229	253	275	297	317	336	355	374	393
	(GVA)	254	233	257	280	302	323	343	362	381	401
> 33 kV - 66 kV	('000 ckm)	17	15	17	19	20	21	23	24	25	26
	(GVA)	59	53	59	65	70	75	80	83	88	92
> 66 kV - 132 kV	('000 ckm)	14	13	14	15	16	17	18	20	20	21
	(GVA)	72	66	73	79	85	90	95	102	106	110
Total	**('000 ckm)**	**728**	**673**	**747**	**818**	**887**	**952**	**1017**	**1080**	**1145**	**1210**
	(GVA)	**562**	**517**	**573**	**627**	**678**	**725**	**773**	**820**	**866**	**912**

Source: Global Market Insights, CRISIL Consulting

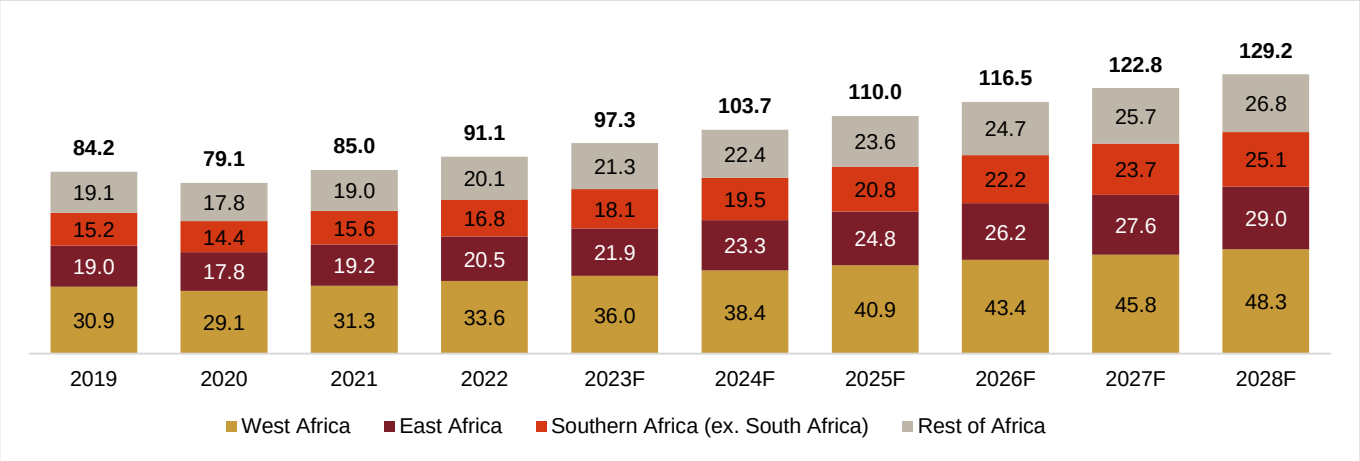
Figure 107: Asia Pacific distribution lines y-o-y investment forecast (USD million)



Source: Global Market Insights, CRISIL Consulting

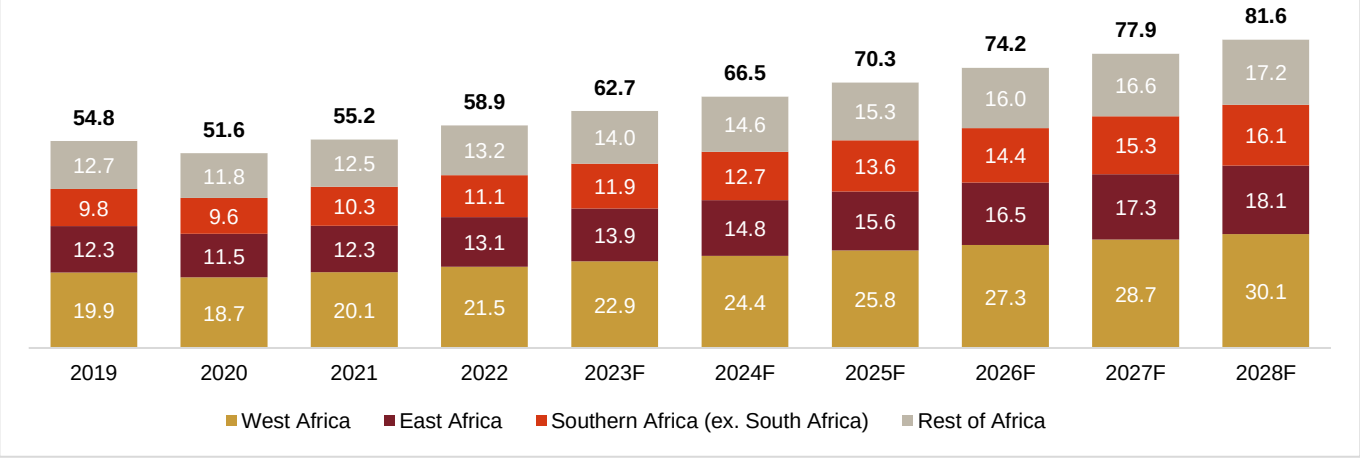
4.5.5 Africa

Figure 108: Africa distribution lines y-o-y additions forecast ('000 ckm)



Source: Global Market Insights, CRISIL Consulting

Figure 109: Africa distribution lines y-o-y additions forecast (GVA)



Source: Global Market Insights, CRISIL Consulting

Table 69: Africa voltage-wise distribution lines y-o-y additions forecast

Voltage	Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
≤ 11 kV	('000 ckm)	52	49	53	57	62	66	70	75	79	84
	(GVA)	18	17	18	20	21	23	24	26	28	29
> 11 kV - 33 kV	('000 ckm)	29	27	29	31	32	34	36	38	40	42
	(GVA)	25	24	25	27	29	30	32	34	36	37
> 33 kV – 66 kV	('000 ckm)	2	2	2	2	2	2	2	2	2	2
	(GVA)	5	5	5	5	6	6	6	6	7	7
> 66 kV – 132 kV	('000 ckm)	2	1	1	2	2	2	2	2	2	2
	(GVA)	7	6	7	7	7	8	8	8	8	9
Total	**('000 ckm)**	**84**	**79**	**85**	**91**	**97**	**104**	**110**	**117**	**123**	**129**
	(GVA)	**55**	**52**	**55**	**59**	**63**	**67**	**70**	**74**	**78**	**82**

Source: Global Market Insights, CRISIL Consulting

Table 70: Western Africa voltage-wise distribution lines y-o-y additions forecast

Voltage	Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
≤ 11 kV	('000 ckm)	19	18	20	21	23	24	26	28	30	31
	(GVA)	7	6	7	7	8	8	9	10	10	11

Voltage	Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
> 11 kV - 33 kV	('000 ckm)	11	10	11	11	12	13	13	14	15	16
	(GVA)	9	9	9	10	11	11	12	12	13	14
> 33 kV - 66 kV	('000 ckm)	1	1	1	1	1	1	1	1	1	1
	(GVA)	2	2	2	2	2	2	2	2	2	3
> 66 kV - 132 kV	('000 ckm)	1	1	1	1	1	1	1	1	1	1
	(GVA)	2	2	2	3	3	3	3	3	3	3
Total	**('000 ckm)**	**31**	**29**	**31**	**34**	**36**	**38**	**41**	**43**	**46**	**48**
	(GVA)	**20**	**19**	**20**	**22**	**23**	**24**	**26**	**27**	**29**	**30**

Source: Global Market Insights, CRISIL Consulting

Table 71: Eastern Africa voltage-wise distribution lines y-o-y additions forecast

Voltage	Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
≤ 11 kV	('000 ckm)	12	11	12	13	14	15	16	17	18	19
	(GVA)	4	4	4	4	5	5	5	6	6	7
> 11 kV - 33 kV	('000 ckm)	7	6	7	7	7	8	8	9	9	9
	(GVA)	6	5	6	6	6	7	7	8	8	8
> 33 kV - 66 kV	('000 ckm)	0	0	0	0	0	0	1	1	1	1
	(GVA)	1	1	1	1	1	1	1	1	2	2
> 66 kV - 132 kV	('000 ckm)	0	0	0	0	0	0	0	0	0	0
	(GVA)	2	1	2	2	2	2	2	2	2	2
Total	**('000 ckm)**	**19**	**18**	**19**	**21**	**22**	**23**	**25**	**26**	**28**	**29**
	(GVA)	**12**	**12**	**12**	**13**	**14**	**15**	**16**	**17**	**17**	**18**

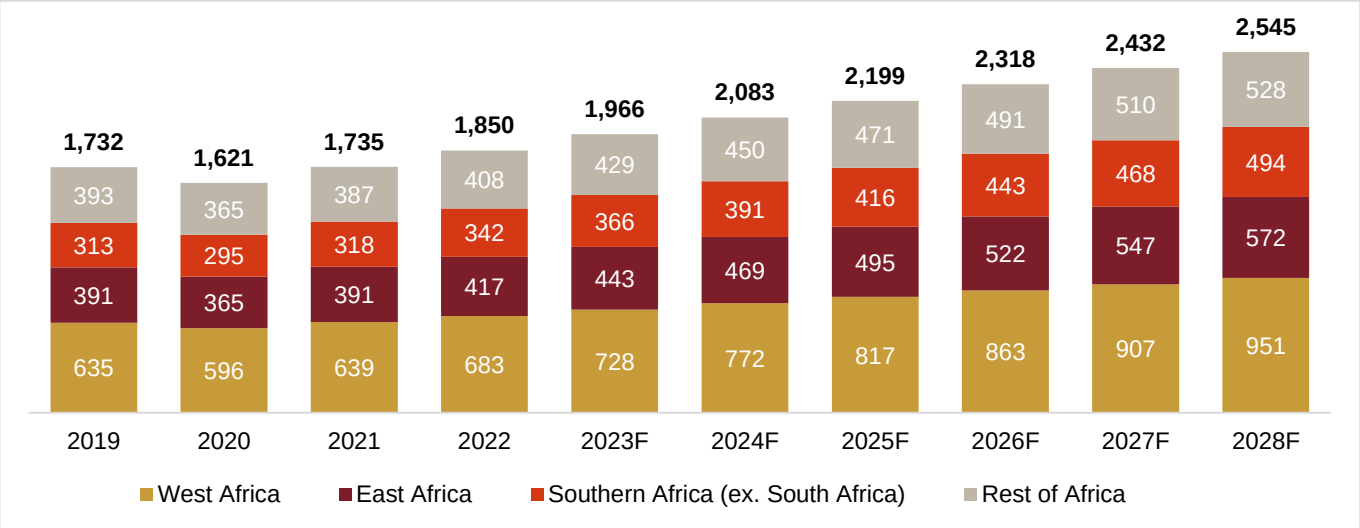
Source: Global Market Insights, CRISIL Consulting

Table 72: Southern Africa (excl. South Africa) voltage-wise distribution lines y-o-y additions forecast

Voltage	Lines	2019	2020	2021	2022	2023F	2024F	2025F	2026F	2027F	2028F
≤ 11 kV	('000 ckm)	10	9	10	11	12	12	13	14	15	16
	(GVA)	3	3	3	4	4	4	5	5	5	6
> 11 kV - 33 kV	('000 ckm)	5	5	5	6	6	6	7	7	8	8
	(GVA)	5	4	5	5	5	6	6	7	7	7
> 33 kV - 66 kV	('000 ckm)	0	0	0	0	0	0	0	0	0	0
	(GVA)	1	1	1	1	1	1	1	1	1	1
> 66 kV - 132 kV	('000 ckm)	0	0	0	0	0	0	0	0	0	0
	(GVA)	1	1	1	1	1	1	2	2	2	2
Total	**('000 ckm)**	**15**	**14**	**16**	**17**	**18**	**20**	**21**	**22**	**24**	**25**
	(GVA)	**10**	**10**	**10**	**11**	**12**	**13**	**14**	**14**	**15**	**16**

Source: Global Market Insights, CRISIL Consulting

Figure 110: Africa distribution lines y-o-y investment forecast (USD million)



Source: Global Market Insights, CRISIL Consulting

5 An overview of the roads and highways sector in India

5.1 Road sector's contribution to Indian gross value added (GVA)

The road transport sector's share in Indian GVA stood at 3.2% in fiscal 2022. The share of road transport in India's GVA has hovered between 3.2% and 3.3% from fiscal 2012 to fiscal 2022 with fiscal 2021 being an exceptional year in which it contributed 2.5% of the GVA mainly due to covid-19 impact. On absolute terms, road transport GVA at constant prices was Rs. 4,355 billion in fiscal 2022.

Table 73: GVA trajectory (% change)

GVA (at constant prices)	FY17	FY18	FY19	FY20	FY21	FY22
Road transport share (%)	3.2%	3.3%	3.3%	3.3%	2.5%	3.2%
Road transport (Rs. Billion)	3,623	3,964	4,175	4,322	3,217	4,355

Source: Ministry of Statistics and Programme Implementation (MoSPI), CRISIL Consulting

5.1.1 Road network in India

India has the second-largest road network in the world, spanning 6.3 million km. Road transportation, the most frequently used mode of transportation in India, accounts for about 86% of passenger traffic and close to 67% of freight traffic. Although Indian national highways span nearly 144,955 km, constituting just 2% of road length, they accounted for about 40% of total road traffic in fiscal 2023. The secondary system of roads comprises state roads and major district roads, which accounted for the remaining 60% of traffic and 98% of road length.

Table 74: Road network in India in fiscal 2023*

Road network	Length ('000km)	Percentage of total - length	Percentage of total - traffic	Connectivity to
National highways	145.0	~2%	~40%	Union capital, state capitals, major ports, foreign highways
State highways	167.1	~3%	~60%	Major centers within the states, national highways
Other roads	6,019.8	95%		Major and other district roads, rural roads- production centers, markets, highways, railway stations

Note: Fiscal 2023 number is as of 31 December 2022 as reported in MoRTH annual report
Source: MoRTH Annual Report 2020-21, CRISIL Consulting

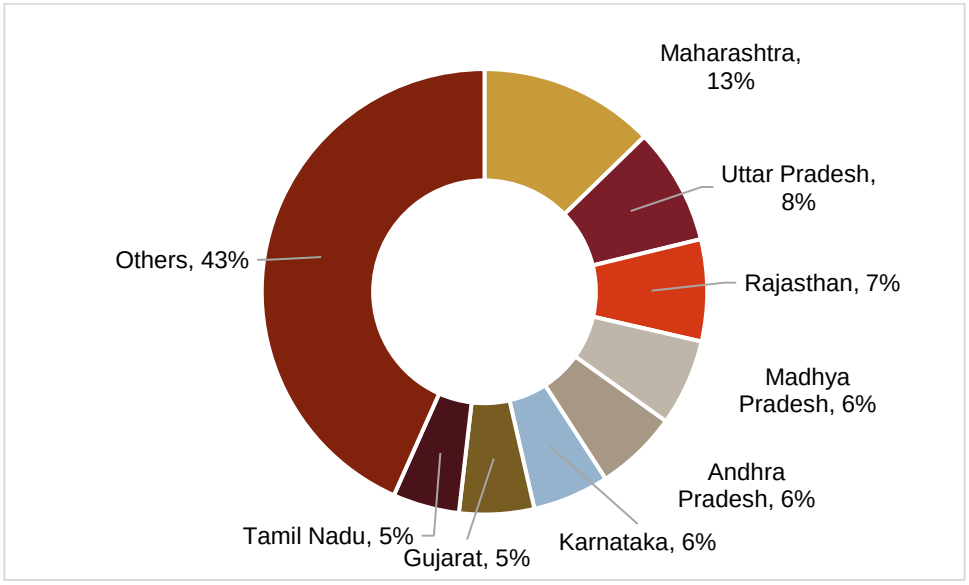
5.1.2 Total length and break-down of national, state and rural roads

Table 75: Break-down of road length across different regions (km)

Units: KMs	FY17	FY18	FY19	FY20	FY21	FY22	FY23*
National highways	103,933	120,543	132,500	132,500	136,440	140,995	144,955
State highways	161,487	155,222	156,694	156,694	176,818	171,039	167,079
Other roads	5,207,044	5,207,044	5,608,477	5,608,477	5,902,539	6,059,813	6,019,757
Total	5,472,464	5,482,809	5,897,671	5,897,671	6,215,797	6,371,847	6,331,791

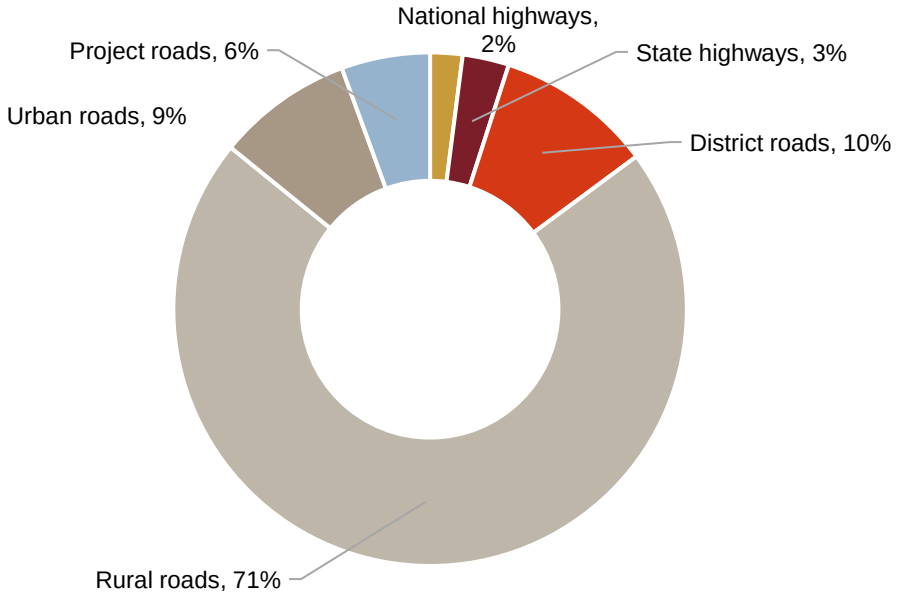
*Note: *- Fiscal 2023 number is as of 31st December 2022 as reported in MoRTH annual report*
Source: MoRTH Annual Report 2020-21, CRISIL Consulting

Figure 111: State-wise length of national highways in India as of FY23



Note: Fiscal 2023 number is as of 31 December 2022 as reported in MoRTH annual report
Source: MoRTH Annual Report 2020-21, CRISIL Consulting

Figure 112: Road length breakup by segment as a percentage of total road length in India



Source: Road transport yearbook 2019-20, CRISIL Consulting

5.2 Road maintenance in India

Road maintenance is necessary to ensure that roads constructed or improved later on are maintained at their original condition to the extent possible as varied environmental and traffic conditions can impact their quality and render them non-commutable. Adequate maintenance can extend road lifespan and defer further investments on road reconstruction.

The pace at which a road deteriorates mainly depends on initial construction levels, materials used during construction, traffic count, drainage facilities near the road and weather conditions. Gravel roads deteriorate faster

than bitumen-surfaced roads, and their value is assumed to be insignificant after five years if they go without maintenance. Bitumen roads have a longer lifespan than gravel roads, but their maintenance costs are high.

A clear distinction between maintenance and repair work is paramount. Maintenance involves activities such as road supervision and periodic monitoring of roads even when they are in an optimal condition. Road maintenance also differs from repair as it is time-oriented and carried out to increase road safety.

The quality of roads in India is subpar, with only 60-65% of the road network being paved. Stretches developed via the public-private partnership (PPP) route are being maintained in line with required standards by the concessionaire. Stretches developed using public funds need to be maintained at adequate service levels by national or state authorities.

Regular maintenance of bitumen-type roads generally accounts for 1.0-1.5% of the project cost incurred during road construction. A road has to undergo major maintenance every 5-6 years and the maintenance activity typically comprises 5-6% of the project cost incurred during construction.

5.3 Key growth drivers for the road sector

5.3.1 Policy impetus to drive private participation

To promote competition among investors and increase participation of private players in road construction, the Ministry of Road Transport and Highways (MoRTH) and the National Highways Authority of India (NHAI) introduced some policy changes under PPP models in FY 16. The major changes are as follows:

- To promote the entry of small players, the government revised the eligibility criteria under engineering, procurement and construction (EPC) and hybrid annuity model (HAM) projects
- Major changes were made in the HAM concession agreement to ease cash flows of developers and protect their returns
- To encourage private players, changes were made to the build-operate-transfer (BOT) concession agreement

Further, the government has taken various steps under the Aatma Nirbhar Bharat scheme to mitigate the impact of Covid-19 on the sector:

- Extension of time (EOT) up to 3-6 months for all projects and relaxation of milestone achievement
- Release of performance security, Covid-19 emergency loan facilities and moratorium on loan repayment up to August 2020
- Extension of concession period for BOT-toll operators due to toll suspension and restrictions on movement during lockdowns

5.3.2 New region-specific initiatives to increase road network

New initiatives have been taken by the government to build state roads. Road Requirement Plan (RRP) for left wing extremism-affected areas and Special Accelerated Road Development Programme for North-Eastern Region (SARDP- NE) are two ongoing projects covering state roads. MoRTH has set up National Highways and Infrastructure Development Corporation Ltd (NHIDCL), an organization that will award national highway projects specifically in border areas and north-east states. Apart from these projects, the Bharat Mala programme has been proposed to build new roads along the border.

5.3.3 The government's focus on infrastructure and roads with focus on expressways

Under the national monetization pipeline announced in the Union Budget 2021-22, NHAI and Power Grid Corporation of India Limited (PGCIL) have each sponsored infrastructure investment trust (InvIT) that will attract international and domestic institutional investors. NHAI launched its InvIT in Fiscal 2022. So far, till December 2022, NHAI InvIT has raised more than Rs.102 billion from high quality foreign and Indian institutional investors. Similarly, transmission assets valued at more than Rs 70 billion have been transferred to PGCIL InvIT. More expressways are planned across the country. With more than 20 expressways planned across the country and with award of approximately ~5000 km of highways every year in the next five fiscals from fiscal 2023 to fiscal 2028

5.3.4 Healthy economic growth to push road development

With the economy expected to grow at a healthy pace, per capita income is set to improve, which will increase demand for TWs and PVs in the country. Initiatives such as Make in India and the implementation of Goods and Services Tax (GST) are also expected to add to road freight traffic in India. Rise in TWs and four-wheeler vehicles, increasing freight traffic, and strong trade and tourist flows between states are all set to augment road development in the country. Also, all road segments, i.e., national highways, state roads and rural roads, are expected to see higher traffic growth due to faster economic growth.

5.3.5 Increase in competition for EPC projects

EPC projects being bid out are smaller in terms of both size and cost than HAM projects by almost half. The average length of EPC projects awarded was 22 kms as compared with HAM projects whose average length was 46 kms. Similarly, when comparing costs, the average size of EPC projects in terms of cost was Rs 3750 million as compared with HAM which was more than Rs 7000 million.

For EPC projects, a developer is eligible to bid if its bid capacity is more than the bid value. Bid capacity is calculated based on the highest annual revenue earned through EPC projects in any of the previous five years. Thus, a lower bid value ensures more eligible bidders, increasing the competitive intensity of the project.

Also, many road developers are now focused on bidding for only EPC projects owing to their poor financial health as well as overhang of past issues with regard to delays in land acquisition, clearances, and mismatches in traffic projections. With the recent reduction in bidder eligibility EPC have witnessed even more stiff competition with even 30-35 contractors bidding per project.

5.4 Operational models and the regulatory landscape

A few operational models are given below:

- BOT-toll/-annuity/-hybrid annuity model (HAM)
- EPC
- Toll collection
- Operate, maintain and transfer (OMT)
- Toll, operate and transfer (TOT)

Electronic toll collection (ETC) is a strategic focus area for regulatory and administrative bodies involved in the process of toll collection. It presents several advantages such as limiting toll leakages, reducing waiting time for vehicles, and improving overall traffic flow at toll plazas. In the future, ETC may result in significant changes in toll collection procedures followed in each of the PPP models.

Table 76: Types of PPP models

Type of project	Description	Net cash outflow for the government	Revenue for private party	Concession period	Award criteria
BOT-toll	Private party builds road, undertakes O&M and collects toll	No	Toll	Around 20-25 years for the NHAI**	Highest revenue sharing bid/ highest premium
BOT-annuity	Private party builds road, undertakes O&M* and collects annuity from the granting authority	Yes, net payment to be made is the difference between the toll collection and the annuity payable	Annuity payment	Around 20-25 years for NHAI	Lowest annuity
BOT-HAM	Private party builds road, undertakes O&M. Gets 40% of payment during construction and 60% as annuity	40% during construction and 60% as semi-annual annuity, net of toll collected	Construction grant plus annuity payments	Around 15 years of operations	Lowest project cost plus O&M cost
EPC	Private party builds road, money is spent by the government	Yes	Contract amount	Not required	Lowest tariff requested
OMT	Private party collects toll and undertakes O&M	No	Toll	Around nine years for NHAI projects	Highest % of toll revenues or highest premium per year
Tolling	Private party pays the estimated toll upfront to the authority and collects the toll during concession period	No	Toll	Around one year for NHAI projects	Highest revenue-sharing bid
TOT	Private party pays the estimated toll upfront to the authority, undertakes O&M and collects the toll during concession period	Yes	Toll	30 years	Highest upfront payment

Note: Development risk refers to construction risk in developing a road project
**Operations and maintenance*
*** National Highways Authority of India*
Source: NHAI, CRISIL Consulting

Table 77: Description of risks in various PPP models

Type of project	Development risk	Financing risk	Traffic risk and accrual of toll fee collection
BOT-toll	Concessionaire	Concessionaire	Concessionaire
BOT-annuity	Concessionaire	Concessionaire	Authority
BOT-HAM	Concessionaire	Concessionaire	Authority
EPC	Concessionaire	Authority	Authority
OMT	No development except in case of paved shoulders	Concessionaire	Concessionaire
Tolling	No development	Concessionaire	Concessionaire
TOT	Authority (in case upgradation of lanes is taken up during the concession period)	Concessionaire	Concessionaire

Source: CRISIL Consulting

5.4.1 Build-operate-transfer (BOT)

These contracts are typically PPP agreements wherein a government agency provides a private player the right to build, operate and maintain a facility on public land for a fixed period. After the concession period, the assets are transferred back to the public authority.

Funding for the project is arranged by the concessionaire through a mix of equity and debt from banks and other financial institutions. Under the basic BOT mode, the concessionaire charges a fee to the users of the project/ facility and may either transfer the entire user fee collected to the authority or may retain the entire amount as revenue. BOT contracts are, therefore, classified into the following types:

- **Annuity-based contract**: Under this contract, the concessionaire is responsible for construction and maintenance of the project during the concession period. Variability in the user fee gives rise to revenue risk, which is borne by the authority. However, the concessionaire generates revenue through fixed annuity payments received from the authority over the concession period. Since this annuity payment is a cost to the authority, the contract is awarded to the lowest bidder. Toll charged under these contracts are generally regulated by a policy or a public agency.

- **Toll-based**: Under this model too, the concessionaire is responsible for construction and maintenance of the project, post which the project's ownership is transferred to the public authority. However, the toll collected is retained by the concessionaire and not transferred to the authority. Therefore, the concessionaire bears the revenue risk during the concession period. As in BOT annuity-based projects, the toll charged under these contracts is generally regulated by a policy or a public agency.

- **HAM**: This is a mix of EPC and BOT (annuity) model. In this model, the total project cost is shared between the authority and the concessionaire in a 40:60 ratio. This model aims to lower the financial burden on the concessionaire during the project implementation phase. Compared with EPC projects, the shift to HAM will also ease cash flow pressure on the NHAI. It will lower project risk for developers because the agency will bear the risk of traffic volumes and the developer earns through fixed annuity payments. It will also help developers participate in more projects given that the equity contribution per project will now be lower. This model will also encourage banks to lend to road projects because of NHAI's involvement. HAM was approved by the Cabinet Committee on Economic Affairs on January 27, 2016.

Viability gap funding

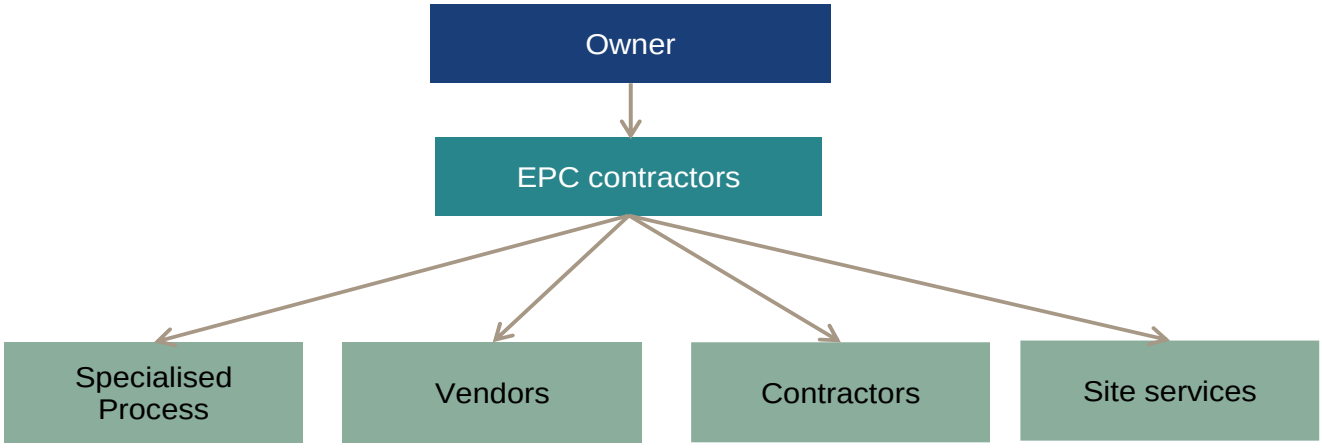
Viability gap funding (VGF) is a one-time or deferred grant provided to support infrastructure projects that are economically justified but fall short of financial viability. The VGF scheme was launched in 2004 to support projects that come under PPPs. It was a method used by the government for awarding a few BOT projects. Projects generally expected to have traffic numbers insufficient to compensate the costs to the developer were provided an additional grant from the government for execution. The bidder who quoted the lowest grant used to be awarded the project. The number of projects that got such a grant fell from 23 in fiscal 2010 to only two in fiscal 2016 and no projects in fiscal 2017. Up to fiscal 2012, the rise in bidding aggression led to a fall in the number of projects receiving VGF. Over fiscal 2013-15, the awarding numbers of the NHAI fell drastically. Since fiscal 2016, a majority of the projects awarded by the central government have been on an EPC basis.

In the recently developed HAM model, which in a way is VGF, the government provides 40% of the total cost incurred by the developer during the construction period itself.

5.4.2 EPC

EPC contracts are fixed-price contracts, wherein the client provides conceptual information about the project. Technical parameters, based on the desired output, are specified in the contract. The contractor undertakes the responsibility of designing the project, either through an in-house design team or by appointing consultants. Unlike item rate and Lump sum turnkey (LSTK) contracts, the contractor is allowed to innovate on the project design. Based on these designs, the contractor draws up cost estimates and accordingly bids for the project.

Figure 113: EPC contracts



Source: CRISIL Consulting

5.4.3 Toll collection

Toll collection evolved as a separate business model in 2009. Under this model, the authority invites bids from private players to collect toll on roads constructed under EPC and BOT-annuity. It is used for short-duration projects, typically those lasting 12 months. The private player making the highest bid is awarded the project. The user fee is pre-determined by the contracting authority. The right to collect user fees during the concession period lies with the private player. A contract of this category involves negligible to minimal road construction and maintenance.

5.5 Key trends for the road sector

Improvement in the rate of execution: National highway authority of India has seen uptick in the pace of construction of highways in last few years with 14-15 km being constructed each day in fiscal 2022,compared to 9 km constructed in fiscal 2019.

Improved awarding momentum: The government has tried to improve the rate of awarding over the years. HAM has seen a significant share of awards recently, which is expected to increase going forward.

Private equity investment likely to increase: Private equity funds have contributed to road projects in the past. Going forward, private equity investments could increase further following recent announcements of the exit policy for debt-stressed operators of toll roads.

Re-emergence of EPC contracts: Given the current financial crunch faced by BOT players, CRISIL Consulting expects the share of EPC/cash contract projects to widen, especially in low traffic volume projects under NHDP-Phase IV, over the next five years.

Other favorable policies: These include a 100% exit policy for stressed BOT players, providing 'secured' status for PPP projects while lending and the proposal to scrap slow-moving highway projects (under consideration).

HAM: HAM has been successful in bringing a new set of private players by mitigating risks related to traffic, interest rate and inflation, and by requiring a smaller equity commitment (only 12-15% of project cost).

TOT: The toll-operate-transfer (TOT) model is a PPP model introduced by NHAI to spur private participation in the road sector to raise funding and divest and transfer tolling and maintenance to private entities.

InvIT: NHAI is planning to raise Rs 400 billion ($5.72 billion) to monetize its highway assets through InvIT and has raised Rs.102 billion by December 2022.

OMT: Apart from NHAI, a few large Indian states have also adopted operate-maintain-transfer (OMT) models, where state road development authorities have invited bids or awarded state highway projects on an OMT basis.

ETC lane: Electronic toll collection (ETC) enables road users to pay highway tolls electronically without stopping at toll plazas. Dedicated ETC lanes help reduce congestion at toll plazas and enable seamless movement of vehicles on national highways. The transport ministry has decided to roll out the ETC program in the country under the brand name 'FASTag'. FASTag collections as of December 31, 2022, crossed Rs 1.6 billion per day, with 10 million FASTag transactions per day. As of December 31, 2022, more than 63.3 million FASTag have been issued and the program has partnered with 38 issuer banks and includes several options to simplify the recharging process such as Bharat Bill Payment System (BBPS), Universal Payment Interface (UPI), online payments, My FASTag mobile app, Paytm and Google Pay.

5.6 Policy pushes for hybrid annuity model (HAM)

The Ministry and NHAI, post multiple suggestions from various stakeholders, amended the HAM model concession agreement (MCA) across the below mentioned parameters in Oct 2020. These changes are largely aimed at protecting developers' returns and easing their liquidity.

Table 78: Recent changes in HAM MCA incorporate developers' concerns:

	Old clause	Revised clause	Impact
Annuity payments	Interest on annuity payment linked to RBI determined bank rate +3%	Interest on annuity payment linked to average of one-year MCLR to top 5 scheduled banks +1.25%	Differential between cost of borrowing & interest reduced on an annual basis, preventing erosion of developers' return due to RBI
Milestone payments	5 instalments, each equal to 8% of the bid project cost	10 instalments, each equal to 4% of the bid project cost	Quicker payments support developers' liquidity
Change in ownership	Original sponsor/ concessionaire shall hold at least 26% of equity during construction period & 2 years thereafter	Original sponsor/ concessionaire shall hold at least 26% of equity during construction period & 6 months thereafter	Quicker state sell-off would ease up developers' balance sheets to bid for new projects
Financial closure	No clarity on amount of FC	FC to be undertaken for an amount no lower than earlier: • Total project cost (60% of BPC) • 10% less than estimated project cost minus 40% of bid project cost	Would likely prevent termination of projects due to inadequate financing
Dispute resolution	In case of a dispute	FC to be undertaken for an amount no lower than earlier: 1. Total project cost (60% of BPC) 2. 10% less than estimated project cost minus 40% of bid project cost	Would likely prevent termination of projects due to inadequate financing
Others	Interest mobilization advance linked to bank rate. Termination payments based on previous milestone payments	Interest on mobilization advance linked to MCLR. Termination payments based on new milestone payments.	NA

Source: CRISIL consulting

On the back of the higher HAM awarding, CRISIL MI&A's estimates of split for the NHAI capex mix indicates that the share of HAM in NHAI capex is expected to rise. However, given that EPC has also cornered a large share in awarding in the previous fiscals, its share in NHAI capex is expected to remain at ~50-55% in fiscal 2024. Overall, the share of public funds in NHAI investments is likely to hover around the 70% range. Therefore, NHAI funding would remain critical to sustain the sector forward.

5.7 Changes in built-operate-toll (BOT) model

To improve private participation via the BOT-toll mode, NHAI and the ministry also introduced changes to the BOT MCA aimed at key issues such as land acquisition, revenue assessment in case of traffic shortfall and stalled projects. Despite these changes, we don't expect the awarding of any BOT contracts this fiscal due to uncertainty over traffic growth on account of Covid-19 restrictions and muted economic activity.

Table 79: BOT MCA revamped to reinstate interest in the model.

Land acquisition	Traffic risk	Stuck projects
• Minimum 90% ROW before issue of appointed date. This is 80% earlier, providing more comfort to lenders & developers. • Balance 10% to be granted within 180 days of AD, else it would be removed from scope of **work**. Automatic descoping clause would enable the developer to receive PCOD/COD on the completed stretch & start tolling. • Termination clause if appointed date is not received within one year of concession signing date.	• Revenue assessment of project to be done every 5 years instead of 10 years. • In case of traffic shortfall against the target, the concession period would be adjusted accordingly.	• In case the project has not achieved COD one year post its scheduled completion date, the project will be mutually foreclosed, and the authority shall pay the concessionaire an amount equal to: **a.** 90% of debt due less insurance cover **b.** Value of work done • This will prevent dragging of projects and the resultant time and cost overruns that

Source: MoRTH, NHAI, CRISIL Consulting

5.8 Policy initiatives or schemes

The recent policy changes that MoRTH and NHAI have introduced to improve private participation in the sector and increase competition are as follows:

- Technical and financial bidder eligibility criteria reduced for HAM and EPC projects to promote entry of smaller players
- Changes in the hybrid annuity model (HAM) concession agreement aimed at protecting developers' returns and easing their cash flows during the construction period
- Changes in the build-operate-transfer (BOT) concession agreement to reinstate developer interest in the model
- Apart from this, the government has taken various steps under the Aatma Nirbhar Bharat scheme to mitigate the impact of Covid-19 on the sector:
  - Extension of time (EOT) up to 3-6 months for all projects and relaxation of milestone achievement
  - Monthly payment mechanism instead of milestone-based payments
  - Reduction in performance security from 5% to 3%, release of retention money to the extent of work done
  - Plus, Covid-19 emergency loan facilities and moratorium on loan repayment up to Aug 2020
  - Extension of concession period for BOT-toll operators due to toll suspension and restrictions on movement during lockdowns

5.8.1 Bharatmala Pariyojana

Bharatmala Pariyojana is an umbrella project of the central government since 2015 that aims to improve efficiency in the roads sector. It is expected to supersede the National Highways Development Project (NHDP) and envisages the construction of 65,000 km of highways under the following categories: national corridor (north-south, east-west, and Golden Quadrilateral), economic corridor, inter-corridor roads, and feeder roads. As per the Ministry, Bharatmala, along with the schemes currently undertaken, could require a total outlay of Rs 6.9 trillion.

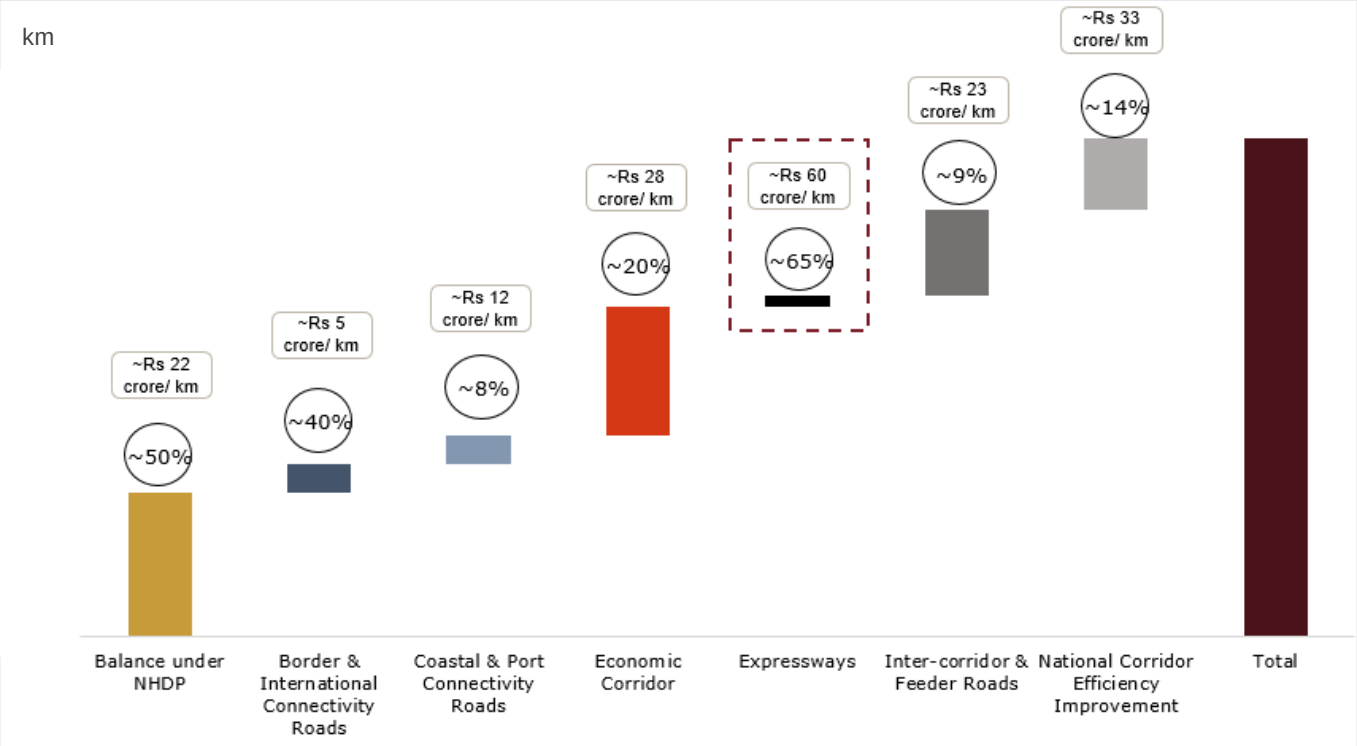
Phase-I of the scheme envisages development of about 24,800 km of national highways/roads, plus residual 10,000 km of NHDP between fiscals 2018 and 2022. Awarding under Bharatmala began in fiscal 2018 and we believe it will stretch till fiscal 2025 for Phase 1 involving development of about 9,000 km of economic corridors; about 6,000 km of inter-corridor and feeder roads; about 5,000 km of national corridor efficiency improvements, about 2,000 km of border and international connectivity roads; about 2,000 km of coastal and port connectivity roads; and about 800 km of expressways.

Table 80: Components of BMP Phase -I

Category	Description	Total length (km)	Upgrade proposed in Phase I (km)
National corridor efficiency improvement	Lane expansion, decongestion of existing national corridors	13,100	5,000
Economic corridor development	Connecting economically important production & consumption centers	26,200	9,000
Inter-corridor and feeder route development	Inter-connection between economic corridors, first mile and last mile connectivity	15,500	6,000
Border and international roads	Connectivity to border areas and boosting trade with neighboring countries	5,300	2,000
Coastal and port connectivity roads	Connectivity to coastal areas to enable port-led economic development	4,100	2,000
Expressways	Greenfield expressways	1,900	800
Total		**66,100**	**24,800**

Source: NHAI, CRISIL Consulting

Figure 114: Cost per km for expressways are highest



Source: MoRTH, CRISIL Consulting

5.8.2 National Highway Development Project (NHDP)

NHDP encompasses building, upgradation, rehabilitation and broadening of existing national highways. The project is executed by NHAI in coordination with the public works departments of various states. NHAI also collaborates with the Border Roads Organization for the development of certain stretches. NHDP is being implemented in seven phases.

The projects are awarded to private players either on EPC (cash) or on build-operate-transfer (BOT) basis and now based on the newly introduced hybrid annuity model (HAM). NHDP cash contracts are mainly financed through budgetary allocations from the Central Road Fund (CRF), grants/premium received, and toll revenue. Loans and grants are also received from the World Bank and Asian Development Bank.

The NHDP, which was undertaken in the year 2001, has been merged with the Bharatmala pariyojana which was announced in 2017. There were approximately 10,000 km of residual roads to be developed under NHDP which is now subsumed under Bharatmala project. Out of this residual 10,000 km in NHDP 6,649 km has been awarded and 3,756 km of the roads have been completed as of December 2022.

5.8.3 Other schemes focused on the north-eastern region

The Ministry has been paying special attention to the development of NHs in the north-eastern region and 10% of the total budget allocation is earmarked for the region. The total length of national highways in the North-East is 15,735 km and these roads are being developed and maintained by four agencies - state PWDs, BRO, NHAI and NHIDCL. Of the total length of 15,735 km, about 12,133 km is with NHIDCL and respective state PWDs, 882 km is with NHAI and 773 km with BRO. The details of national highways and their development and maintenance works taken up under various schemes in the North-East are given below:

Table 81: Status of National Highways construction

Sr. No.	Programme	Total length (km)
1	Length under NHDP phase-3	110
2	Length of National highways, state roads under SARDP-NE	
	Phase A	4,099
	Phase B	3,723
3	Arunachal Pradesh package of roads and highways	2,319

Source: MoRTH, CRISIL Consulting

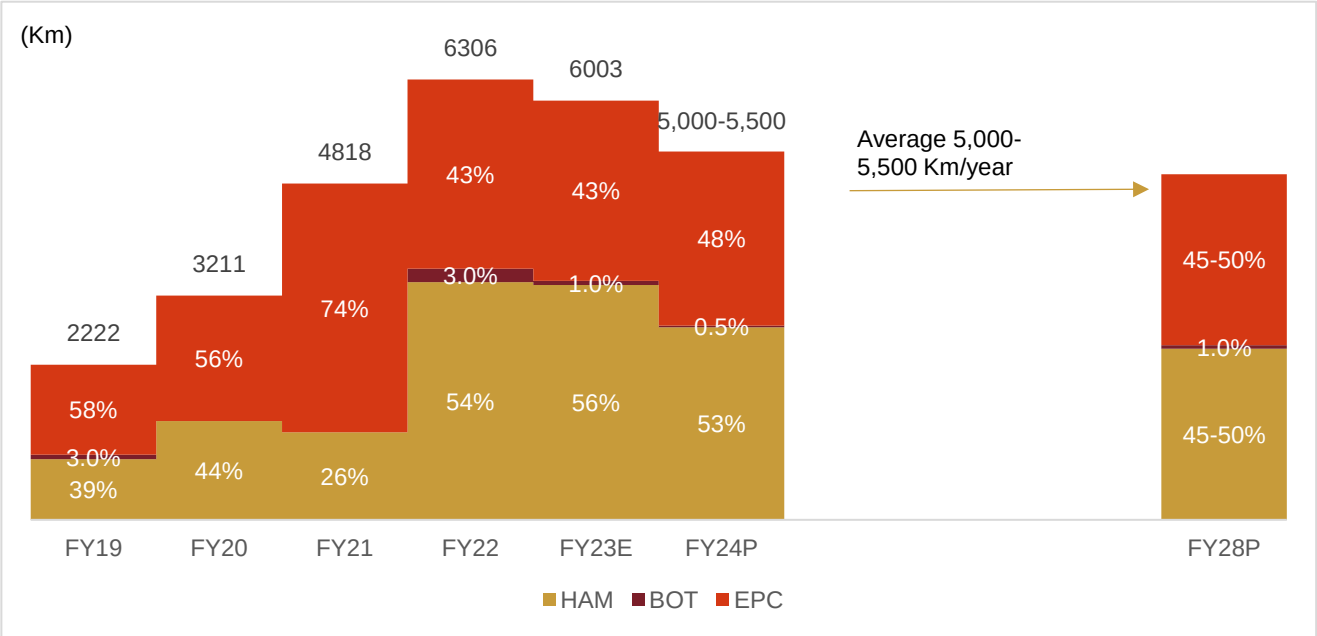
Special Accelerated Road Development Programme for North-Eastern region (SARDP-NE): This programme envisages providing road connectivity to all the district headquarters in the north-eastern region by minimum 2-lane highway standards apart from providing road connectivity to backward and remote areas, areas of strategic importance and neighboring countries. The programme has been planned in two phases (A & B), including Arunachal Package. Phase 'A' of SARDP-NE envisages improvement of about 4,099 km of roads (3,014 km of NHs and 1,085 km of state roads) and Phase 'B' covers 3,723 km (2,210 km of NHs and 1,513 km of state roads). About 4,473 km has been completed in SARDP-NE. Phase 'A' of SARDP-NE is expected to be completed by fiscal 2024.

5.9 NHAI awarding to moderate in fiscal 2024, share of HAM likely to remain stable

National Highways Authority of India (NHAI) awarding has witnessed a rise from merely 2,222 km in fiscal 2019 to 6,003 km in fiscal 2023. Fiscal 2021 was a pivotal year since despite the COVID-induced disruptions, there was a healthy growth in awarding. The NHAI awarded 4,818 kms in the fiscal 2021 which was a three fiscal high back then. Additionally, favorable changes in the BOT and HAM agreements, and relaxation of bidder eligibility criteria not only indicated a clear policy shift to improve private-sector participation but also aided the spurt in the HAM awards. In fiscal 2022, the awarding momentum continued unabated as the NHAI awarded 6,306 kms in the fiscal year. The share of HAM and EPC in the awarding stood at 54% and 43% respectively whereas projects under the BOT model accounted for only a paltry 3%. While the awarding momentum dipped slightly in fiscal 2023, the awarding volume still remained above the 6,000 km mark with the NHAI awarding 6,003 km during the fiscal year. The share of HAM in awarding increased slightly to 56% while that of EPC remained unchanged.

In fiscal 2024, as per CRISIL MI&A estimates, NHAI awarding is expected to moderate to ~5,000-5,500 kms while the respective shares of HAM, EPC and BOT in the total awarding are expected to remain at similar levels vis-à-vis fiscal 2023. A limited rise in budgetary support coupled with the higher capex for high-value expressways currently under construction, could defer NHAI awards under Bharatmala Phase 1 beyond fiscal 2024 — the year construction was originally scheduled to be completed. Over the medium term, it is expected that the NHAI would continue to award ~5,000-5,500 kms per year on an average between fiscals 2024 and 2027. Furthermore, the shares of HAM, EPC and BOT in the awarding are expected to remain largely stable without any significant deviations. Additionally, going forward, developers are also likely to free up capital and deleverage their balance sheets through stake sales supported by the strong pipeline of projects under Bharatmala and the NIP.

Figure 115: Awarding of national highways



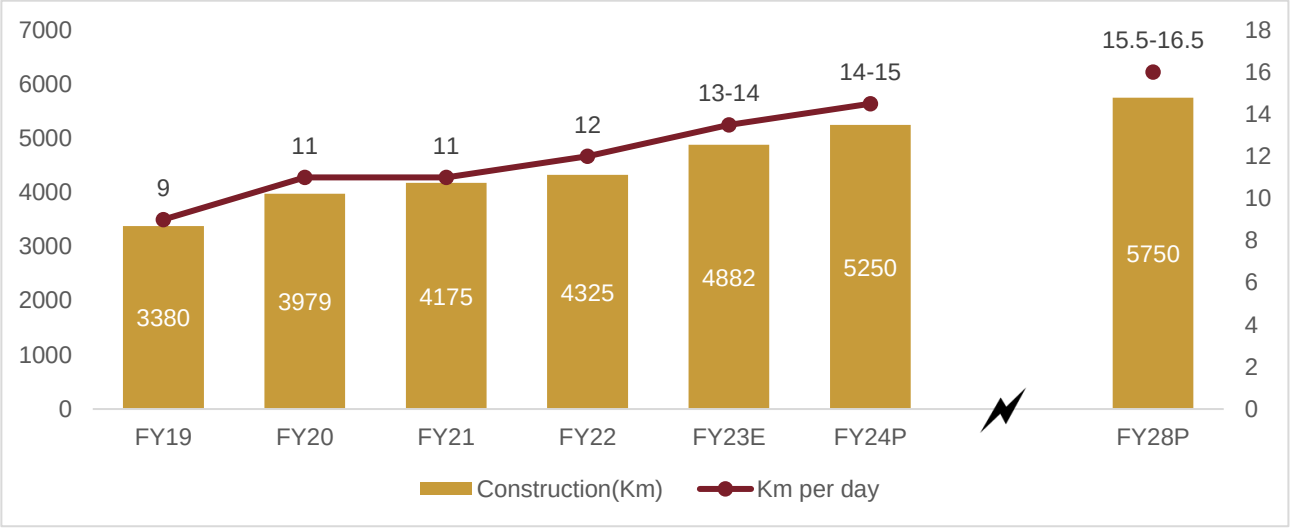
Note: E-Estimated, P-Projected
Source: MoRTH, CRISIL Consulting

5.10 National Highway construction is also rising steadily with focus on swifter execution

Even though overall national highways construction at the MoRTH level remained flattish in fiscals 2022 and 2023, NHAI execution witnessed strong momentum. NHAI execution sequentially rose from 4,175 km in fiscal 2021 to 4,882 km in fiscal 2023. Acceleration in project awards, sharper focus on resolving land acquisition issues, and the 'Atmanirbhar Bharat' initiatives to ease liquidity (monthly milestone payments, release of retention money, reduction in performance security & extension of 3-6 months in milestones & SCODs) for EPC road players augured well for the pace of construction during this period even though issues such as exorbitant commodity prices and elongated monsoons acted as headwinds.

CRISIL MI&A expects fiscal 2024 NHAI construction to be in the range of 5,000-5,500 kms on the back of higher awarding witnessed in the previous fiscals and many of those projects receiving appointed dates only towards the fag end of fiscal 2023. Over the medium term, the pace of construction is expected to rise steadily to reach ~16 km per day by fiscal 2028.

Figure 116: NHAI national highway construction



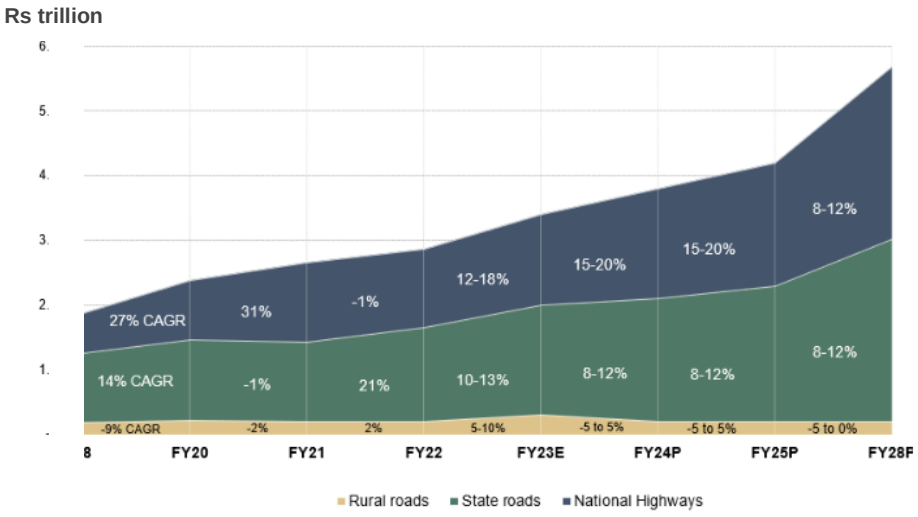
Note: E-Estimated, P-Projected
Source: MoRTH, CRISIL Consulting

5.11 Strong government thrust likely to deliver steady growth in fiscal 2024 for road capex

Overall road sector capex, comprising of National Highways, State Highways & rural roads is estimated to have grown at a CAGR of 14% between fiscals 2018 & 2023. This growth, driven by Bharatmala and increased state spends on roads has been achieved despite brief hiccups such as the pandemic and hampered construction due to elongated monsoons. The outlook of the sector also remains firm supported by higher awarding of previous fiscals, Bharatmala, NIP pipeline of DPR ready projects and steady state capex.

The NH segment contributes around 40-45% of the overall capex. While the execution remained flattish in fiscal 2023 vis-à-vis fiscal 2022, capex grew by 12-18% due to a rise in construction of high value projects and high commodity prices. In fiscal 2024, CRISIL Consulting expects the national highway capex to grow by 15-20% driven primarily by increased execution.

Figure 117: Government spends on road sector



Note: E-Estimated, P-Projected
Source: MoRTH, CRISIL Consulting

On the low base of fiscal 2021, the state spends grew by 21% in fiscal 2022 and are estimated to have grown further by 10-13% in fiscal 2023 largely in line with the growth in budgetary outlay. In fiscal 2024, state spending are expected to go up further by 8-12% as their percentage achievement of budgetary allocations are expected to be largely in line with historical average.

5.12 Expenditure on rural roads to remain muted

Given lower construction targets under PMGSY III, the rural road construction was already on a decline in fiscal 2020. Despite the corona virus pandemic spread in India, kms constructed were up by 34% in fiscal 2021 with a ramp up in Q4 on the low base. In fiscal 2022, ~42,000 kms of rural construction under PMGSY was witnessed. Given that only few kms are pending under PMGSY targets, in fiscal 2024 and 2025, CRISIL Consulting expect flattish rural road construction which would be largely in the northern and eastern parts of the country.

Rural road construction (in kms) was almost half in fiscal 2020 at ~27,000 kms construction, as compared with ~49,000 kms in the previous year. Fiscal 2021, saw construction of ~37,000 kms, while fiscal 2022 construction was ~42,000 kms. In fiscal 2023, rural road construction remained muted and failed to achieve the year's target. In fiscal 2024, the target for rural road construction has been slashed to 38,000 km.

After fiscal 2017, budgetary allocation by the Central government to the scheme was kept at Rs 190 billion, budgetary allocation for FY23 has been increased to Rs 195 billion. The actual expenditure has been lower than the allocation, achievement ratio has slipped to 74% from 81% in fiscal 2019. Total investment in PMGSY, both state and Centre, was Rs 234 billion in fiscal 2019, up 35% from Rs 173 billion in fiscal 2018, because of an uptick in length being constructed as well as higher cost per km.

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5.13 Overview of bridges and elevated road projects

With the government increasing the target for investments in national highways over the next five years, construction of bridges and elevated roads is also expected to rise substantially supported by road capex in north-east region, safety and traffic regulation concerns for village / town intersection, and robust connectivity between national highways.

India is one of the fastest growing markets for tunnel construction, with the tunnelling industry witnessing high growth and willingness to adopt advanced technologies. Over the past few years, the size of tunnelling projects has witnessed a substantial increase. Almost all the upcoming tunnel projects are lengthier, have larger diameters, and are of even higher contract values. Increasing investments in tunnel construction have boosted the tunnel equipment market as well. Going forward, as pressure to increase the productive economic and social utilisation of land heightens, there will be greater need to construct underground structures in the metro, water and sewerage, and road sectors

Data from the MoRTH shows India has in total about 44.4 km of tunnels as of December 2022 in operation compared with 119.3 km under construction and another 191.6 km in the planning stage. The ministry has set a target to complete 355 km of tunnels by 2027.

Key factors that will aid the growth in tunnelling projects are:

- Sharper focus on development of road network in mountainous regions, such as Jammu & Kashmir and Ladakh and the northeast. The Himalayan region itself has more than 30 projects planned
- More expressways planned across the country. These roads require tunnels to serve their purpose — reduce travel time. With more than 20 expressways planned over the next five years, tunnel construction will also gain momentum
- Availability of advanced technology is crucial to building efficient construction of tunnels

Following are some of the landmark and challenging highway tunnel projects under planning and execution stages:

- Zojila tunnel — It is under construction on the Srinagar-Leh section of the NH 1. It is 14.2 km long and connects Baltal and Minamarg. Built at an altitude of 11,578 m above the sea level, the Zojila tunnel will be India's longest road tunnel. It will ensure safer, all-weather connectivity between Leh, Kargil and Srinagar
- Z-Morh Tunnel — It is under construction on Srinagar-Kargil-Leh highway, 20 km from the Zojila Pass. The 6.5 km long tunnel will connect Gagangir directly to Sonamarg in Kashmir
- Char Dham tunnel, which is 4.5 km long
- Sela Nechiphu Pass tunnel
- Under-water tunnel in the Brahmaputra River in Assam
- Igatpuri Tunnel — The Mumbai-Nagpur expressway will have 6 tunnels. The 7.7-km twin tunnels between Kasara Ghat and Igatpuri will be the longest highway tunnel in Maharashtra
- Mumbai undersea tunnel — Twin tunnels are being built as part of the Mumbai Coastal Road Project. Of their 2.07 km length, a kilometre will be under the sea

Tunnelling opportunity:

Tunnelling infrastructure opens immense opportunities for contractors, consultants, technology and equipment providers, material suppliers etc. over the long term. The per km cost of tunnel construction can vary between Rs.2,000-3,000 million/Km. With more industry players tying up with international players, either for risk assessment, design or construction technology, risks in project construction will decline and ensure timely completion.

The scope of tunnel projects is also expanding as a result of growing urbanization and the increasing demand for better infrastructure. The roads and highways sector witnessed limited tunnel construction, with some in hilly regions.

Figure 118: Key tunnel projects in India

Key tunnel projects in India				
S no	Name of tunnel	Length (km)	Total cost (Rs million)	Status
1.	Qazigund Banihal section on NH-44	8.45	19,870	completed
2.	Pir ki Gali Tunnel (between Chattapani and Zaznar (Mughal Road)	8	20,000	Proposed by the state government with JICA funding
3.	Bhaderwah Tunnel (between BhaderwahBani-Basohli) on SH	3.5	11,330	-
4.	Chhatergala Tunnel (between Kishtwar to Anantnag via Singhpora) on SH	2.5	8,080	-
5.	Vailoo La Tunnel on NH-244	10	46,650	DPR by NHIDCL

Key tunnel projects in India				
S no	Name of tunnel	Length (km)	Total cost (Rs million)	Status
6.	Dharanga Tunnel Sudhmahadev – Goha	4.5	20,940	DPR by NHIDCL
7.	La Chunga La Tunnel on Leh-Manali Road	14.5	67,470	DPR by NHIDCL
8.	Tanglang La Tunnel on Leh-Manali Road	7.5	34,900	DPR by NHIDCL
9.	Shinkun La Tunnel on Leh-Manali Road	8.8	40,950	DPR by NHIDCL
10.	Construction, operation and maintenance of Z-Morh tunnel on DBFOT (annuity basis)	6.50	26,800	To be completed by Dec 2023
11.	Khellani- Kishtwar Bidirectional Tunnel	1.27	910	To be completed by March 2024
12.	Chisopani Traffic Tunnel on NH-10 in East District	0.42	360	Completed
13.	2-L Bidirectional Silkyara Bend- Barkot Tunnel on NH- 134 (old NH-94)	4.86	13,840	To be completed by May 2025
14.	Churhat Bypass, including Tunnel & Aqueduct on Rewa-Sidhi section of NH-75E	15.35	10,040	Completed
15.	Zojila Tunnel	14.15	45,100	To be completed by Sept 2026
	Total	**~110.3**	**~367,240**	

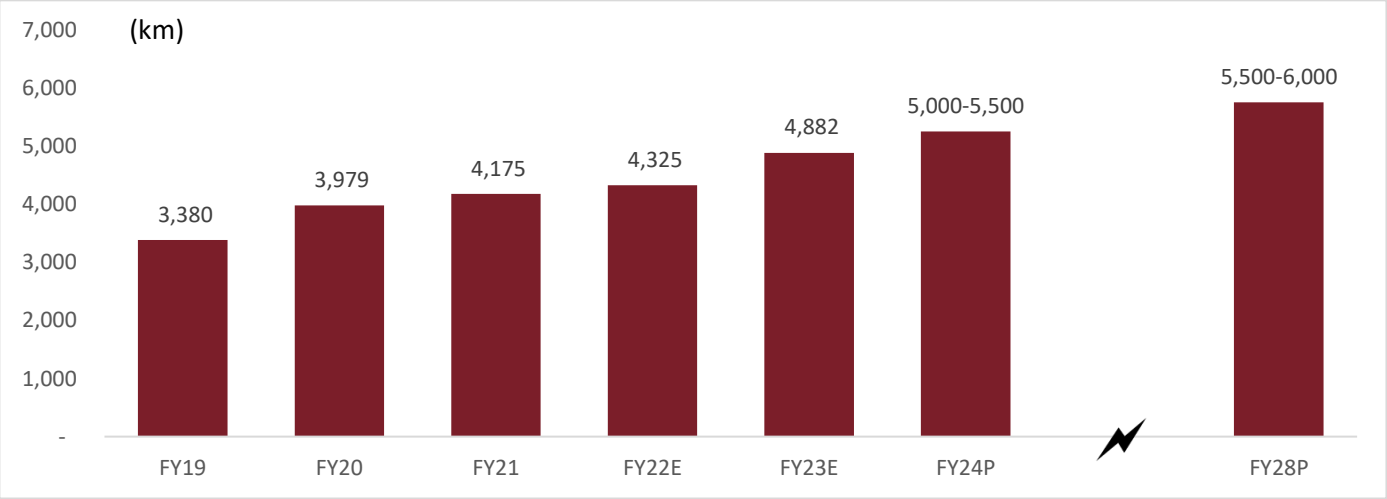
Source: NPCC, NHIDCL, CRISIL Consulting

5.14 Bridges and elevated roads require more per km spending as compared to non-elevated road

Bridges and elevated roads contribute to nearly 4-5% of national highway construction in terms of Kms but contributes to 10-15% in terms of construction spends.

Based on primary sourcing from some major EPC road construction players and technical consultants CRISIL estimates that for every 50Km of 4 lane highway stretch average 4%-5% Major Bridge of (2-3 Kms length) is constructed.

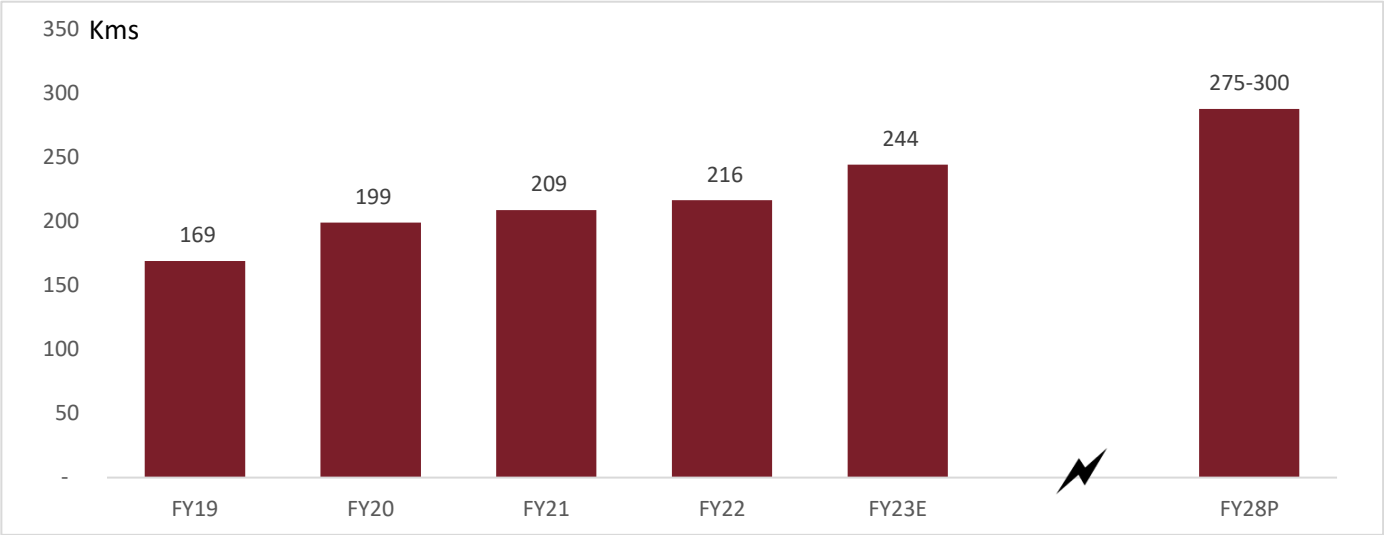
Figure 119: National Highway Road construction (Kms)



Note: E-Estimated, P-Projected

Source: MoRTH, CRISIL Consulting

Figure 120: Bridges and elevated road construction (Kms)



Note: E-Estimated, P-Projected

The numbers for Bridges and elevated roads construction are under panel review. Updates if any will be done in subsequent drafts.

Source: MoRTH, CRISIL Consulting

Table 82: Average cost of construction

Parameter	Average Cost (Rs. Mn. Per Km.) *
Road Construction	140-150
Road + Bridge	300-350
Bridge Construction	850-900
Factor: Bridge/Road construction (x)	6.5-7.0x

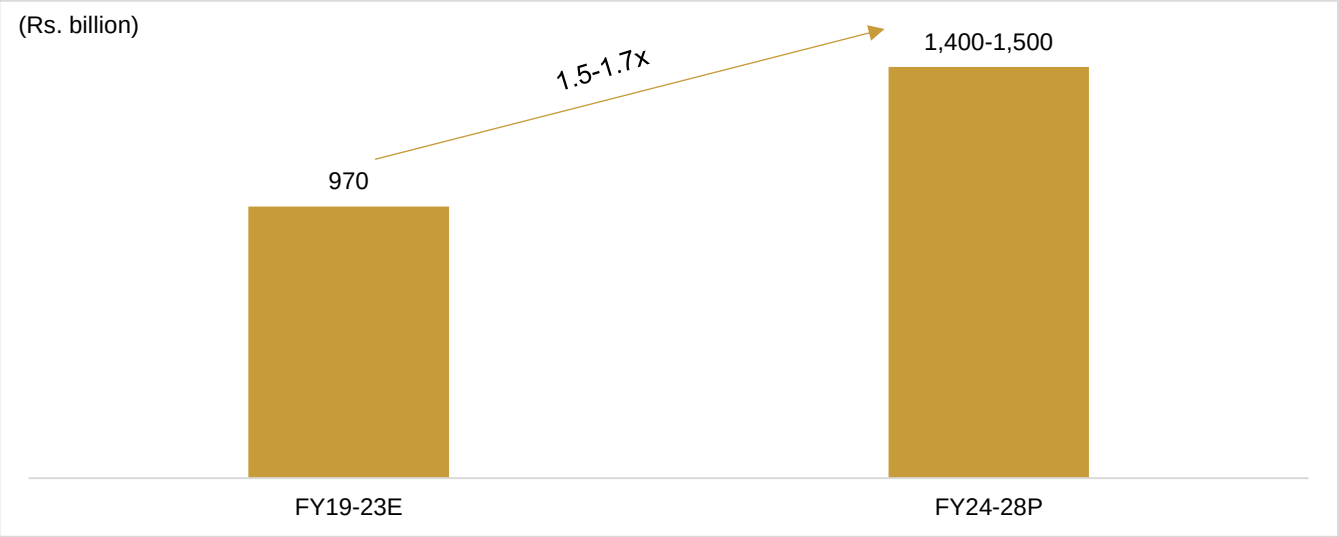
**Based on primary interaction with major EPC payers*

Source: CRISIL Consulting

5.15 Bridge and elevated road construction is expected to see 1.5-1.7x times rise

CRISIL estimates the construction spend on bridges and roads for national highways at Rs. 970 billion between fiscal 2019 and 2023. Going forward, over the next five year that is from fiscal 2024 to 2028, spending on bridges and elevated will be supported by rise in spend on elevated expressways, rise in construction of national highways and robust road network connection. With this CRISIL expects the spending on bridges and roads to increase by 1.5-1.7x times to Rs. 1,400-1,500 Bn between fiscal 2024 and 2028.

Figure 121: Construction of bridge and elevated roads



Note: E-Estimated, P-Projected
Source: MoRTH, CRISIL Consulting

Table 83: Key bridge projects in India

key bridge projects in India				
S no	**Project**	**Length (km)**	**Total cost (Rs Mn)**	**Status**
1.	Major bridge over Middle Strait Creek on NH-223 in Andaman & Nicobar Islands	1.96	2,629	-
2.	Major Bridge over Humphrey Strait Creek on NH-223 in Andaman & Nicobar Island	1.45	2,710	Completed
3.	Bridge over river Mani on NH-80	-	163	NA
4.	High Level R.C.C Major Bridge (Near Tungi) over Dhadhar River of NH-82 (Wazirganj-Hisua Section) in the State of Bihar	0.9	250	Under implementation
5.	Umagaon-Saharsa Koshi Bridge in the state of Bihar	13.30	11,996	Likely to be completed by Aug 11, 2023

Note: NA-Not available
Source: Setu Bhartam Yojana & MoRTH, CRISIL Consulting

6 Railways sector in India

6.1 Overview and evolution of railways sector in India

6.1.1 History of Indian Railways

The British laid the foundation

The railway, as a mode of transport, was introduced in India in the 19th century. The first passenger train took about 400 people from Mumbai to Thane for a 21-mile journey. In the south the first line was opened on 1st July 1856 by the Madras Railway Company. It ran between Vyasarpadi Jeeva Nilayam (Veyasarpandy) and Walajah Road (Arcot), a distance of 63 miles. In the North a length of 119 miles of line was laid from Allahabad to Kanpur on 3rd March 1859. These were the small beginnings which in due course developed into a network of railway lines all over the country. By 1880 the Indian Railway system had a route mileage of about 9000 miles. INDIAN RAILWAYS, the premier transport organization of the country is the largest rail network in Asia and the world's second largest network under one management.

Indian Railways is a government-owned organization with a monopoly in rail transportation in the country. Its operations are overseen by the Railway Board, which, in turn, is headed by the Ministry of Railways. The Railway Board comprises a chairman and six members. The Minister of Railways, two Ministers of State for Railways, and the Railway Board constitute the Ministry of Railways.

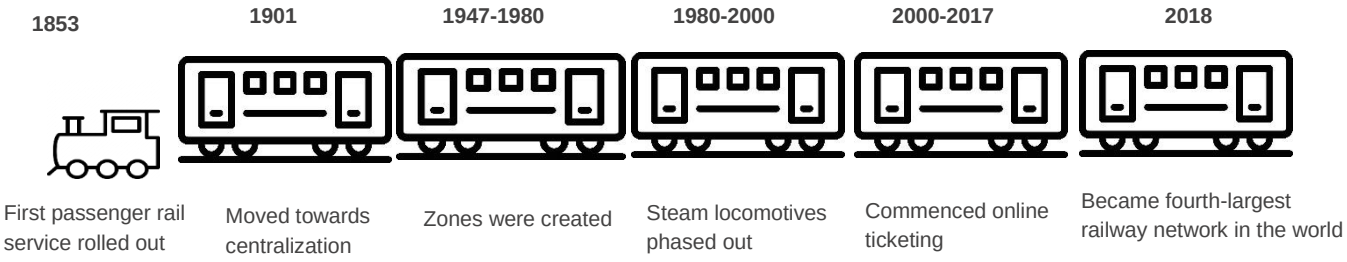
Figure 122: Indian Railways: At a glance as on year 2021-22

The focus and functioning of Indian Railways took a turn for the better following the announcement of the Railway Budget 2016-17 that outlined the five-year capex, along with steps to ensure minimal populism, key structural reforms such as delegation of power, mooting an independent Rail Development Authority for setting tariff and performance norms, expediting project sanctioning and hosing resources into priority projects.

6.1.2 Evolution of Indian Railways

Today, Indian Railways has become a budget-friendly transport option for the common man. The railway industry is also making new strides with high-speed, bullet trains and luxury trains in India.

Figure 123: Key timelines



Source: Indian Railway statistics, CRISIL Consulting

6.1.3 Overview of Indian Railways

India's rail network is a multi-gauge, multi-traction system

Gauge, also called Railway Gauge, in railroad transportation, the width between the inside faces of running rail. In India Gauges are of three types: Broad Gauge (1.676m width), Meter gauge (1 m width) & Narrow Gauge (0.762m & 0.610 m in width).

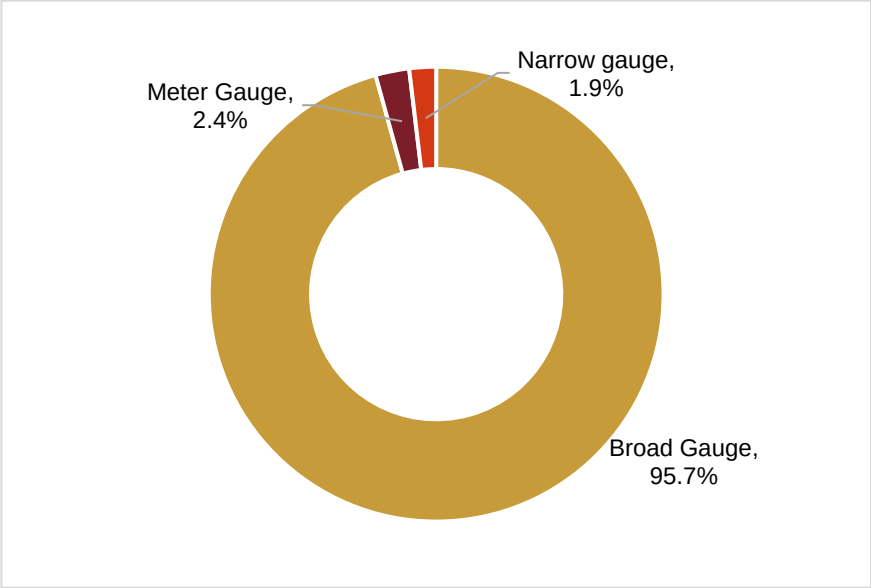
Traction system, system which causes propulsion of train vehicle in which driving force is obtain from various device such as Diesel or Electric. Indian Railway uses both Diesel and Electric traction system through its locomotives.

Table 84: Gauge type and Route covered

Gauge type	Route Kilometers
Broad gauge (1.67m)	65,093 km
Meter gauge (1.00m)	1,656 km
Narrow gauge (0.76m/0.61m)	1,294 km
Total	**68,403 km**

Source: Indian Railway statistics, CRISIL Consulting

Figure 124: Share of various gauges in the overall network

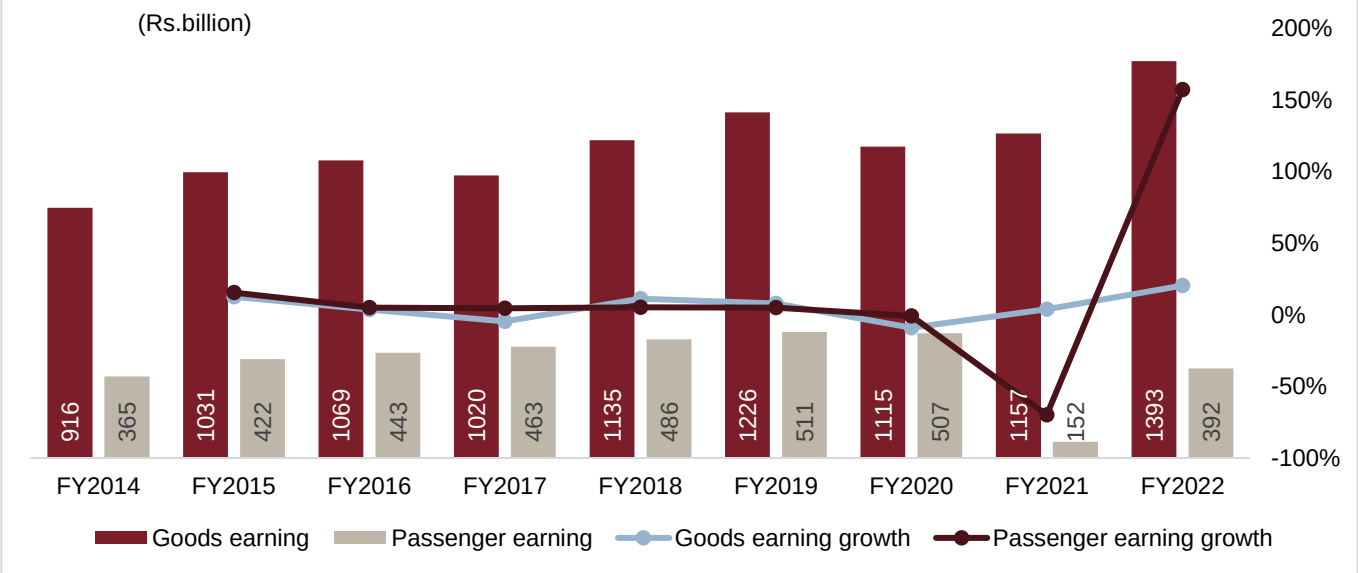


Source: Indian Railway statistics 2021-22, CRISIL Consulting

Review of financial performance of the railways

The financial position of Indian Railways has been improving slowly, but steadily. In fiscal 2021, operating ratio improved from 98.36% in fiscal 2020 to 97.45% in fiscal 2021. The Railways established a new milestone in incremental freight loading in July 2021 by carrying 5.70 million tonnes of goods.

Figure 125: Railway Earnings growth



Source: Annual Reports, Indian Railways, CRISIL Consulting

Freight earnings accounted for ~78% of total earnings of Indian Railways as on fiscal 2022. Passenger earnings show steady CAGR of 5%, whereas freight earnings indicate CAGR growth of 3% during the seven years from FY 2013-14 to FY 2019-20. However, in fiscal 2021, due to impact of covid-19, revenue was significantly impacted especially in the passenger segment with ~70% decline in the fiscal 2021. Goods revenue largely remained stable in fiscal 2021. After partial recovery in fiscal 2022, revenue grew at ~157% in fiscal 2022 albeit on the low base for passenger segment; Goods segment registered growth of ~20% in fiscal 2022.

Table 85: Growth in passenger and goods earnings

	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22
Goods earnings (y-o-y growth)	12.6%	3.7%	-4.6%	11.3%	8.0%	-9.1%	3.8%	20.3%
Passenger earnings (y-o-y growth)	15.5%	5.0%	4.5%	5.1%	5.0%	-0.8%	-69.9%	157.2%

Source: Annual Reports, Indian Railways, CRISIL Consulting

6.2 Developments and investments in the sector

6.2.1 Share of various infrastructure segments in total construction spend

The total construction spends in the infrastructure segment over fiscals 2018 to 2022 was Rs 23.4 trillion. Of this, the roads sector accounted for ~Rs 11.7 trillion, while railways contributed to Rs. 3.3 trillion

Table 86: Railways and roads dominated by public funds; to lead growth in infrastructure

	Sector	FY18-FY22 CAGR	FY22 Rs trillion	FY23 Rs trillion	FY24P Y-o-Y Growth	FY23-27P/FY18-22E	Source of funds (FY23E)
	Roads	13%	2.7-2.8	**3.1-3.3**	**20-25%**	1.9	Centre State Private 62% 27% 11%
	Power	5%	0.2-0.3	**0.3-0.4**	**10-12%**	1.5	25% 31% 44%
	Railways	17%	0.8-0.9	**1.1-1.2**	**12-14%**	2.1	84% 16%
	Urban infra	17%	0.8-0.9	**1.0-1.1**	**31-33%**	2.4	41% 55% 5%
	Irrigation	2%	0.7-0.8	**0.8-0.9**	**7-9%**	1.5	9% 91%
	Other infra	5%	0.2-0.3	**0.2-0.3**	**14-16%**	1.6	
	Infrastructure	**12%**	**5.7-5.9**	**6.9-7.1**	**18-20%**	**1.9**	

Source: CRISIL Consulting

The investments in railways have grown at ~17% CAGR from fiscal 2018 to fiscal 2022 and going froward in the period fiscal 2023-2027 investments are expected to be 2.1 times the investments in fiscal 2018 to fiscal 2022 period primarily driven by central government sponsored schemes.

6.2.2 Construction spends in railways to record double growth in next five years

CRISIL expects a 12-14% rise in investments in railways in fiscal 2024 led by rise in budget allocation for railways, implementation of high value projects such as the Mumbai-Ahmedabad Bullet train, gaining traction in station redevelopment and completion of the freight corridor. The rise is post the expected rise of 32-34% rise in investments in Railways in fiscal 2023 owing to government focus on completion of DFC projects, traction in high-speed rail, investment in newer avenues such as Vande bharat trains and rising focus on station redevelopment program. A construction capex of Rs 6.8-7.2 trillion is seen over the next 5 years compared to 3.1-3.3 trillion over the past 5 years led by investments in network decongestion, dedicated freight corridors and high-speed trains.

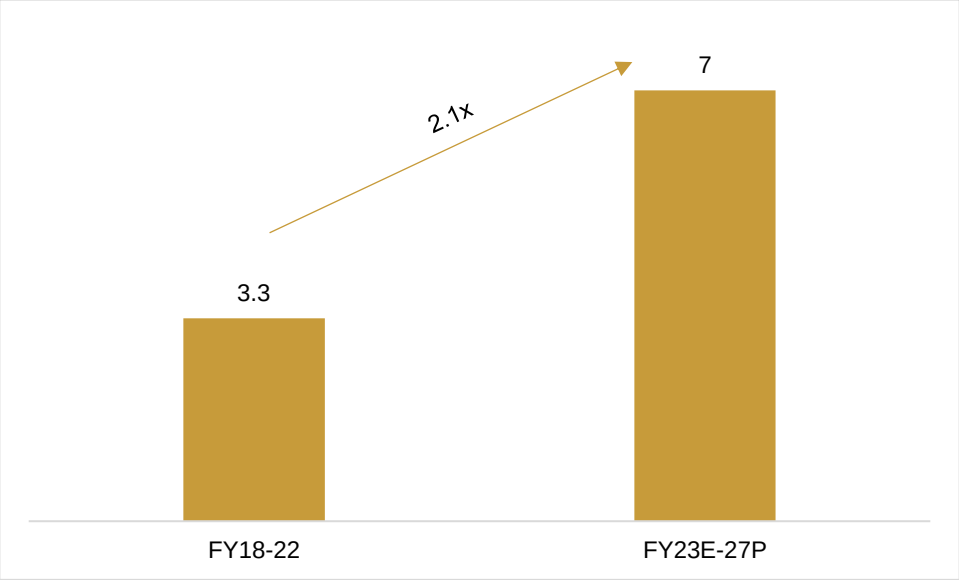
The central government announced a capital outlay of Rs 2.4 trillion for the Indian Railways in the Union Budget 2024 which is 50% higher than the preceding year's revised estimate of Rs 1.6 trillion. The optimistic rise is due to planned investments in manufacture of 400 new generation Vande Bharat trains and development of 100 PM GatiShakti cargo terminals for multimodal logistics during the next three years. The 14% rise is lower than the 17% CAGR in investments over the preceding 5 years (FY18-22E) and based on historical achievement ratio, CRISIL is expecting a 12-14% rise in FY24 with a downward positive revision possible. More than half of the planned outlay is expected to be financed through budgetary support, and the remaining through internal sources and market borrowings/institutional finance

Spend over next five years hinges on the possibility to attract private participation, however efforts remain futile.

With construction investments over FY23-27P expected almost doubling over the preceding five years, raising funds through external agencies, IEBR and via PPP would be a key monitorable. The railways had initiated the station redevelopment program and the new cargo policy from 15th December 2021 which should aid the ministry in garnering funds for deployment in its core functions of network decongestion/doubling and electrification.

CRISIL expects construction expenditure in railway projects to double between fiscals 2023 and 2027 compared with the preceding five years, fiscals 2018 to 2022.

Figure 126: Construction spend in the railway sector (Rs trillion)

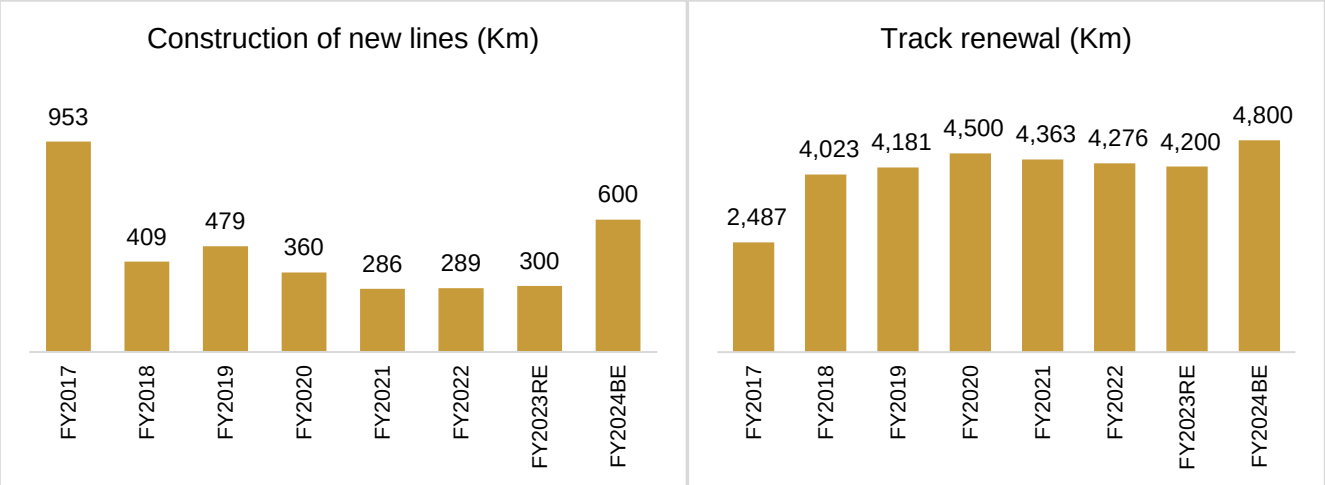


Source: CRISIL Consulting

6.2.3 Railway network saw an average of 497 km/year of new line construction and 3,548 km/year of track renewal from fiscal 2014 to fiscal 2022

Tracks are the basic infrastructure of a railway system and bear the burden of coping with ever-increasing traffic. High-speed and heavy axle load operations on Indian railways have led to the need to upgrade the track structure. Several policy initiatives have been taken to modernize the tracks. Construction of new lines and track renewal is a continuous process of strengthening the enormous network and maintaining efficiency. Construction of new lines picked up pace after fiscals 2016 and 2017 due to infrastructure push by the newly formed BJP government with 953 km of new tracks added to the rail network in fiscal 2017, however in the past three years the pace of construction of new lines have moderated with 286 and 289 km being constructed in fiscal 2021 and fiscal 2022 respectively.

Figure 127: Overview of construction and renewal of railway network over the years



Source: Annual Reports, Indian Railways, CRISIL Consulting

Table 87: Asset acquisition, construction and replacement for FY23 and FY24

Programmes	Rs million for FY23RE	Rs million for FY24BE
New line construction	249,140	318,500
Doubling	240,926	307,494
Rolling stock	151,578	375,810
Gauge conversion	32,200	46,000
Level crossing development/Upgradation	7,500	7,500
ROB/RUB	60,000	74,000
Bridge work	12,150	12,550
Signalling/Telecom	24,283	41,982
Track renewal	153,880	172,968
Total	**931,657**	**1,356,804**

Note: RE-Revised Estimate, BE-Budget Estimate
Source: Pink Book, Indian Railways, CRISIL Consulting

Electrification: Railways get power to chug on

Indian Railways has been slowly, but steadily, electrifying its routes, as the benefits of electrification of railway lines are far greater than running with diesel engines. Most importantly, in India, the cost of electrification is cheaper than running trains with diesel.

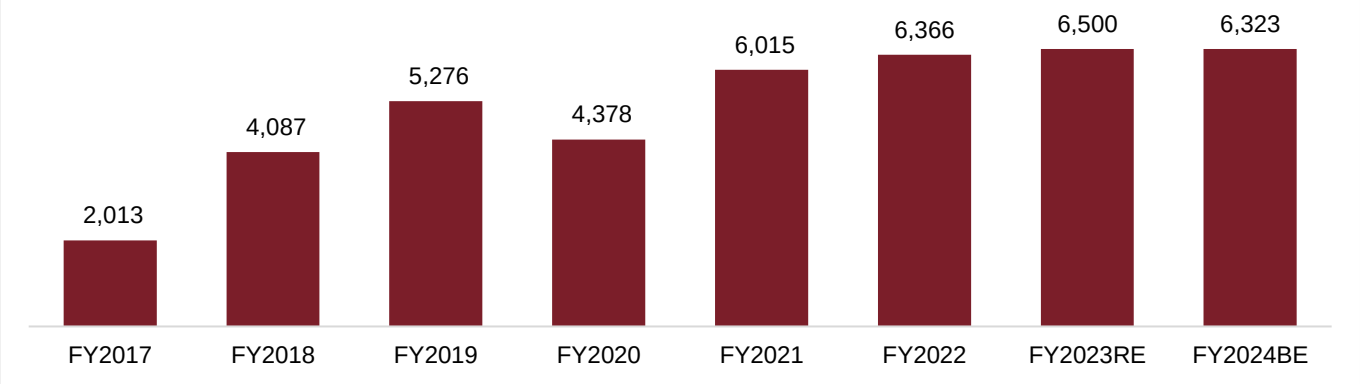
The focus on electrification is mainly because of the cost benefits compared with diesel

- Marginally capital intensive but lowers line haul cost compared with diesel traction
  - Cost of hauling goods by electric engine is nearly half of that by diesel engine
  - Every 100 km of electrified section results in saving of annual consumption of more than four million litres of diesel

  - In the US, the focus is still on diesel locomotives as dieselisation is cheaper than electrification. In India, the cost of diesel, including taxes, is 50% higher than the cost to US railways, so electrification works out to be cheaper.

- Electric multiple units (EMUs) are ideal for suburban services with higher acceleration and braking features required for frequent starts and stops; Mainline EMUs (MEMUs) will be increasingly used for inter-city travel or as feeder trains to mainline trains for higher reliability and on-time runs
- Higher speeds and improved throughput - Electrification frees up 12-19% of additional line capacity owing to faster speeds. Hence, to release the line capacity in dense rail corridors, investment in electrification is justified
- Leads to lower carbon footprint
- Enables haulages of heavier freight and longer passenger trains at higher speeds
- Higher payload-to-tare ratio
- Integration of non-electrified routes with electrified ones for seamless movement

Figure 128: Electrification (km)



Source: Annual Reports, Indian Railways, CRISIL Consulting

As on August, 2023, ~59,524 km i.e. ~92% of the total broad-gauge network has been electrified, whereas the goal is to achieve 100% by 2024

Growth in demand for railway infrastructure

Increasing urbanization and rising income (both urban and rural) are driving growth in the passenger segment. India is projected to account for 40% of the total global share of rail activity by 2050.

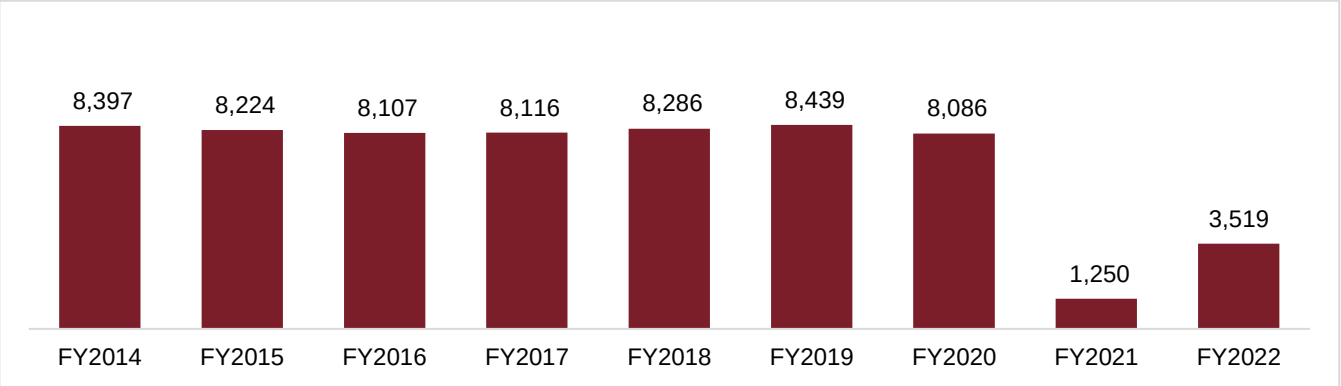
Advantage India:

1. Growing Demand: Increasing urbanization & rising income (both urban & rural) is driving growth in the passenger segment. India is projected to account for 40% of the total global share of rail activity by 2050.

2. Attractive opportunity: Indian Railways is developing & creating technology in areas such as signaling & telecommunication with 3,549 route kms converted to automatic signaling and 1,445 route kms fitted with KAVACH which is a domestically developed Train Collision Avoidance System.

3. Higher Investments: FDI inflows in railway-related components stood at US$1.23 billion from April 2000 to March 2023. Railway infra investment is expected to increase from US$58.96 billion in 2013-17RE to US$124.13 billion by 2018-22E.

Figure 129: Passenger originating/Boarding (million)



Source: Annual Reports, Indian Railways, CRISIL Consulting

Freight and commodity traffic—important sources of revenue for railways

Freight traffic is a major source of revenue for the Indian Railways. While just one-third of the 13,000 trains running daily are freight trains, they account for ~70% of the total revenue. Railway freight traffic is vital for economic and industrial progress of the country. Coal is the most transported commodity across the network.

Raw materials have to be transported from producing centers to factories and finished/semi-finished products have to be moved from factories to consumption areas or ports for exports. Example: Coal reserves from Bengal and Bihar have to be transported to thermal and steel plants all over the country.

Table 88: Commodity share

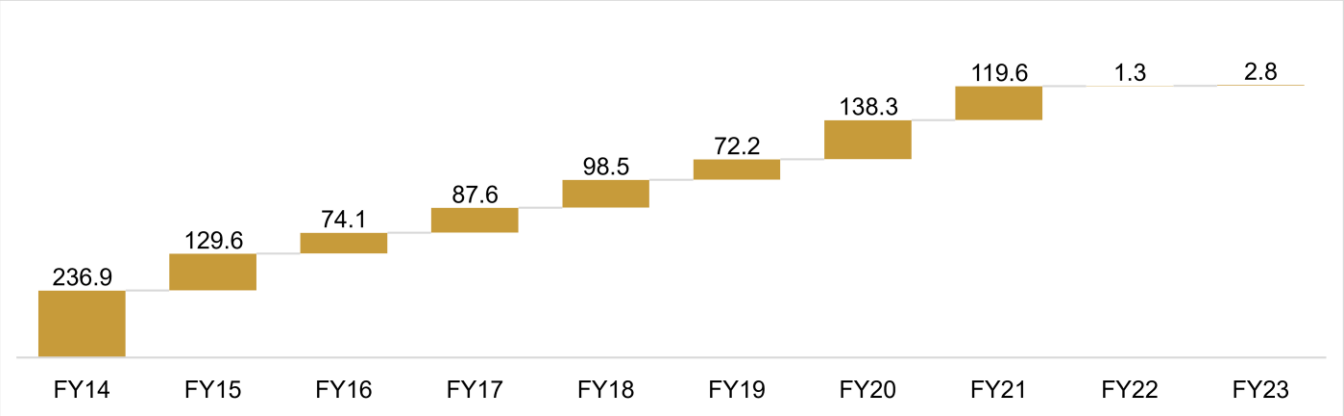
S.no	Commodity	FY19		FY20		FY21		FY22	
		Million tonnes	%	Million tonnes	%	Million tonnes	%	Million tonnes	%
1.	Coal	605.84	50.8%	586.87	48.6%	541.82	44.0%	652.8	46.1%
2.	Food grains	39.31	3.3%	37.53	3.1%	62.82	5.1%	73.38	5.2%
3.	Iron & steel	53.99	4.5%	53.13	4.4%	60.06	4.9%	68.5	4.8%
4.	Iron ore	137.34	11.5%	153.37	12.7%	159.13	12.9%	168.36	11.9%
5.	Cement	117.34	9.8%	110.1	9.1%	120.4	9.8%	137.19	9.7%
6.	POL (Mineral oil)	43.01	3.6%	44.68	3.7%	42.48	3.5%	44.46	3.1%
7.	Fertilisers	51.83	4.3%	51.39	4.3%	53.79	4.4%	49.18	3.5%
8.	Other commodities	144.95	12.1%	171.34	14.2%	190.44	15.5%	222	15.7%
	Total	**1193.61**	**100%**	**1,208.41**	**100%**	**1,230.94**	**100%**	**1,415.87**	**100%**

Source: Yearbook, Indian Railways, CRISIL Consulting

FDI inflows in railways set to rise

From April 2000 to June 2019, FDI in railways-related components industry stood at $977.24 million. The FDI investment has been used for manufacturing rolling stock such as coaches and wagons including its parts, signaling equipment and locomotives (diesel and electric) and parts of locomotives. The Ministry of Railways has signed a Memorandum of Understanding (MoU) with China, France, Spain, South Korea, Japan, the United Kingdom, Russia and Germany for cooperation in the area of high-speed railways.

Figure 130: FDI Investments in Railways (USD million)



Source: Press Information Bureau, IBEF Nov 2019, Indian Railways, CRISIL Consulting

The FDI investment has been utilized for manufacturing of rolling stock (coaches and wagons including its parts), signaling equipment and locomotives (diesel and electric) & parts of locomotives. Ministry of Railways has signed Memorandum of Understanding (MoU) with China, France, Spain, South Korea, Japan, United Kingdom, Russia and Germany for cooperation in the area of high-speed railways. FDI inflows in railway related components stood at US$1.23 billion from April 2000 to March 2023. Government has allowed 100% FDI in the railway sector.

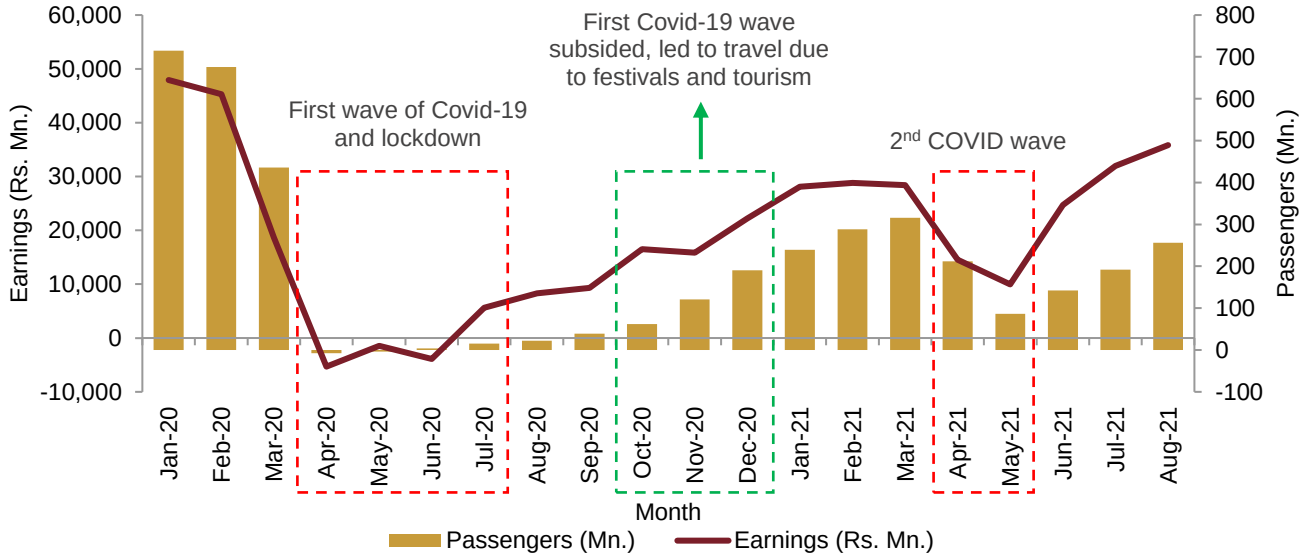
Major foreign collaborators: Alstom Transport India Ltd, Bombardier Transportation India Pvt Ltd, Ansaldo STS Transportation Systems India, Titagarh Wagons Ltd, CAF India Pvt Ltd for rolling stocks etc.

6.2.4 Impact of Covid-19 on railways

The Covid-19 pandemic has had a significant impact on nearly all sectors of the Indian economy. Due to restricted connectivity during the lockdown, supply chain disruptions, exchange and transfer of essential goods and services and distribution of various commodities were all affected. Passenger revenue was severely hit in response to the measures taken in the wake of the pandemic. The government decided to suspend all passenger train services on the Indian Railways, including premium trains, mail or express trains, suburban trains, Kolkata Metro Rail, Konkan Railway, etc. until the situation gets under control.

Goods services continued with trains carrying essential commodities to various parts of the country. While passenger traffic was completely banned, freight traffic was moving. Transportation of essential goods, and operation of railways for cargo movement, relief and evacuation and their related operations, organizations was allowed under the lockdown. Several goods carried by the Railways (coal, iron ore, steel, petroleum products, food grains, fertilizers) were declared as essential goods. The Railways also started operating special parcel trains (to carry essential goods, e-commerce goods, etc.) since the lockdown. These activities helped generate freight revenue for the railways.

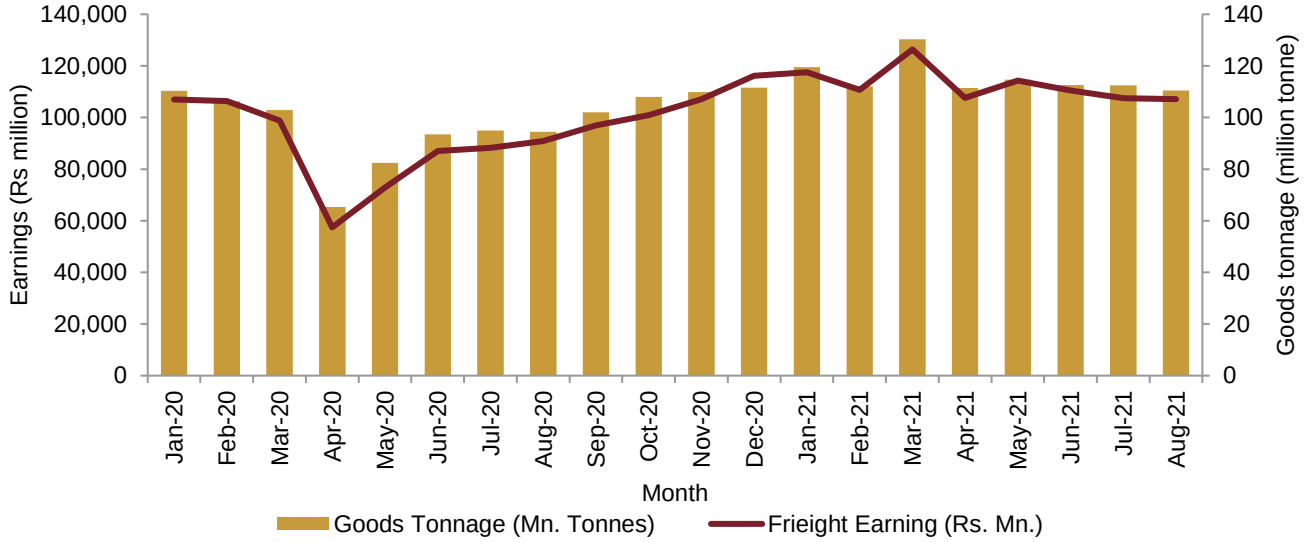
Figure 131: Impact on Passenger nos. and earnings due to Covid-19



Source: Railway monthly reports, CRISIL Consulting

After complete travel restrictions during the first wave of the pandemic, passenger earnings and traffic started gaining pace only in the festive months of October and November 2020 once travel restrictions were lifted as the daily caseload started declining. Passenger earnings and traffic were again affected in April and May 2021 when the second wave of the pandemic struck.

Figure 132: Impact of Freight traffic and earnings due to COVID-19



Source: Railway monthly reports, CRISIL Consulting

Freight earnings were only affected in the initial phase of the pandemic. Earnings returned to pre-Covid levels by the end of October 2021. Freight earnings and traffic were not affected by the second wave of the pandemic.

6.3 Regulatory overview of Indian Railways

6.3.1 Policy initiatives

Iron-ore Policy 2021 (w.e.f. February 10, 2021)

Steel production is critically dependent on transportation of iron and other raw materials. Iron ore is the second-most important stream of traffic for Indian Railways. Iron ore and steel together accounted for nearly 17% (68.5 MT of steel and 168.4 MT of iron ore) of total 1,416 MT freight loading of Indian Railways in fiscal 2022. The new Iron-ore Policy 2021 governing the allocation of rakes and transportation of iron ore, issued by the Ministry of Railways, is expected to have a positive impact on the steel industry, provide powerful impetus to the core sector of the economy, and boost the country's economic growth.

The policy aims to attune it to the present-day needs of customers and meet the complete requirement of transportation of iron ore customers and provide total logistics support to the steel industry to meet the competitive challenges.

Policy highlights:

- Existing categorisation based on customer profile into Central Board of Trade (CBT)/non-CBT customers is discontinued (customer refer to the sector or industry)
- Old and new plants will be treated similarly as far as allotment/loading of rakes is concerned
- Priority of movement of iron ore has now been based on the availability of railway infrastructure developed by the customer for loading/unloading, and the nature of movement between various types of sidings with a view to maximising iron-ore movement by rail
- The priority preferences for customers will be self-generated by the system based on customer profile
- Higher priority will be given to movement of iron-ore traffic for domestic manufacturing activity
- Customers are free to choose the priorities or a combination of priorities for moving their traffic as per eligibility and necessity. No permission is required for this
- To differentiate rail-cum-sea traffic from export traffic, the former should be accompanied by a self-declaration

Revised Private Freight Terminal (PFT) Scheme/Policy

The policy seeks to supplement the in-house programme of the Ministry of Railways by opening the area of terminal development with participation of logistics service providers to create world-class logistics facilities. A prospective terminal management company (TMC) will need to apply for setting up a PFT.

Policy objectives:

- Enable rapid development of a network of freight handling terminals with private-sector participation
- Enhance the presence and share of railways in the overall transport chain
- Divert traffic so far predominantly moving by road to rail and attain increased rail freight volumes by offering integrated, efficient and cost-effective logistics and warehousing solutions to users

Development of goods sheds at small/road-side stations through private investment

Indian Railways has been striving to increase its freight business volumes as well as its modal share in freight transport. This policy aims at augmenting terminal capacity through private participation by allowing setting up of new goods sheds and developing existing goods sheds at a larger number of stations.

Highlights:

- The policy would be applicable for setting up of greenfield and brownfield goods sheds as decided by respective zonal railways
- For greenfield, private parties would be permitted to develop loading/unloading facilities and other related infrastructure at goods-sheds

- For brownfield, private parties would be permitted to repair/redevelop and maintain existing facilities and set up additional facilities
- Incentives would be given to private parties in the form of a share in terminal charges and terminal access charges for all inward and outward traffic dealt

FDI Policy

The government has allowed 100% FDI in the railway sector, except for the operations. The inflow of FDI in railway-related components stood at US$1.23 billion from April 2000 to March 2023, with a projected FDI inflow of US$715.41 billion in railway infrastructure by 2030.

Table 89: Areas/activities where FDI is allowed

S.No.	Area/activity	Permitted activity
1.	Suburban corridor projects in PPP	All new suburban corridor projects are permissible when launched through the PPP route by the Ministry of Railways. The developer can construct, maintain and operate the corridor within the concession period
2.	High-speed train projects	Construction, maintenance and operation of all new high-speed train projects above 250 kmph, including supply of rolling stock
3.	Dedicated freight lines	Construction, maintenance and operation of freight lines under the non-government railway model
4.	Rolling stock	Construction, maintenance and operation of new locomotive/wagons/coaches/train sets manufacturing facilities can be undertaken by the developer
5.	Railway electrification	Construction, maintenance and operation of power transmission lines and ancillary facilities
6.	Signaling system	Construction, maintenance and operation of new rail signal component manufacturing facility Upgradation of signaling system on Indian Railways' network
7.	Freight terminal/logistic park	Construction/upgradation, maintenance and operation of non-Indian Railways-owned freight terminals
8.	Passenger terminal	Construction/redevelopment, management and maintenance of passenger terminals
9.	Railway technical training institutes	Investments in construction, maintenance and operation of any training/education facility
10.	Rolling stock procurement	Purchase/leasing for use on Indian Railways' network/private line
11.	Bio-toilets	Installation and maintenance of bio-toilets in passenger coaches
12.	Technological solutions to improve safety and reduce accidents	Installation and maintenance of asset failure detection systems

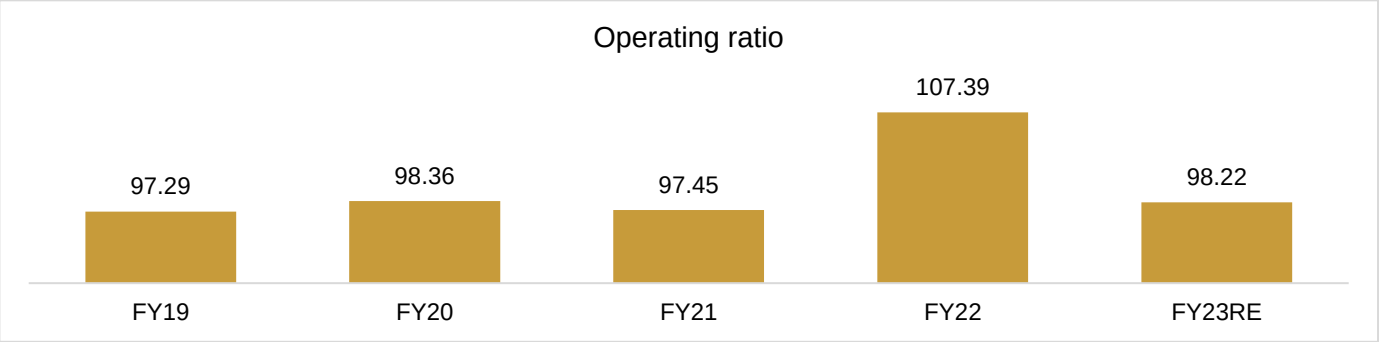
Source: Annual Reports, Indian Railways, CRISIL Consulting

6.3.2 Rail Budget 2023

The total Capital Outlay for the Ministry of Railways for the year 2023-24 has been kept at Rs. 2602 billion including Rs. 100 billion as Gross Budgetary Resource contribution for RRSK, Rs. 2 billion for Nirbhaya Fund and Rs. 10 billion from the contribution by IR from their Internal Resources. A Capital outlay of Rs. 2.40 trillion has been

provided for the Railways in the General Budget 2023-24. This highest-ever outlay is about 9 times the outlay made for the Railways in 2013-14.

Figure 133: Operating Ratio (%) of IR



Note: RE-Revised Estimate,
Source: Budget Documents, CRISIL Consulting

Indian Railways' operating ratio (OR) declined slightly to 97.45 in fiscal 2021 from 98.36 in fiscal 2020. The OR for fiscal 2022 deteriorated as it climbed to 107.39. The operating ratio is pegged at ~98.22 in fiscal 2023.

Budgetary support and targets

The total Capital Outlay for the Ministry of Railways for the year 2023-24 has been kept at Rs. 2,602 billion. The share of GBS, internal resources (IRs) and extra-budgetary resources (EBRs) in actual expenditure for fiscal 2021, budget estimates for fiscal 2022, revised estimates for fiscal 2023 and budget estimates for fiscal 2024 are shown in the table below.

Table 90: Overview of capital outlay for Ministry of Railways

Particulars	FY21	FY22	RE FY23	BE FY24
GBS (Rs billion)	29923.0	1175.1	1593.0	2402.0
Percentage of total capex	46.6%	61.8%	64.9%	92.3%
IRs (Rs billion)	20.6	16.5	43.0	30.0
Percentage of total capex	0.9%	0.9%	1.8%	3.0%
EBRs (Rs billion)	1232.0	710.7	817.0	170.0
Percentage of total capex	52.5%	37.4%	33.3%	0.1%
Total capex (Rs billion)	**1551.8**	**1902.7**	**2453.0**	**2602.0**

Note: RE-Revised Estimate, BE-Budget Estimate
Source: Budget Documents, CRISIL Consulting

The annual plan outlay of Rs 2,602 billion for fiscal 2024 comprises GBS of Rs 2,401 billion, IRs of Rs 30 billion and EBRs of Rs 170 billion (consisting of market borrowings, PPP, FDI, etc.)

Table 91: Item wise break-up of capital outlay

Rs billion

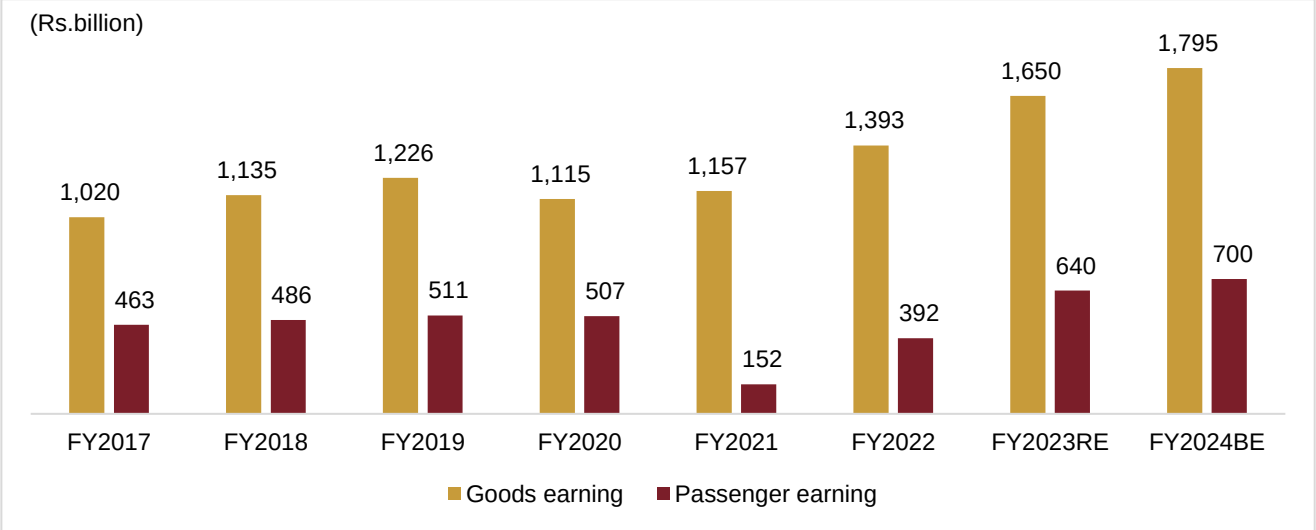
S.No.	Sources of funds	FY22	FY23RE	FY24BE
1	Capital from general exchequer	817	1,143	1,852
2	RRSK (Rashtriya Rail Sanraksha Kosh	247	100	100
3	Railway safety funds	111	350	450
4	**GBS (1+2+3)**	1,175	1,593	2,402
5	Capital funds	-	13	-

S.No.	Sources of funds	FY22	FY23RE	FY24BE
6	Depreciation reserve fund	7	10	10
7	Development fund	10	10	10
8	RRSK from revenue	200	-	500
9	**IR (5+6+7+8)**	17	43	30
10	Market borrowing through(bonds)	282	365	-
11	Institutional finance	325	305	-
12	Funding through EBR(P)	104	147	170
	Total	**1,903**	**2,453**	**2,602**

Note: RE-Revised Estimate, BE-Budget Estimate
Source: Budget Documents, CRISIL Consulting

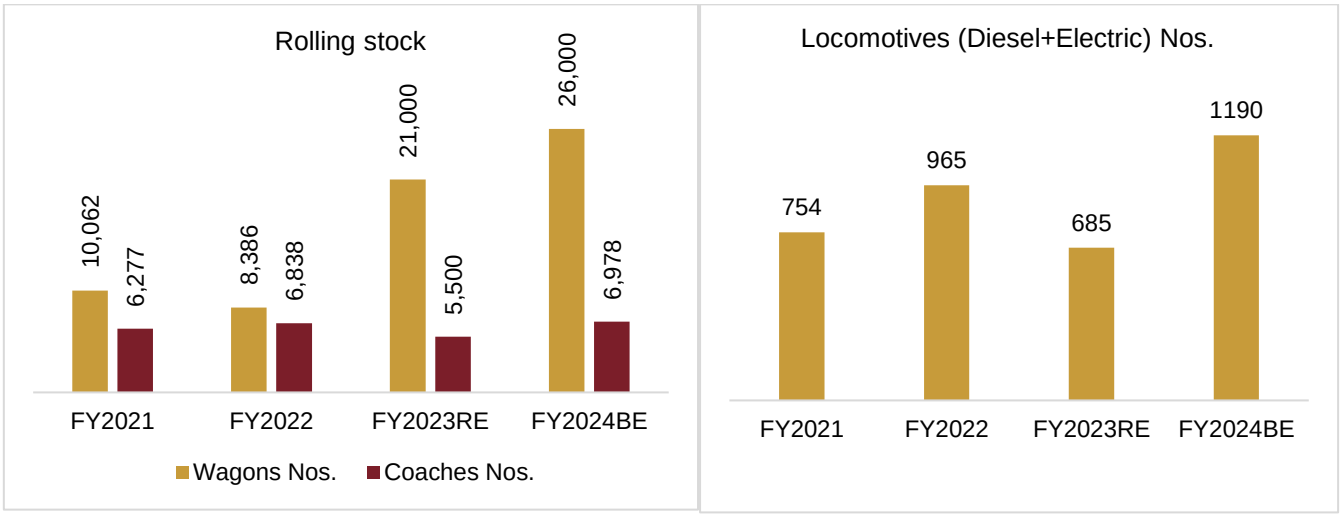
Earnings and infrastructure targets

Figure 134: Passenger and freight earnings targets



Note: RE-Revised Estimate, BE-Budget Estimate
Source: Budget Documents, CRISIL Consulting

Figure 135: Infrastructure targets



Note: RE-Revised Estimate, BE-Budget Estimate
Source: Budget Documents, CRISIL Consulting

6.3.3 National Rail Plan

Indian Railways has prepared a National Rail Plan (NRP) for India – 2030. The plan is to create a 'future-ready' railway system by 2030. The NRP is aimed at formulating strategies based on both operational capacities and commercial policy initiatives to increase modal share of railways in freight. The objective of the plan is to create capacity ahead of demand, which in turn would also cater to future growth in demand, right up to 2050; and increase the modal share of railways to 45% in freight traffic and sustain it.

As part of the NRP, **Vision 2024** has been launched for accelerated implementation of certain critical projects by 2024, such as 100% electrification, multi-tracking of congested routes, raising of speed to 160 kmph on Delhi-Howrah and Delhi-Mumbai routes, raising of speed to 130 kmph on all other Golden Quadrilateral-Golden Diagonal (GQ/GD) routes, and elimination of all level crossings.

NRP objectives:

- Formulate strategies based on both operational capacities and commercial policy initiatives to increase modal share of railways in freight to 45%
- Reduce transit time of freight substantially by increasing average speed
- Identify new dedicated freight and new high-speed rail corridors
- Assess rolling stock requirement for passenger traffic, as well as wagon requirement for freight
- Assess locomotive requirement to meet twin objectives of 100% electrification
- Sustained involvement of the private sector in operations and ownership of rolling stock, development of freight and passenger terminals, development/operations of track infrastructure, etc.

6.3.4 Rail corridors

High-speed rail corridors

The Railways is undertaking measures for improving speed of both passenger and freight trains. Improvement in average speed of trains is a continuous exercise for Railways. To recall, the ministry had set up a dedicated subsidiary — High Speed Rail Corporation of India Ltd (HSRCIL) — under Rail Vikas Nigam Ltd in 2012 to implement HSR projects.

HSRCIL has identified five corridors for HSR projects

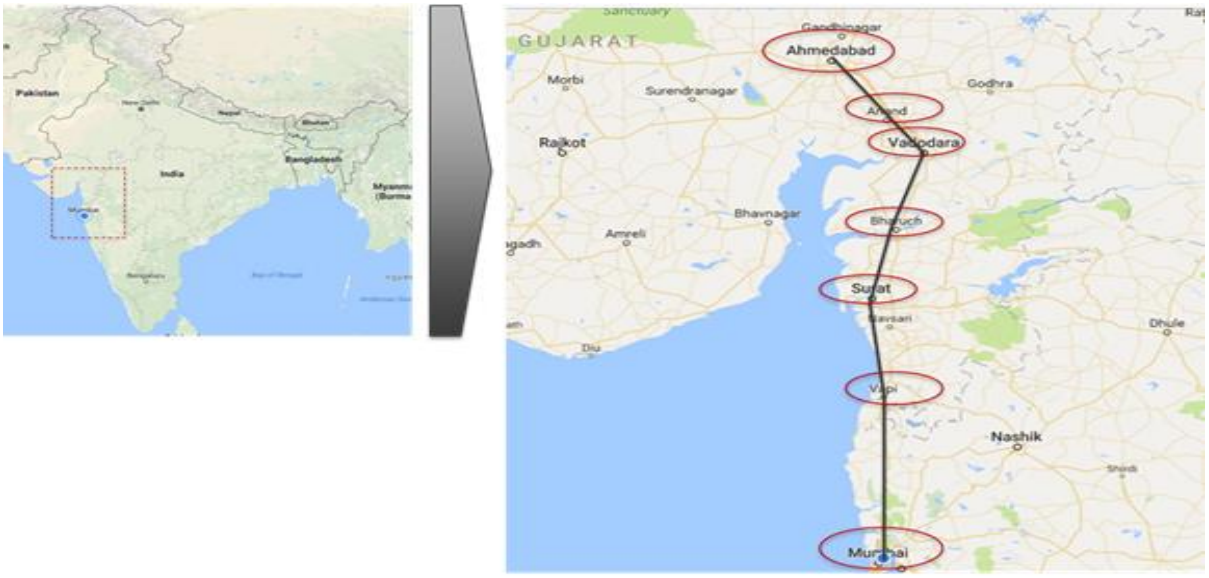
- Delhi-Chandigarh- Amritsar
- Delhi-Chennai
- Chennai-Bengaluru- Mysuru
- Mumbai-Ahmedabad
- Golden Quadrilateral
  - Package 1- Delhi Mumbai
  - Package II- Mumbai- Chennai
  - Package III- Delhi Kolkata

Source: High Speed Rail Corporation of India Ltd

Mumbai-Ahmedabad project the first to be taken up

At present, the Mumbai-Ahmedabad High Speed Rail (MAHSR) Project is the only sanctioned High Speed Rail project in the country which is being implemented with technical and financial assistance from Government of Japan. A total of 12 stations have been planned on the route — Mumbai, Thane, Virar, Boisar, Vapi, Bilimora, Surat, Bharuch, Vadodara, Anand, Ahmedabad and Sabarmati.

Figure 136: Representation of Mumbai – Ahmedabad project



Source: CRISIL Consulting

The Ministry of Railways has constituted a special-purpose vehicle — National High Speed Rail Corporation Ltd — to implement the Mumbai-Ahmedabad bullet train project. The project will be in collaboration with Japan and based on Japan's Shinkansen network.

The Japan International Cooperation Agency (JICA) carried out the feasibility study and submitted the final report to the ministry in July 2015. The project is targeted for commissioning in 2023-24.

Table 92: Overview of Mumbai – Ahmedabad project

Project Features	
Total Length	506 km
Average inter station distance	46 Km
Expected time to complete	10 years
Operating speed	320-350 kmph
Journey Time	
Limited stops	120 min
Stopping train	180 min

Source: CRISIL Consulting, Industry

The standards adopted for the HSR project are as follows:

- Standard gauge
- EMU type rolling stock, with maximum axle load of 17 tonne
- Combination of ballast-less and ballasted tracks
- Compound catenary system of overhead equipment
- 2 x 25 kV power feeding system

- Digital automatic train control system
- Cab signalling system
- Corridor length: 508 km

The ministry expects around 186,000 users both ways by 2053. Revenue will largely come from tariffs (near airfare) and economic activities at the stations (negligible land monetization).

Table 93: Debt from JICA tied up, but states may have to chip in with equity

Project Cost & funding	
Project Cost	**Rs. billion**
Total Project Cost	1,080
JICA Loan	875
Equity Financing (IR)	205
Interest Rate	0.10%

Source: Industry, CRISIL Consulting

The negotiated terms of the Rs 875 billion loan from JICA are:

- Rate of interest of 0.1% per annum
- Tenure of 50 years, with a grace period of 15 years

The loan's hedging cost is expected to be 4-5%.

Semi-high-speed corridors have seen some movement

Railways has also taken up a programme of running of semi high speed trains (160 kmph+ - 200kmph) in a big way. It has already started running such a train with the name Gatimaan Express between Hazrat Nizammuddin to Agra Cantt Station w.e.f. 05.04.2016 with a maximum speed of 160 kmph. In addition to this Delhi –Agra semi high-speed corridor, Indian Railways have also identified eight more corridors for feasibility of semi high speed rail, Zone wise details are as under:

Table 94:Semi-High-speed corridor -Indian Railways

Corridor	Zonal Railways
Delhi-Chandigarh	Northern
Chennai-Bengaluru-Mysore	Southern, Southwestern
Delhi-Kanpur	Northern, North Central
Nagpur-Bilaspur	Southeast Central
Mumbai-Goa	Central, Southwestern, Konkan Railway
Mumbai-Ahmedabad	Western
Chennai- Hyderabad	Southern, South Central
Nagpur - Secunderabad	Central, South Central

Source: CRISIL Consulting

Other measures to improve passenger convenience

- **Induction of semi-high speed Vande Bharat trains**

Semi High-Speed Self-Propelled trains have been manufactured by Integral Coach Factory/Chennai with indigenous efforts and turned out as Vande Bharat Express. As of September 2023, 34 (~50 services) Vande

Bharat trains are presently running in service over Indian Railways. Two Vande Bharat trains are running between New Delhi – Varanasi & New Delhi- Shri Mata Vaishno Devi Katra since 2019.Three new and improved version of Vande Bharat trains with enhanced safety features and passenger amenities have been introduced recently between Mumbai Central- Gandhi Nagar Capital, New Delhi-Amb Andaura & Chennai-Mysore, Nagpur- Bilaspur. Apart from this across the country, Vande Bharat trains have been introduced for improving the railway infrastructure in the country.

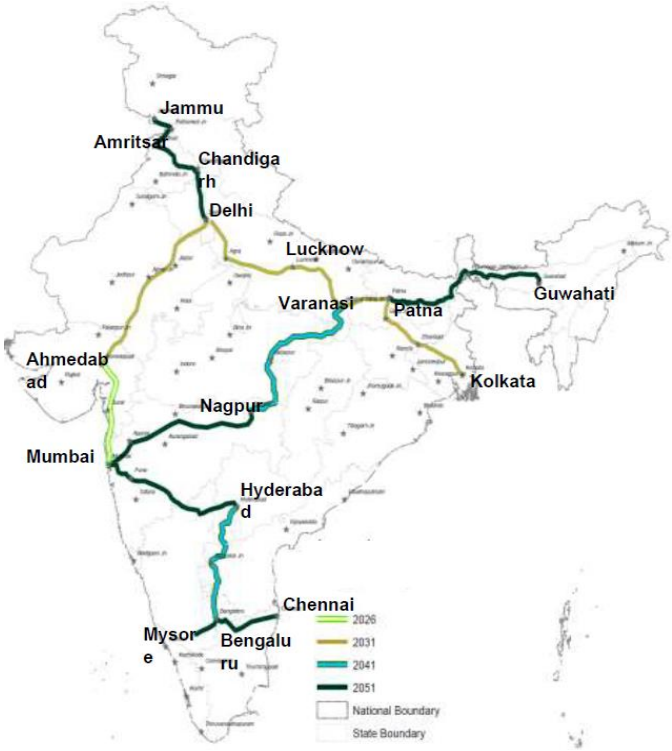
Indian railway in 2022 had issued tender for manufacturing and maintenance of ~100 Vande Bharat train sets which was awarded to French company Alstom. Indian railways have issued fresh tender for 100 nos of New Generation Energy Efficient Vande Bharat Trainsets with Concentrated Power System including upgradation of the Government Manufacturing Units and Trainset Depots. In February 2023, French railway major Alstom and the Medha-Stadler consortium, comprising Swiss railway rolling stock manufacturer Stadler Rail and Hyderabad-based Media Servo Drives, have submitted bids to manufacture and maintain 100 aluminum Vande Bharat trains.

Indian railways have also envisaged manufacturing of Vande Bharat Sleeper Trains planned for middle- and long-distance strains journey with a maximum speed of 200 kmph. The new version aims to replace Rajdhani Express trains and reduce travel time.

Introduction of Tejas Rajdhani trains

Ultra-modern Tejas trains have been introduced on LHB platform with sleeper coaches over Indian Railways. These ultra-modern trains have following major distinguished features: Automatic entrance doors, Passenger Announcement / Passenger Information System, Fire and Smoke detection system, CCTV cameras, Improved lavatory - vacuum assisted flushing with bio-toilets, etc.

Figure 137: High Speed Rail Corridors



Source: National Rail Plan, CRISIL Consulting

Some of the other measures to increase speed of trains that are under consideration or under execution are:

- A proposal to acquire modern electrical EMU train sets
- Removing speed restrictions

- Constructing roads over and under bridges
- Right powering of passenger trains sets
- Introducing twin-pipe brake systems in wagons
- Replacing conventional loco-hauled commuter trains by main line electric multiple unit (MEMU) and diesel electric multiple unit trains

6.3.5 Dedicated Freight Corridors (DFCs)

As a part of the Indian Railways' plan to boost its freight-carrying capacity and regain some of its lost modal share, several DFCs have been planned along the most congested routes (the Golden Quadrilateral). The eastern and the western DFCs are being implemented first.

Constructed exclusively for movement of goods train, the first phase of the dedicated freight corridor (DFC) project includes the Western DFC, running from Mumbai to Dadri, near Delhi, and the Eastern DFC, running from Dankuni in West Bengal to Ludhiana in Punjab. The western corridor will cater mainly to containers as 60% of container traffic originates from this region. The eastern corridor will cater primarily to dry bulk cargo. In fact, though this network accounts for only 20% of the tracks across the country, 55% of the traffic moves on it.

DFCs are intended to help the IR regain lost freight share. By cutting the turnaround time between the importing and consuming destinations, they are expected to compel several industries to realign their logistics strategies. The DFCs and associated logistics parks can help lower plant-level inventory to a great extent, ensuring huge savings in working capital. Sectors such as cold chain and transportation of perishables and express distribution may be encouraged to choose rail for freight due to the expected efficiencies of DFCs. Due to DFC, the wagon availability is expected to increase along with decrease in haulage time. Not only would DFCs ensure faster freight movement but also help the overall economy through decongestion of major highways due to the partial shifting of some freight to rail. It will also allow for faster evacuation of cargo from ports, improving efficiency. However, to maintain the rail share in tonnage in the long term, additional capacity needs to be added.

Table 95:The status of DFCs as of July 2023

Section/Package	Length	Commissioning	Remarks	Financial Progress
WDFC				
Dadri - Rewari	127	Commissioned	Dadri-Rewari (127 Km) section is commissioned.	87%
Rewari - Madar	306	Commissioned	Hon'ble Prime Minister Sh. Narendra Modi inaugurated Rewari - Madar section (306 Km) of WDFC on 07.01.2021.	
Madar - Palanpur	353	Commissioned	Hon'ble Prime Minister Sh. Narendra Modi inaugurated Madar-Palanpur (353 Km) of WDFC on 18.06.2022.	
Palanpur - Makarpura	290	31-Dec-23	New Palanpur- New Sanand (152 Km) section is Commissioned. Hon'ble Prime Minister Sh. Narendra Modi inaugurated New Palanpur-New Mahesana (75 Km) of WDFC on 30.09.2022	
Makarpura - Sachin	135	31-Dec-23		
Sachin - Vaitarna	186	31-Dec-23	Bhestan-Sanjan (108 Km) section is commissioned.	
Vaitarna - JNPT	109	30-Mar-24		
EDFC				
Sahnewal - Pilkhani	179	31-Aug-23	Sahnewal-Shambhu (80 Km) section is commissioned.	92%
Pilkhani - Khurja	222	31-Aug-23	Khurja-Khatauli (134 Km) section is commissioned.	
Khurja - Dadri	46	Commissioned	Khurja-Dadri (46 Km) section is commissioned.	

Section/Package	Length	Commissioning	Remarks	Financial Progress
Khurja - Bhaupur	351	Commissioned	Hon'ble Prime Minister Sh. Narendra Modi inaugurated Khurja - Bhaupur (351 Km) section of EDFC on 29.12.2020.	
Bhaupur - DDU	402	Commissioned	New Bhaupur-New DDU (402 Km) section is commissioned.	
DDU - Sonnagar	137	Commissioned	DDU-Sonnagar (137 Km) section is commissioned.	

Source: Dedicated Freight Corridor Corporation of India Ltd (DFCCIL), CRISIL Consulting

For the eastern DFC, general commodities carried include coal, iron, steel, petroleum, food grains and miscellaneous items. A total of 571 trains operated on this section up to January 2021.

For the western DFC, major traffic movement comprised containers (double decker) and cement, for which a total of 93 trains were operated in this section up to January 2021.

Figure 138: DFCs Corridors

Source: National Railway Plan, CRISIL Consulting

6.4 Growth drivers for the sector

6.4.1 Bolstering finances by monetising land and revenue from advertising

- The Ministry of Railways set up the Rail Land Development Authority in January 2007 to push commercial development of vacant railway land and air space. The land could be developed as commercial, retail mall, institutional, hospitality or entertainment spaces.

- Indian Railways is also planning to monetise land along the tracks through various ways. Some of the options being explored include using the land for generation of solar energy, planting trees and making horticulture gardens.

6.4.2 Fast-tracking of approvals

- As per the existing procedure in the railways for sanctioning a project, proposals for various projects received from zonal railways are examined internally by the Railway Board. Of these, the firmed-up proposals are sent for an 'in-principle' approval to the National Institution for Transforming India (NITI) Aayog. Projects costing less than Rs 5 billion are approved by the Minister of Railways and those above that are reviewed by both NITI Aayog and the expanded railway board and approved by the Cabinet Committee on Economic Affairs.
- After obtaining requisite approvals, projects are included in the budget. Thereafter, Indian Railways carries out a final location survey and prepares detailed estimates. Generally, tenders are floated after the sanction of detailed estimates. This entire process between the initiation of the proposal and the final award of tender is now 9-12 months in general, compared with 2-2.5 years earlier.

6.4.3 Running of private trains to see investments in locomotives and coaches; no construction investments seen

The ministry of railways has held pre-bid meetings and invited RFQ's from interested parties for operating private train on pre-decided routes. An investment of Rs 300 billion is envisaged with all of it going to locomotives and coaches and none of it flowing into construction expenditure. The proposal for running private trains on Government railway tracks despite calling for bids from interested parties saw muted demand, which led to the Railways scrapping the process and calling for a revised model to be drawn up.

6.4.4 PPP in railways

The Indian railways has envisaged a station redevelopment opportunity of ~ Rs 1 lakh crore with commercial development accounting for ~70% of the development. 400 stations have been identified by the railways and the first station, Habibganj, has completed construction.

The station redevelopment scheme was expected to be implemented under the PPP program, however, with disbandment of the Indian railway station development corporation (IRSDC) with the stations reverting under the zonal railways, station redevelopment is being explored under the HAM (Hybrid annuity model) where the Railways contribute 40% with the private entity bringing in the balance.

A lot of focus is being made on the station redevelopment programme with around 36 new projects worth Rs 13000 crore being awarded and 14 under tendering stage.

6.5 Outlook on railway sector growth

6.5.1 Strengthening supply-side infrastructure

To cater to this demand, the Indian Railways has to strengthen infrastructure for tracks, rolling stocks, electrification, and identification of new corridors.

The immediate vision of the Indian Railways for fiscal 2030 is divided into two parts *(*i.e., Target & Funds requirement for fiscals 2020-24 for the projects targeted to be commissioned by fiscal 2024 and Target & Funds requirement during fiscals 2020-24 for the projects planned to be commissioned during fiscals 2025-30*).*

Railway lines

For the projects targeted to be completed by fiscal 2024

Table 96: Target & Funds requirement for projects to be completed in fiscal 2024

Plan head	FY23	FY24	Total funds required
	Target km	Target km	Rs million
New lines	300	600	578,641
Gauge conversion	500	150	84,700
Doubling	1,700	2,800	732,755

Source: Vision 2024 document, Indian Railways, CRISIL Consulting

Electrification

As on August, 2023, ~59,524 km i.e. ~92% of the total broad-gauge network has been electrified. The table below shows the work in progress and balance kilometers planned for completion progressively as per the planning given below:

Table 97: Current status and target for electrification

Year	Target of electrification for the year (RKM)	Total route km electrified at the end of the year (RKM)	% Electrification
FY21	6,000	44,802	69.3%
FY22	6,000	50,394	77.9%
FY23	6,500	58,366	90.2%
FY24*	6,323	64,689	100.0%

*Note: RKM- Route kilometres *Target*

Source: Budget documents, Press Information Bureau(PIB),CRISIL Consulting

Rolling stock requirement

Table 98: Overview of rolling stock requirement

Year	Locomotives numbers	Freight wagon numbers	Passenger coaches numbers
FY26	16,799	407,769	60,741
FY31	20,739	545,225	72,115
FY41	31,581	779,071	106,427
FY51	46,017	10,68,130	152,509

Source: Budget documents, CRISIL Consulting

Railway corridors

Table 99: DFCs

Phasing	2026	2031	2041	2051
New DFC corridors	Eastern DFC, 1,324 Km (Under Construction till Sonnagar)	East Coast DFC, 1,265 Km (Kharagpur to Vijayawada)	North South DFC, 1,206 Km (Itarsi to Chennai via Nagpur and Vijayawada)	North South DFC, 751 Km (Palwal to Itarsi)
	Western DFC 1,483 Km (Under Construction)	East West DFC, 2,013 Km (Palghar to Dankuni and EDFC Connectors)		
		Eastern DFC, 515 Km (Sonnagar to Dankuni)		

Phasing	2026	2031	2041	2051
Total (Km)	**2,807**	**3,278**	**1,206**	**751**

Source: Budget documents, CRISIL Consulting

Table 100: High-speed rail corridors

Phasing	2026	2031	2041	2051
New DFC corridors	Mumbai Ahmedabad, 508 Km (As per NIP also)	Delhi Varanasi via Ajodhya, 855 Km (As per NIP also, Ajodhya included)	Hyderabad Bangalore, 618 Km (New)	Mumbai Nagpur, 789 Km (As per NIP)
		Varanasi to Patna, 250 kms (New)	Nagpur Varanasi, 855 Km (New	-Mumbai Hyderabad, 709 Km (As per NIP)
		Patna to Kolkata, 530 Km (New)		Patna Guwahati 850 Km (New)
		Delhi Udaipur Ahmedabad 886 Km (As per NIP also)		Delhi Chandigarh Amritsar, 485 Km (As per NIP)
				Amritsar - Pathankot - Jammu, 190 Km (New)
				Chennai to Mysuru via Bangalore, 462 Km (As per NIP)
Total (Km)	**508**	**2,52**	**1,473**	**3,485**

Source: Budget documents, CRISIL Consulting

6.5.2 Overview of signal and telecommunication segment in Indian railways

To enhance safety in train operations and make it efficient, Modern Signaling Systems comprising of Panel Interlocking/Route Relay interlocking /Electronic Interlocking (PI/RRI/EI) with Multi Aspect Colour Light Signals (MACLS) are being installed by Indian Railways. So far till 30th June 2023, 6,443 stations covering about 99% of interlocked Broad Gauge stations on Indian Railways have been provided with such systems, replacing the obsolete Multi Cabin Mechanical Signaling System, thus optimizing operational cost involved in its operation as well as enhancing safety by reducing human intervention. Also, as of 30th June 2023, 3,946 route kilometers have been provided with automatic signaling system.

Table 101: Overview of signalling systems in Indian railways

Particulars	March 2018	March 2019	March 2020	March 2021	March 2022
Panel Interlocking (Stations)	4,130	4,052	3,863	3,747	3,438
Route Relay Interlocking (Stations)	282	228	228	247	226
Electronic Interlocking (Stations)	1,358	1,606	1,927	2,206	2,572
Automatic Signaling (Route Km)	2,901	3,039	3,309	3,447	3,549

Also, for telecommunication, Indian Railways has set up a state of the art, nationwide telecom network for meeting its communication needs. RailTel, a Railways Central Public Sector Enterprise is using surplus capacity of IR Telecom network commercially. As on March 2022, Indian Railways has about 62,652 Route Kilometres of Optical Fibre Cable (OFC) that is carrying Gigabits of traffic. Railways Control Communication which is used for train operation and control is also being transferred to OFC system. This OFC network is also contributing significantly in building National Knowledge Network through RailTel. RailTel also provides RailWire Broadband services

7 Poles and Lighting

7.1 Launch of indigenous innovative products have changed the landscape of lighting industry in India

The lighting industry in India has experienced a period of transition and growth. Its development from the status of an importer of finished products to assembling components and finally to a largely indigenous and self-sufficient producer of lighting systems has been a gradual process, producing today General Service Lamps, Fluorescent Tubes, High Intensity Discharge Lamps, Halogen, Dichroic and Compact Fluorescent Lamps.

The emphasis on the power sector and its phenomenal growth and distribution laid the foundation for the lighting industry in India. In the sixties, serious foreign exchange problem in the country encouraged production of vital lamp components in India. In the nineties, the government liberalization policies saw international players in the lighting field participate actively in the Indian market as well as in exports.

With the ongoing massive rural electrification programme and the emergence of strong middle class, an increment in demand both in quantity and lighting types is likely to occur in the near future with emphasis on energy saving light sources.

Lack of economies of scale coupled with high input costs of raw material and components result in uncompetitive prices impeding export efforts. The trend has however started changing with companies paying attention to improving organizational efficiencies and participating competitively in the international market for lamps as well as components.

There has been an effective widening of the locally produced range of lamps along with advent of electronics in lighting, thereby supplying better, more efficient and cheaper lighting systems with improved aesthetics. The outlook of the industry envisages prospects of growth and development for technologically advanced and cost-effective organizations. Miniaturization, electronic circuitry, newer chemicals, better luminaires are the latest technologies the industry players have adopted to innovate products of larger light output at minimum cost helping energy conservation.

7.2 Applications of outdoor lighting

Road and highways: Road and highways lighting is a functional requirement which provides safety and security to motorists and residents as well as pedestrians, but it helps in creating an identity and image. Fixed lighting of public roadways for both vehicles and pedestrians can create a nighttime environment in which people can see comfortably and can quickly and accurately identify objects on the roadway being travelled. Roadway lighting can improve traffic safety, achieve efficient traffic movement, and promote the general use of the facility during darkness and under a wide variety of weather conditions.

As a supplement to vehicular headlight illumination, fixed lighting can enable the motorist to see details more distinctly, locate them with greater certainty, and react safely to roadway and traffic conditions present on or near the roadway facility. Pedestrians must be able to see with sufficient detail to readily negotiate the pedestrian facility and recognize the presence of other pedestrians, vehicles, and objects in their vicinity. Energy-effective Street lighting design integrates efficient lamp technologies, optimum pole spacing, efficient luminaire distribution and pleasing aesthetics.

Stadiums and sports arena: Lighting of sports arenas is important from the viewpoint of providing adequate light, coverage, angles, illuminance, color, etc. The lighting and lighting arrangement have a bearing on the game played and therefore, the design should be according to the requirement of the particular sport.

Utility areas (Railways, Airports, Docks): Some of the key utility areas where outdoor lighting finds application is waterways, quays, jetties; shipyards including docks, repair and construction sites; railway areas and airport aprons. The lighting of harbors and shipyards has to facilitate safe and efficient navigation, handling of cargo, passenger facilities, etc. The lighting function should provide hindrance free light and light free from direct glare caused by reflected light from the water surface.

In railways, areas covered are those for passengers, freight, yards, servicing, maintenance and repair. Descriptions of the visual tasks to be performed in railway areas as well as data are also given. Airport apron floodlighting is located so as to provide adequate illuminances on all apron service areas, with a minimum of glare to pilots of aircraft in flight and on the ground, airport controllers and personnel on the apron. The aiming arrangement of the floodlights should be done in such a way that an aircraft stand receives light from two or more directions to minimize shadows.

Industrial Areas: Well-designed outdoor lighting systems can make important contributions to the aesthetics, efficiency and safety of the public, and to commercial and industrial outdoor environments. it is necessary to take into account the interests and needs of users and to meet the general requirements of the authorities concerned. The objectives of area lighting are to ensure efficient and safe working conditions for personnel, easy and safe movement of vehicles, ships, railway wagons, aircraft, etc. and pedestrians, security of people and property and a pleasing visual environment, particularly for decorative lighting.

City and urban beautification lighting: Outdoor lighting in city beautification in areas such as parks, gardens and monuments have seen traction in recent years and authorities are investing in outdoor lighting of these areas. Investment in urban decorative lighting thus has both social and economic impact. Earlier, a decorative lighting project was expected to enable recognition of the object. Today modern architects use light as an additional tool for showing the buildings at night in a way that is original and quite often different from the daytime view. Hence, decorative lighting is increasingly planned at the very initial stage of a project. This has enabled the designer to place light sources inside the building or construction to bring out additional effects, unlike earlier when light sources were found only on the outside. This approach reinforces the three-dimensional images of architecture.

7.3 High masts, solar lighting and sports lighting are some of the key segments in the outdoor lighting

High Masts: High-mast lighting towers are vertical, cantilevered structures that are used to illuminate a relatively large area. Although primarily used for highway intersection lighting, they are also utilized in other large areas such as parking lots, sporting venues, or even penitentiaries. High mast luminaires are usually installed on 40ft-100 ft tall mounting poles and approximately four to six luminaries are installed on each pole. These luminaries are mounted on considerable heights to illuminate large areas uniformly. High masts have seen traction in the recent years especially with roads and highways construction gaining pace in the Indian market. Large highways and expressways are the key demand drivers for the high mast lighting in India. With more than 20 expressways planned across the country and with award of approximately ~5000 km of highways every year in the next five fiscals from fiscal 2023 to fiscal 2028, the demand for high masts is expected to be supported by road segment.

Sports lighting: Sports/stadium lighting is emerging as one of the attractive avenues for the lighting companies as there has been a recent demand surge in the segment. The demand can be attributed to evolving sporting scenario in the country in both indoor and outdoor sports. There has been rapid upgradation in the sports infrastructure in the country owing to rising impetus for hosting various sporting events in the country. Also, with general trend of people taking up sports have spurred the overall demand for sports infrastructure across the country.

Solar lighting: The recent surge in the demand of solar panel installation in rooftops and government's focus on renewable energy have led to the rise in demand for solar cells. Moreover, recent technological advancements have significantly boosted the adoption of solar panels. Apart from installations on the rooftops, solar energy is also used in solar lighting especially in the streetlights in rural and urban areas where streetlights are powered through solar energy. To expand the use of efficient streetlights, Street Light National program (SLNP) was launched by the Government in January 2015 to replace conventional streetlights with smart and energy efficient LED streetlights in the municipal sector across the country.

The Ministry of New and Renewable Energy launched Atal Jyoti Yojana (AJAY) on 20.09.2016 with the main objective to provide Solar Street Lighting Systems for public use at different locations for improvement in quality of life, safety and security. Under AJAY Phase-I, the Parliament Constituencies of the states of Assam, Bihar, Jharkhand, Odisha and Uttar Pradesh were covered. Subsequently, Phase -II of AJAY was launched in December 2018. Coverage of AJAY Phase -II included Parliament Constituencies of the states covered in AJAY Phase-I, Hill States/UTs, North-Eastern States, Island UTs and aspirational district not covered in above mentioned States/UTs. The AJAY Phase-II was closed in April 2020. In the AJAY Phase-I, over 135,000 solar streetlights were installed against sanction of around 145,000 lights. Under AJAY Phase-II over 137,000 solar streetlights have been reported installed against sanction of around 150,000 lights.

Table 102: Solar streetlights (SSLs) installed under AJAY Phase-I and Phase-II

Sr.No.	State/UT	AJAY phase-I		AJAY phase-II	
		SSLs installed	No. of Districts covered	SSLs installed	No. of Districts covered
1.	Uttar Pradesh	79,543	56	40,948	51
2.	Bihar	29,923	25	23,822	31
3.	Jharkhand	10,535	10	3,500	4
4.	Odisha	8,733	9	4,498	8
5.	Assam	6,659	7	6,495	10
6.	Manipur	-	-	1,500	1
7.	Tripura	-	-	4,000	2
8.	Himachal Pradesh	-	-	800	2
9.	Uttarakhand	-	-	8,450	8
10.	Jammu & Kashmir	-	-	6,000	4
11.	Tamil Nadu	-	-	2,000	1
12.	Telangana	-	-	500	1
13.	Lakshadweep	-	-	2,000	1
14.	Chhattisgarh	-	-	2,499	3
15.	Gujarat	-	-	3,000	2
16.	Karnataka	-	-	3,000	2
17.	West Bengal	-	-	9,477	5
18.	Punjab	-	-	1,000	1
19.	Rajasthan	-	-	2,262	3

Sr.No.	State/UT	AJAY phase-I		AJAY phase-II	
		SSLs installed	No. of Districts covered	SSLs installed	No. of Districts covered
20.	Andhra Pradesh	-	-	5,500	2
21.	Madhya Pradesh	-	-	5,975	8
Total		**1,35,393**	**107**	**1,37,226**	**150**

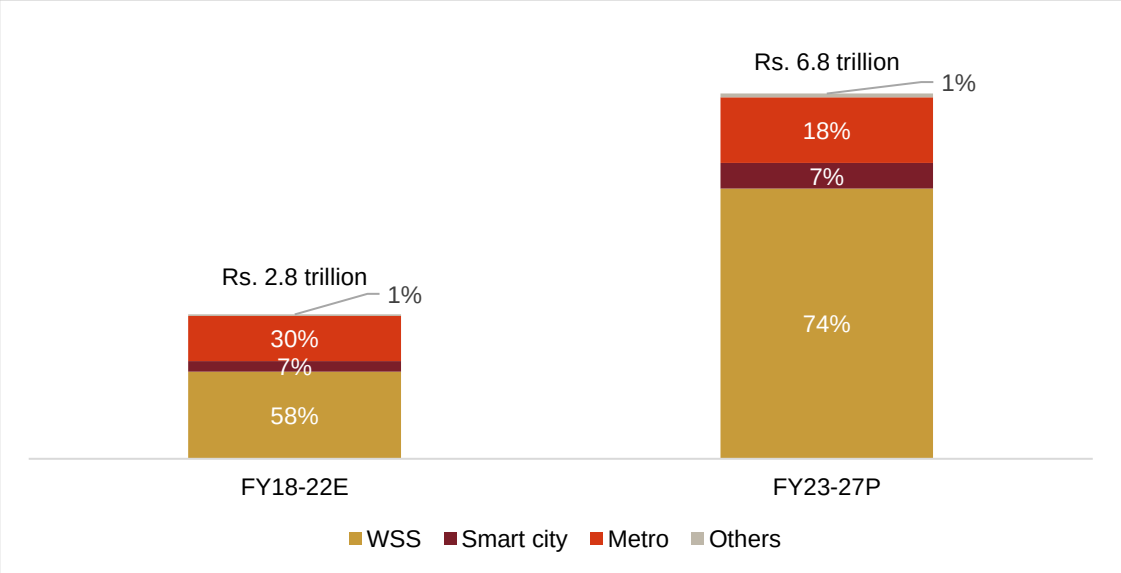
Source: Ministry of New and Renewable Energy, CRISIL Consulting

7.4 Urban infra investments to continue rising in the medium term

CRISIL expects investment in India's urban infrastructure to be driven by government schemes such as AMRUT, Swachh Bharat, Clean Ganga and Jal Jeevan mission. Water supply and sanitation (WSS) projects and metro construction in major Indian cities are expected to boost urban infrastructure investment in the next five years. Commencement of work on 105 smart cities announced so far will also be a key monitorable.

CRISIL expects ~Rs 6.8 trillion spends on urban infrastructure between fiscals 2023 and 2027, which is about ~140% more than the amount invested in the previous five years. Urban infrastructure includes construction-intensive mass rapid transit system (MRTS), bus rapid transit system (BRTS), water supply and sanitation (WSS) projects, smart cities, and related infrastructure development. Construction spends in urban infrastructure: Smart cities to maintain share at ~7%

Figure 139: Investments in urban infrastructure



Source: EESL, CRISIL Consulting

7.5 Launch of Street Light National Program has aided in betterment of street light infrastructure in India

Providing street lighting is one the most important and expensive responsibilities of a city: Lighting can account for 10–38% of the total energy bill in typical cities worldwide (NYCGP 2009). Street lighting is a particularly critical concern for public authorities in developing countries because of its strategic importance for economic and social stability. Inefficient lighting wastes significant financial resources each year, and poor lighting creates unsafe conditions. Energy efficient technologies and design can cut street lighting costs dramatically (often by 25-60%);

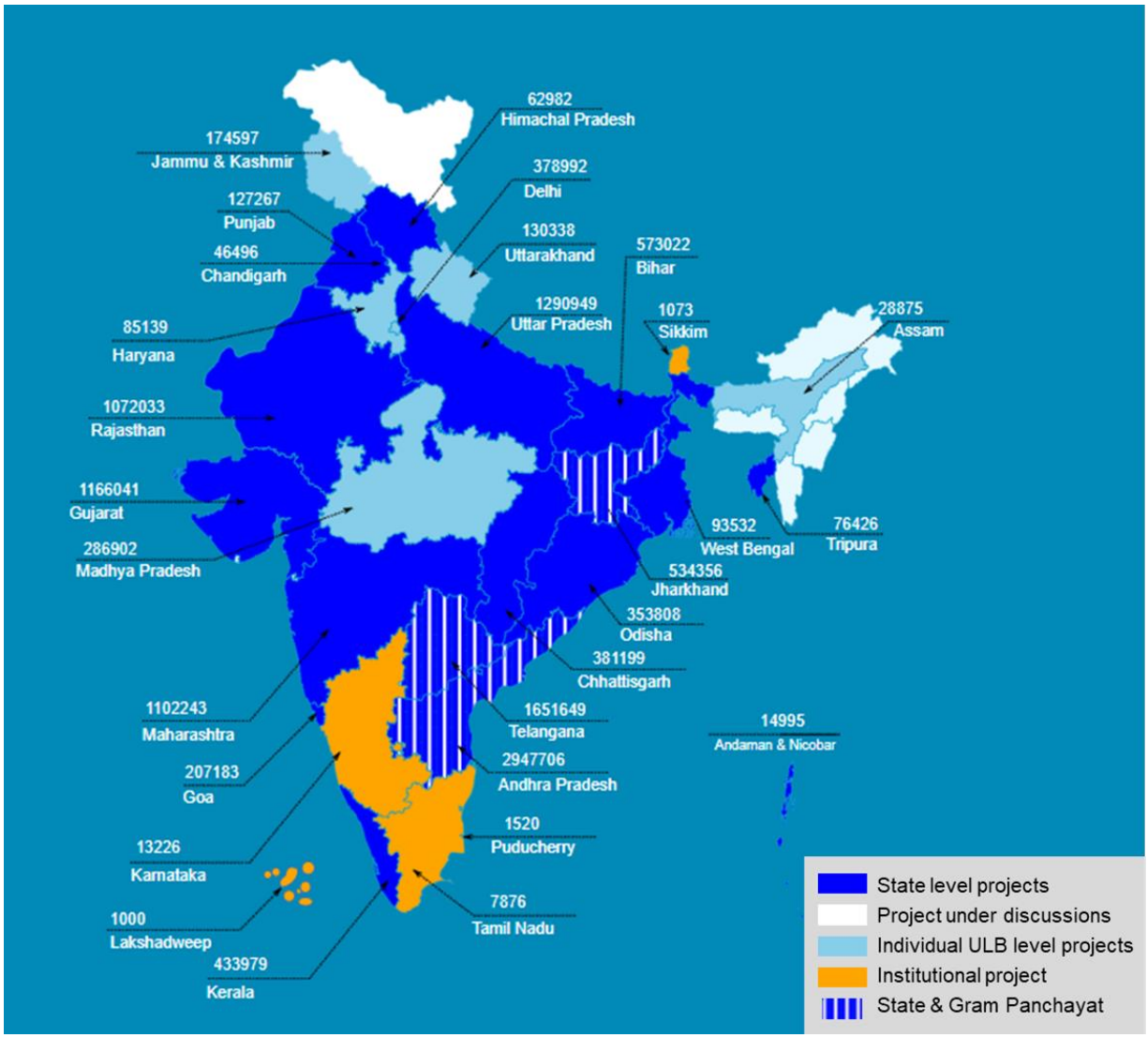
these savings can eliminate or reduce the need for new generating plants and provide the capital for alternative energy solutions for populations in remote areas. These cost savings can also enable municipalities to expand street lighting to additional areas, increasing access to lighting in low-income and other underserved areas. In addition, improvements in lighting quality and expansion in services can improve safety conditions for both vehicle traffic and pedestrians.

Street lighting infrastructure in most parts of India was observed outdated and its inefficient operation placed a heavy burden not only on municipal budgets but also on utility grid capacity and reliability. To better the situation, the government launched Street Light National Program (SLNP). Under the program, Under SLNP programme, Energy Efficiency Services Limited (EESL) is working across India, to replace the conventional streetlights with energy efficient streetlights. EESL is a joint venture of Public Sector Undertakings (PSUs) under the Ministry of Power, Government of India.

SLNP is the world's largest streetlight replacement programme. Till July 2023, EESL has installed over 13 million LED streetlights in Urban Local Bodies (ULBs) and Gram Panchayats across India. This has resulted in estimated energy savings of over 8.8 billion kWh per year.

Under SLNP, 1576 ULBs have been enrolled, out of these ULBs, work has been completed in 1060 ULBs. EESL is also implementing LED Street lighting projects in Gram Panchayats on the same service model as the SLNP for municipalities with the objective to promote the use of efficient lighting in rural areas.

Figure 140: State-wise installation of LED under SLNP



Source: EESL, CRISIL Consulting

Going forward, EESL has an ambitious plan in the SLNP portfolio where it intends to bring investment to the tune of Rs 80 billion by 2024 by covering entire rural India. It is expected that more than 30 million LED streetlights would be retrofitted/installed by EESL.

7.6 Smart city mission has a key focus area in form of street lighting and smart poles

The Government of India has launched the Smart Cities Mission on 25 June 2015. The objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions. The focus is on sustainable and inclusive development and the idea is to look at compact areas, create a replicable model which will act like a light house to other aspiring cities. Accordingly, the purpose of the Smart Cities Mission is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes. Area-based development will transform existing areas (retrofit and redevelop), including slums, into

better planned ones, thereby improving livability of the whole city. New areas (greenfield) are expected to develop around cities in order to accommodate the expanding population in urban areas.

One of the crucial components of a smart city is intelligence and connected lighting. With an appropriate illumination system, the possibilities of connecting light points to the available communication technology as well as to back-end software becomes possible. Though a number of cities in the country lack proper street lighting systems, the concept of smart streetlights to change the cityscape is gradually gaining prominence. In the upcoming smart cities in particular, the installation of smart streetlights is a key focus area. Several cities have already started work on the installation of smart poles and have tendered projects on a public private partnership (PPP) basis.

Key benefits of LED streetlights

- LEDs have extremely long lives compared to conventional lamps.
- LED luminaries don't have filaments that can quickly burn out and they don't contain toxic chemicals like mercury, unlike traditional high-pressure sodium lamps or mercury-vapor lamps.
- LED luminaries can last 70,000 hours approx., also have reduced maintenance costs because of their long lives.
- LED luminaries produce less heat than other bulbs. As it provides more lumens per watt than conventional lamps
- LEDs are suitable for places where replacing light bulbs is expensive, inconvenient or otherwise difficult.
- LEDs are highly energy efficient. While compact fluorescent lamps (CFLs) recently have been touted as the standard in green lighting, LEDs actually have double their energy efficiency
- LED use 15 percent of the energy of an incandescent bulb while generating more light per watt. LEDs produce approx. 80 lumens per watt, traditional streetlights can only muster 58 lumens per watt
- Energy efficient LED helps to reduce carbon emission

Integral parts of smart poles

- Smart pole has telecom tower infrastructure to match with city aesthetic and ready to accommodate technologies like 4G and 5G
- Energy efficient and remotely controllable LED Street Lights
- Wi-Fi hotspot services for the city
- Surveillance cameras for safety and parking violation detection
- Environmental Sensors to monitor air quality, temperature and humidity
- Electric Vehicle charging points to promote use of electric vehicles in the city
- Mobile based application with functionality of SoS
- Centralizes Command and Control centre for monitoring the implementation of smart solutions.
- Optical fibre for better bandwidth to the Wi-Fi users/providing backhaul to telecom operators

Benefits of smart poles

- Smart pole looks good and matches with city infrastructure. It has the telecom power infrastructure in built to facilitate telecom operators to place their equipment
- Smart pole has Li- ion batteries to eliminate Diesel generator as secondary power source. Li-ion battery provides the back up during electricity outage

- Implementation of LED Street lights help to improve the quality of life of city residents by improving the city lighting.
- Optical fiber networks across the city ensures robust connectivity and enable the city to accommodate future technologies. It will also help to establish connectivity between Government departments, City infrastructure and Command & Control Centre.
- Camera surveillance ensures the safety, security and parking management in the city.
- Charging facility for electric vehicles through EV Charging Points will encourage the use on electric vehicle which will help to reduce carbon footprint
- Digital advertising panels across the city through smart billboards will keep the city residents updated with city information and provide the platform to the corporates for promotion.
- SOS application for emergency, distress, citizen's response system will facilitate the city residents with quick response in case of emergency.
- Mobile application for citizen services will help the citizens to use the government service through smart phone.

The adoption of smart city street lighting systems is progressing well with such systems already installed in some cities. Under the Smart City Mission, over 70 projects worth over Rs 40 billion have either been taken up or are proposed to be taken up for the installation of smart street lighting systems and deployment of smart/intelligent poles. Notably, many of these projects are proposed to be awarded on a public-private partnership (PPP) basis while only a few cities such as Amritsar and Ludhiana are planning to implement these projects on an engineering, procurement and construction (EPC) basis. Below is the list of projects planned for respective city for street lighting and smart poles under Smart City Mission.

Table 103: List of street lighting and smart poles projects

City	State	Project details	Cost (Rs Mn)
Bhopal	Madhya Pradesh	Installation of intelligent streetlight with scheduling, surveillance and SOS, environment and water level sensors, Wi-Fi, intelligent shopping apps, smart phone detection, interactive digital signage	6,900.0
Amaravati	Andhra Pradesh	Provision for solar power intelligent street lighting system along with smart solar light pole with CCTV	2,750.0
Chennai	Tamil Nadu	Installation of energy efficient street LED lighting and monitoring system	2,484.7
Dehradun	Uttarakhand	Installation of city smart sensors and intelligent poles	2,349.0
Muzaffarpur	Bihar	Pan-city installation of smart street lighting system	2,277.0
Tumakuru	Karnataka	Provision of energy-efficient solar and LED street lighting system along with street lighting control system	2,160.0
Aurangabad	Maharashtra	Installation of smart street lighting and surveillance system	1,689.0
Jalandhar	Punjab	LED street lighting system	1,402.5
Jammu	Jammu and Kashmir	Installation of smart street lighting system, upgradation of streetlights to smart streetlights and conversion of existing streetlights from sodium bulbs to LED light	1,168.8
Varanasi	Uttar Pradesh	Installation of energy-efficient 36,000 street lighting at city level along with smart street lighting system integrated with Wi-Fi, panic/emergency buttons, CCTV and video analysis, digital analytics, digital signage, air quality monitoring, consumption analytics and management	1,028.0
Kanpur	Uttar Pradesh	Installation of intelligent solar LED streetlights	982.9
Pune	Maharashtra	Installation of LED lighting by replacing 77,800 conventional streetlights by energy-efficient LED lights and existing manual-based feeder panel to SCADA-based energy monitoring and control panels	900.0
Salem	Tamil Nadu	Replacement of 100% streetlights with LED street lighting system along with provision of street lighting control system	750.0
New Town, Kolkata	West Bengal	Installation of intelligent streetlights with solar panel, LED lights, and panic button	716.1

City	State	Project details	Cost (Rs Mn)
Thanjavur	Tamil Nadu	Installation of 10,145 smart street light poles along with conversion to LED streetlights and installing solar panels on 20,163 streetlights	645.9
Aizwal	Mizoram	Installation of energy-efficient solar LED street lighting with digital hoarding and heading	609.4
Coimbatore	Tamil Nadu	Installation of energy-efficient streetlights including conversion of SVL to LED/CFL lights and installation of new LED streetlights	590.0
Gwalior	Madhya Pradesh	Installation of street LED lighting system on unified poles and multiple facilities	546.0
Pimpri-Chinchwad	Maharashtra	Provision for smart street lighting system	500.0
Guwahati	Assam	Implementation of smart street lighting for spine roads	491.0
Ludhiana	Punjab	Installation of smart LED streetlights and centralised control and monitoring system	443.8
Indore	Madhya Pradesh	Installation of 800 smart poles with cameras and 70,000 LED lights	436.9
Dharamshala	Himachal Pradesh	Installation of smart street LED lighting system	432.4
Saharanpur	Uttar Pradesh	Provision of LED streetlights	412.5
Kakinada	Andhra Pradesh	Installation of solar LED streetlights along with supply of LED lights to all households	380.2
Shimla	Himachal Pradesh	Provision of streetlights including electrical cables	363.6
Hubballi-Dharwad	Karnataka	Implementation and maintenance of LED streetlights and centrally controlled online monitoring system in Hubballi-Dharwad smart city	360.0
Rourkela	Odisha	Provision for LED streetlights	350.0
Amritsar	Punjab	Implementing smart LED streetlights and centralised control and monitoring system	345.7
Belagavi	Karnataka	Installation of energy efficient street LED lighting system	340.0
Tirupati	Andhra Pradesh	Installation of intelligent poles	323.1
Surat	Gujarat	Installation of smart street LED lighting and monitoring system	320.0
Puducherry	Puducherry	Provision for smart street lighting in ABD area	291.2
Moradabad	Uttar Pradesh	Installation of LED based smart streetlights by replacing conventional lights	286.7
Mangaluru	Karnataka	Conversion of all streetlights into solar LED lights along with LED streetlights on major roads, minor roads, and lanes	285.4
Thane	Maharashtra	Installation of street LED lighting system	270.0
Kohima	Nagaland	Provision of smart street lighting system including CCTV and digital signage	270.0
Solapur	Maharashtra	Installation of energy efficient street LED lighting system and centrally controlled monitoring system for Solapur Smart City	208.3
Patna	Bihar	Pan-city installation of LED street lighting system	200.0
Bareilly	Uttar Pradesh	Installation of LED based smart streetlights	195.0
Thoothukudi	Tamil Nadu	Installation of energy-efficient smart solar street lighting system	193.9
Silvassa	Dadra and nagar Haveli	Provision for solar based LED street lighting with SCADA including smart poles with LED sensors	188.5
Ujjain	Madhya Pradesh	Installation of smart street LED lighting system along with security and surveillance	180.2
Jhansi	Uttar Pradesh	Provision of solar streetlights of 120W with poles, installation of LED streetlights for energy saving and conversion of 1,434 70W sodium fitting [lights to 43W fitting lights and 2,211 250W sodium fitting lights to 120W fitting	178.7
Tiruppur	Tamil Nadu	Installation of energy-efficient smart solar street lighting system	174.0
Sagar	Madhya	Provision of street lighting system along with security and surveillance including	153.2

City	State	Project details	Cost (Rs Mn)
	Pradesh	firefighting	
Vishakhapatnam	Andhra Pradesh	Installation of centrally controlled monitoring system for street lighting	150.0
Dahod	Gujarat	Installation of city smart poles	150.0
Allahabad	Uttar Pradesh	Installation of LED streetlights and smart poles within street of Civil Lines, Colonelganj, Allenganj, Katra, Old Katra and roads outside Allahabad University	147.0
Faridabad	Haryana	Installation of smart solar LED streetlights system	120.0
Namchi	Sikkim	Provision for energy-efficient solar LED streetlights	120.0
Karnal	Haryana	Installation of intelligent smart poles	113.4
Imphal	Manipur	Conversion of existing streetlights with new LED lights	103.0
Vadodara	Gujarat	Provision for smart streetlights	102.0
Kota	Rajasthan	Installation of smart street lighting system	100.0
Agra	Uttar Pradesh	Conversion of streetlights to LED lights along with installation of solar panels on streetlights	70.5
Kalyan-Dombivali	Maharashtra	Provision for solar panels and LED lighting system	64.6
Vellore	Tamil Nadu	Installation of new streetlights in parks, hill ridge and hiking trails, solar LED streetlights along with web-based switch, current flow-based operational status monitoring system and operation and maintenance	58.6
Raipur	Chattishgarh	Installation of street LED lighting system	51.8
Tirunelveli	Tamil Nadu	Installation of 27 smart unified poles	39.0
Rajkot	Gujarat	Installation of streetlights in ABD area	30.0
Srinagar	Jammu and Kashmir	Installation of smart street lighting in ABD area	26.2
Chandigarh	Chandigarh	Installation of smart street LED lighting system and street light poles	24.2
Ahmedabad	Gujarat	Installation of energy efficient street LED lighting system	20.0
NDMC	Delhi	Supply, installation and maintenance of 55 smart street light poles with provision for Wi-Fi, smart LED streetlights, CCTV cameras and environmental sensors	14.5
Pasighat	Arunachal Pradesh	Installation of smart street lighting system with LED streetlights consisting of display panels and daylight sensors	11.0
Bhubaneshwar	Odisha	Installation of LED lighting	6.2
Davanagere	Karnataka	Intelligent solar street lighting system	NA
Lucknow	Uttar Pradesh	Installation of energy-efficient LED streetlights with network redesign	NA
Nashik	Maharashtra	Implementing smart LED streetlights for ABD area under Nashik smart city and replacing around 3,500 light fixtures on 2,850 streetlights poles with remotely controlled LED lights in selected areas	NA
Madurai	Tamil Nadu	Installation of street LED lighting system	NA
Gangtok	Sikkim	Installation of energy-efficient smart solar street lighting system	NA
Jabalpur	Madhya Pradesh	Installation of smart intelligent poles with smart and energy-efficient LED lighting, CCTV with motion detection, earthquake and natural disaster monitoring, city asset management, accident detection and reporting	NA
Kochi	Kerala	Erection of 500 smart poles under Cochin Smart Mission Limited	NA

Source: Ministry of Housing and Urban Affairs, CRISIL Consulting

7.7 Smart cities opportunity is lucrative, but progress is slow

To further push infrastructure spending, the government approved a budget of Rs 480 billion for the development of 100 smart cities over five years, beginning fiscal 2017. The focus is on adequate and clean water supply,

sanitation, solid waste management, efficient transportation, affordable housing for the poor, power supply, robust IT connectivity, e-governance, safety and security of citizens, health, and education.

The selected cities will receive central assistance of Rs 2 billion in the first year, Rs 1 billion in each of the next four years, and a matching contribution from the respective state. The state and central government funds will only meet part of the cost. The rest will be raised through user fees, municipal bonds, existing central/state schemes such as AMRUT, and PPPs.

Each smart city will have two plans:

Area-based development (ABD): Under this plan, one chosen area of the city will be developed, through retrofitting, redevelopment, or greenfield, or a combination of these. The delineated area should be contiguous within the city

Pan-city solution: Under this plan, the entire city area is considered, and information and communications technology (ICT) is used for diverse purposes, such as traffic management, water and electricity supply (smart metering), and solid waste management.

Hence, construction opportunity at the pan-city level is limited. The opportunity in smart cities will primarily come from ABD projects such as affordable housing, sanitation, solid waste management, water supply, and storm water reuse.

Table 104: Status of smart city initiative

Particulars	Number of projects	Project value (Rs. Billion)	Percentage (%)
Completed	4,436	758	41%
Tendering stage	101	22	1%
Under implementation	3,220	1,067	58%
Total	7,757	1,847	-

Note: Data as of 28th March 2023
Source: CRISIL Consulting

7.7.1 All 105 cities announced: Tendering activity on the uptick

Out of the 60 smart cities declared in rounds one and two and the fast-track round, only ~29 cities are seeing reasonable amount of activity. Of the first 20 cities announced, only 10 have progressed in terms of execution. About eight cities have no progress or only marginal progress in execution as against what was planned initially. Except Raipur, cities from the fast-track round that were to start execution from fiscal 2017 have seen almost no activity.

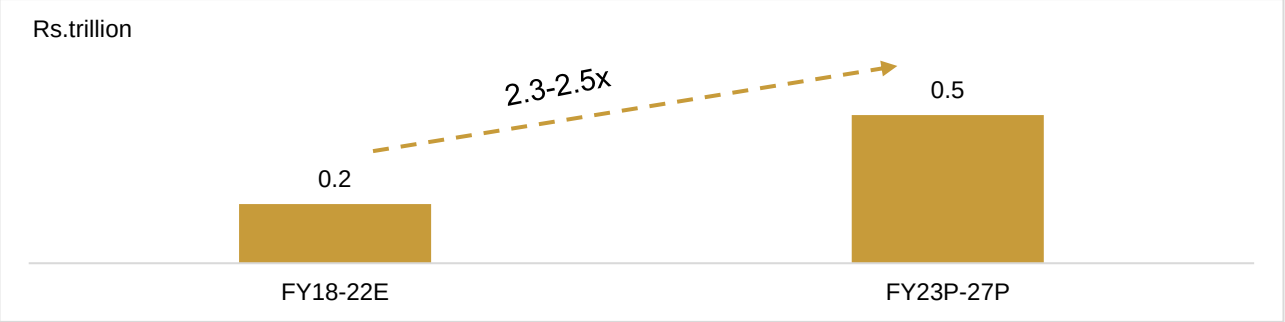
For the balance 40 cities selected in rounds three and four, tendering is at a very nascent stage for the newly formed special purpose vehicles (SPVs).

Key reasons for the slow activity include inability of some states to provide their share of funds, lack of manpower with suitable skills, experience at the SPV level, and failure of urban local bodies to decentralize responsibilities to the SPV.

7.7.2 Investments in smart cities to be construction-intensive

Based on the overall plans for the first 90 cities, investments are expected to be construction-intensive, as segments such as housing, roads, non-residential development, sewage systems, etc., will constitute a considerable portion of the total investments.

Figure 141: Smart city investments to almost quadruple on a low base over the next 5 years



Source: CRISIL Consulting

8 Competitive landscape in T&D, civil construction and pole & lighting sector

8.1 T&D Segment

For peer comparison of Transrail Lighting Ltd., CRISIL has considered Tata Projects Ltd., KEC International Ltd., and Kalpataru Projects International Ltd. along with global players like Chubu Electric Power, NextEra Energy Inc., and E.ON. However, for the purpose of financial analysis, only publicly listed Indian Companies are considered. The competitors are indicative and not an exhaustive list for comparison.

Various financial parameters, such as operating income, EBITDA, profitability margins, net worth, return ratios, EPS, NAV, working capital, etc. have been considered for the comparison.

Table 105: Operational overview of the peer group

Company	Headquarters	About the company	Operational segments
Transrail Lighting Limited	Mumbai, India	• Incorporated in 1984, Transrail Lighting is the one of the leading Indian EPC companies with integrated manufacturing facilities for lattice structures, conductors, and monopoles. • At present, the company operates in T&D (engineering, testing, and manufacturing), substation (design and material supply), railways (earthwork, tunnelling, bridges, electrification, signaling and telecom), civil construction (bridges and tunnel) and poles & lighting solutions (products and manufacturing). • The company has a footprint in more than 50 countries in Asia, the Americas, Europe, and Africa. • D.C. Bagde is the chairman of the company.	Power transmission & distribution, substation, railways, civil construction, poles & lighting solutions
Tata Projects Limited	Hyderabad, India	• TPL was founded in 1979 is one of the leading EPC in the country operates in energy & industrial infrastructure, urban Infrastructure and services groups while providing turnkey end-to-end project implementing services for complex infrastructure projects under these verticals. • The company has commissioned over 13,000 ckm of transmission lines across multiple voltage levels, in addition to various substations across the country. • TPL has a global presence in over 40 countries, along with more than 220 projects sites across Asia Pacific and Africa.	Power generation T&D, urban infrastructure, oil & gas, space & nuclear, transportation, metals & minerals, and water
KEC International Limited	Mumbai, India	• KEC was founded in 1945 with ~52% of the company's shareholding lying with the promoters as on fiscal 2023. • It is a major player in power T&D EPC with a diversified presence in over 70 countries. KEC provides integrated solutions on a turnkey basis for transmission lines up to 1,200 kV, large size substations, and underground cabling up to 220 kV. It has three manufacturing plants in India located in Maharashtra, Madhya Pradesh and Rajasthan, along with international facilities in Brazil, Dubai and Mexico. • The company has executed 2,624 km of transmission lines and built 268 substation bays as of March 2023.	Power transmission & distribution, railways, civil, urban infrastructure, solar, oil & gas pipelines, and cables.

Company	Headquarters	About the company	Operational segments
Kalpataru Projects International Limited	Mumbai, India	• Established in 1981 by Mr. Mofatraj P Munot, KPIL undertakes turnkey contracts for setting up transmission lines and substations for extra high voltage power transmission, providing end-to-end solutions from in-house designs, testing, procurement, fabrication, erection, installation, and commissioning of power transmission lines. It has diversified into civil contracts, railways and oil & gas pipeline construction. • The company has an annual production capacity of ~240,000 MT of transmission towers at its manufacturing facilities in India in addition to an ultra-modern tower testing facility. • KPIL has a presence in 63 countries across 5 continents	EPC for power transmission & distribution, buildings & factories, water supply & irrigation, railways, oil & gas pipelines, urban mobility, highways and airports
Skipper Ltd.	Kolkata India	• Established in 1981,Skipper Ltd. has today evolved into one of the world's leading manufacturers for Transmission & Distribution Structures(Towers & Poles) in it's Engineering Products segment • Skipper's market reach spans across 40+ countries around the globe from South America, Europe, Africa,the Middle East, South and Southeast Asia and Australia. • With an installed T&D Structure capacity of over 265,000 MTPA, Skipper has the unique advantage of producing 100% of its prime raw material - Mild Steel & High Tensile Angles in-house. • The Company is also engaged in EPC Projects in Power Transmission & Distribution, Telecom infra and Railway Structures in various parts of the country along with other geographies.	Transmission towers, Angles, Fasteners Monopoles, Telecommunication, Towers and Railway Infrastructure Structures, PVC Pipes
Bajel Projects Ltd.	Mumbai, India	• Bajel Projects Ltd.(BPL), incorporated in January 2022 is a wholly owned subsidiary of Bajaj Electricals Ltd (BEL). The EPC business operated under BEL is transferred to BPL as a part of a scheme of demerger announced by BEL. Post demerger, BPL is listed on stock exchanges. • BPL is leading company in the Engineering, Procurement and Construction (EPC) business. • The company operates through its four business verticals - Power Transmission, Power Distribution, Monopoles, International EPC and has its own manufacturing facility with state-of-the-art machineries at Ranjangaon MIDC, Pune.	Power Transmission, Power Distribution, Monopoles, International EPC
Chubu Electric Power	Nagoya, Japan	• Established in 1951, Chubu Electric Power (Chuden) is in the business of generating, transmitting, distributing, and selling electricity, as well as supplying gas. • The T&D segment spans across Asia and Europe. The current renewable energy capacity of Chuden stands at 740 MW with plans to expand to 3.2 GW by 2030	Renewable energy, nuclear power, community support infrastructure
NextEra Energy, Inc.	Florida, United States	• NEE is a key electric power and energy infrastructure company in North America. Its energy infrastructure business is involved in the development, construction, and operation of long-term contracted assets with a focus on clean energy in US and Canada. • The company has a total power generation capacity of 57,634	Power generation, T&D, battery storage

Company	Headquarters	About the company	Operational segments
		MW along with over 1,000 substations and ~5147,126 ckm of transmission lines.	
E.ON	Essen, Germany	• E.ON Group is one of Europe's largest operators of energy networks and energy infrastructure and a provider of innovative customer solutions. • The company's energy network spans across Germany, Sweden and East-Central Europe comprising Turkey, Czech Republic, Hungary, Romania, Poland, Croatia, and Slovakia. The company operates over 800,000 km of electricity and gas grids in Germany alone.	Power transmission & distribution, customer solutions

Credit ratings of the peers

For Transrail Lighting, on August 21, 2023, CRISIL Ratings accorded long-term rating of CRISIL A and short-term rating of CRISIL A1 for Rs 5,955 million and Rs 44,745 million, respectively.

Table 106: Credit rating of the peers

Companies	Credit rating		Amount (Rs Mn)		Date	Rating agency
	Long term	Short term	Long term	Short term		
Transrail Lighting	CRISIL A	CRISIL A1	5,955	44,745	21-Aug-2023	CRISIL Ratings
Tata Projects	IND AA	IND A1+	-	2,04,410	16-Jun-2023	India Ratings & Research
KEC International Ltd	ICRA AA-	ICRA A1+	1,500	8,500	21-Feb-23	ICRA
Kalpataru Projects International Ltd	CRISIL AA	CRISIL A1+	26,450	1,80,190	07-Jun-23	CRISIL Ratings
Skipper Limited	ACUITE A-	ACUITE A2+	7,750	1,37,500	02-Aug-2023	Acuite

Source: Company reports, CRISIL Consulting

8.2 Civil construction

For peer comparison, CRISIL has considered Transrail Lighting Ltd, SPL Infrastructure, Tata Projects Ltd, AFCONS Infrastructure Ltd, Patel Engineering Ltd & SP Singla Constructions Pvt Ltd. However, for the purpose of financial analysis, only publicly listed Indian Companies are considered. The competitors are indicative and not an exhaustive list for comparison. Various financial parameters, such as operating income, EBITA, profitability margins, net worth, return ratios, EPS, NAV, working capital, etc. have been considered for the comparison.

Table 107: Operational overview of the peer group

Company	Headquarters	About the company	Operational segments
Transrail Lighting	Mumbai, Maharashtra	• Incorporated in 1984, Transrail is an EPC company with over three decades of experience in providing comprehensive solutions on a turnkey basis globally. • At present, the company operates in **T&D** (engineering, testing and manufacturing), **substation** (design and material supply), **railways** (earthwork, tunnelling, bridges, electrification, signaling and telecom), **civil construction** (bridges and tunnel) and **poles & lighting solutions** (products and manufacturing) • The company has presence in more than 50 countries	Power transmission & distribution, substation, railways, civil construction, poles & lighting solutions

Company	Headquarters	About the company	Operational segments
		across four continents (the Americas, Europe, Africa, and Asia) • D C Bagde is the chairman of the company	
SPL Infrastructure	Chennai, Tamil Nadu	• Established in 1984 and based in Chennai, SPL Infrastructure undertakes civil construction, primarily of roads and bridges • The company operates mainly on EPC contracts • The operations are managed by SP Lakshmanan (founding Chairman) • The company has executed several key infrastructure projects in the past including steel bridges at Marthandam (Tamil Nadu) and Parvathipuram (Tamil Nadu), two of the longest steel bridges in southern India	Roads and flyovers
Tata Projects	Mumbai, Maharashtra	• Incorporated in 1979, Tata Projects is an EPC company. It operates through three strategic business groups: Energy and industrial infrastructure, urban infrastructure, and services • The company has a presence in power, water, oil & gas, metals & minerals, space & nuclear, transportation, urban infrastructure and industrial sectors • Banali Agrawala is the chairman	Energy & Industrial Infrastructure, Urban Infrastructure
AFCONS Infrastructure	Mumbai, Maharashtra	• Incorporated in 1976, AFCONS Infrastructure is part of the Shapoorji Pallonji Group. It operates in segments such as marine works (including construction of jetties and dry docks), offshore oil and gas, bridges and flyovers, road construction, hydro and tunnelling, pipe laying and general civil engineering works • The company has presence in 14 countries across three continents • K Subramanian is the executive vice-chairman of the company	Urban infrastructure, construction, oil & gas, surface transport, marine & industrial
Patel Engineering	Mumbai, Maharashtra	• Incorporated in 1949, Patel Engineering has operations in sectors of the infrastructure industry such as dams, tunnels, micro-runnels, hydroelectric projects, irrigation projects, highways, roads, bridges, railways, refineries to real estates and townships • It has presence in the roads, railways, and utility projects sectors • Pravin Patel is chairman of the company	Construction, hydro power, transport, water works, micro-tunnelling, urban structures, real estate
SP Singla Constructions	Delhi	• SP Singla Constructions Pvt Limited was incorporated 1996 • Activities include investigative work, designing, engineering and constructing bridges over rivers. It also constructs roads over and under bridges at railway crossings, flyovers, underpasses, and grade-separators across cities in India.	Civil construction

Company	Headquarters	About the company	Operational segments
		• Sat Paul Singla is the chairman of the company	

Source: Company website, company annual reports, CRISIL Consulting

Credit ratings of the peers

For Transrail Lighting, on August 21, 2023, CRISIL Ratings accorded long-term rating of CRISIL A and short-term rating of CRISIL A1 for Rs 5,955 million and Rs 44,745 million, respectively.

Table 108: Credit rating for players

Companies	Long term	Short term	Amount (Rs Mn.)		Date	Rating agency
			Long term	Short term		
Transrail Lighting	CRISIL A	CRISIL A1	5,955	44,745	August 21, 2023	CRISIL Ratings
SPL Infrastructure	CRISIL BBB+	CRISIL A2	410	2,390	24-May-2023	CRISIL Ratings
Tata Projects	IND AA	IND A1+	-	204,410	16-June-2023	India Ratings & Research
AFCONS Infrastructure	ICRA A+	ICRA A1	161,500	28,500	01-Sept-2023	ICRA
Patel Engineering	ACUITE BBB+	ACUITE A2	17,208	47,025	30-June-2023	Acuite Ratings
SP Singla Constructions	CRISIL A+	CRISIL A1	4,550	27,950	14-June-2023	CRISIL Ratings

Source: Company website, Credit rating rationale reports, CRISIL Consulting

8.3 Pole and lighting sector

For peer comparison, CRISIL has considered Transrail Lighting, Utkarsh India Ltd, Valmont Structures Pvt Ltd, Skipper Ltd and Bajaj Electricals Ltd. However, for the purpose of financial analysis, only publicly listed Indian Companies are considered. The competitors are indicative and not an exhaustive list for comparison. Various financial parameters, such as operating income, EBITA, profitability margins, net worth, return ratios, EPS, NAV, working capital, etc. have been considered for the comparison.

Table 109: Operational overview of the peer group

Company	Head quarters	About company	Operational segments
Transrail Lighting	Mumbai, Maharashtra	• Incorporated in 1984, Transrail is an EPC company with over three decades of experience in providing comprehensive solutions on a turnkey basis globally. • At present, the company operates in **T&D** (engineering, testing and manufacturing), **substation** (design and material supply), **railways** (earthwork, tunnelling, bridges, electrification, signaling and telecom), **civil construction** (bridges and tunnel) and **poles & lighting solutions** (products and manufacturing) • The company has presence in more than 50 countries across four continents (the Americas, Europe, Africa, and Asia)	Power transmission & distribution, substation, railways, civil construction, poles & lighting solutions

Company	Head quarters	About company	Operational segments
		• D C Bagde is the chairman of the company	
Utkarsh India	Kolkata, West Bengal	• Utkarsh India Limited is a leading manufacturer and supplier of high-end engineering products and services in the infrastructure, agriculture and domestic water piping industry. • The company manufactures galvanized steel structures for **road safety, illumination, power transmission and distribution, telecom, railway electrification** and various other structural applications • It is also present in the domestic & agricultural pipes & fittings segment in the eastern India • It has a presence in 27 countries; Sunil Bansal is its chairman	Road safety system, area lighting illumination, telecommunications, Power transmission & distribution, smart City application, water transportation, industrial application
Bajaj Electricals	Mumbai, Maharashtra	• Bajaj Electricals is part of the Bajaj Group. It has operations in consumer products (appliances, fans, lighting), exports, and EPC (illumination, transmission towers and power distribution • Its manufacturers and sells consumer products, power distribution & transmission equipment, and illumination infrastructure • Shekhar Bajaj is the chairman	Consumer products, lighting infrastructure manufacturer, power transmission & distribution
Valmont Structures	Pune, Maharashtra	• Valmont Structures is a wholly owned subsidiary of Valmont Inc. The company designs, manufactures and supplies poles for three broad segments — lighting, telecom and utility • The company began its operations in 2006 • It also manufactures metal Beam crash barrier systems, more commonly known as guardrails, under the highway safety segment, and lattice structures for telecom and utility • Rajinder Singh Kaushal is the whole-time director	Lighting, telecom, utility, highway Safety, smart solutions and metal coatings
Skipper Limited	Kolkata, West Bengal	• Skipper Ltd was established in the year 1981, Skipper Ltd manufacturers Transmission & Distribution Structures (Towers & Poles) in its Engineering Products segment, • Company also has presence in the Polymer sector as well as capabilities in Infrastructure EPC projects. • Sajan Kumar Bansal is the managing director of the company	Engineering (transmission and telecom towers, poles, Railway electrification, plumbing and sewage

Source: Company website, company annual reports, CRISIL Consulting

Table 110: Key offerings of the peers

Company name	Key offerings in Lighting and pole segment
Transrail Lighting	Flag mast, Decorative Street lighting pole, T&D monopoles, Street lighting pole, High mast, Surveillance and traffic poles, Sports lighting, Signage and gantry structure, Oil and gas structures, telecom monopoles, solar
Utkarsh India	Street and road lighting, Street light pole, Street tubular poles, solar street lighting, stadium & sports lighting, large area & yard lighting
Bajaj Electricals	Street & Road Lighting, Area & Yard Lighting, City Furniture, Sports Lighting, Flag Mast & Specialty Mast, Flag Mast & Specialty Mast
Valmont Structures	Street Light Poles, High Masts, Stadium masts, Signage masts, Smart poles, flag masts, traffic & VMS gantry, Cast iron pole, Decorative pole & access, T&D poles,
Skipper Limited	Lighting poles, distribution poles, Monopoles

Note: The list above is an indicative list and not an exhaustive list
Source: Company website, company annual reports, CRISIL Consulting

8.3.1 Credit ratings of the peers

For Transrail Lighting, on August 21, 2023, CRISIL Ratings accorded long-term rating of CRISIL A and short-term rating of CRISIL A1 for Rs 5,955 million and Rs 44,745 million, respectively.

Table 111: Credit rating of the peers considered

Company name	Long term	Short term	Amount (Rs Mn.)		Date	Rating agency
			Long term	Short term		
Transrail Lighting	CRISIL A	CRISIL A1	5,955	44,745	August 21, 2023	CRISIL Ratings
Utkarsh India	ACUITEA-	ACUITE A2+	3,908	4,100	Oct 6,2022	Acuite Ratings & Research Ltd
Bajaj Electricals	CRISIL AA-	CRISIL A1+	5,475	16,525	July 4, 2023	CRISIL Ratings
Skipper Limited	ACUITE A-	ACUITE A2+	6,500	13,000	Oct 3,2022	Acuite Ratings & Research Ltd

Source: Company website, company rating rationale reports, CRISIL Consulting

8.4 Peer financial comparison-Consolidated

Following tables summarise the various financial parameters considered for peer financial comparison. For the purpose of financial analysis, only publicly listed Indian Companies are considered.

Table 112: Financial Information on Revenue from Operations of Major Companies (Consolidated FY21 to FY23)

Company Name	Revenue from Operations (Rs. Crores)			Y-o-y growth for FY2023 over FY2022	Revenue from Operations CAGR, FY2021 – FY2023
	FY2021	FY2022	FY2023		
Transrail Lighting	2,121	2,284	3,086	35.1%	20.6%
Kalpataru Projects	12,949	14,777	16,361	10.7%	12.4%
KEC International	13,114	13,742	17,282	25.8%	14.8%
TATA Projects	12,187	13,679	16,948	23.9%	17.9%
Skipper Ltd	1,582	1,707	1,980	16.0%	11.9%

Company Name	Revenue from Operations (Rs. Crores)			Y-o-y growth for FY2023 over FY2022	Revenue from Operations CAGR, FY2021 – FY2023
	FY2021	FY2022	FY2023		
Bajaj Electricals Ltd	4,585	4,813	5,429	12.8%	8.8%
Patel Engineering	1,995	3,380	4,202	24.3%	45.1%

Source: Company website, company annual reports, CRISIL Consulting

Table 113: Financial Information on EBITDA of Major Companies (Consolidated FY21 to FY23)

Company Name	EBITDA (Rs. Crores)			EBITDA Margin (%)			EBITDA CAGR, FY2021 – FY2023
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023	
Transrail Lighting	240	206	294	11.3%	9.0%	9.5%	10.8%
Kalpataru Projects	1,381	1,093	1,108	10.7%	7.4%	6.8%	-10.4%
KEC International	1,141	904	830	8.7%	6.6%	4.8%	-14.7%
TATA Projects	792	-108	-372	6.5%	-0.8%	-2.2%	NM
Skipper Ltd	144	164	195	9.1%	9.6%	9.9%	16.5%
Bajaj Electricals Ltd	372	318	434	8.1%	6.6%	8.0%	7.9%
Patel Engineering	20	497	624	1.0%	14.7%	14.9%	452.1%

Source: Company website, company annual reports, CRISIL Consulting

Table 114: Financial Information on PAT of Major Companies (Consolidated FY21 to FY23)

Company Name	PAT (Rs. Crores)			PAT Margin (%)			PAT CAGR, FY2021 – FY2023
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023	
Transrail Lighting	102	65	108	4.8%	2.8%	3.5%	2.7%
Kalpataru Projects	662	535	435	5.1%	3.6%	2.7%	-18.9%
KEC International	553	332	176	4.2%	2.4%	1.0%	-43.6%
TATA Projects	126	-620	-852	1.0%	-4.5%	-5.0%	NM
Skipper Ltd	21	25	36	1.4%	1.5%	1.8%	28.8%
Bajaj Electricals Ltd	189	124	216	4.1%	2.6%	4.0%	6.9%
Patel Engineering	-291	72	183	-14.6%	2.1%	4.4%	NM

Source: Company website, company annual reports, CRISIL Consulting

Table 115: Financial Information on Earnings per Share (EPS) of Major Companies (Consolidated FY21 to FY23)

Company Name	EPS-Basic (Rs.)			EPS-Diluted (Rs.)		
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023
Transrail Lighting	163.29	58.11	47.24	163.29	58.11	47.24
Kalpataru Projects	43.65	35.93	28.68	43.65	35.93	28.68
KEC International	21.50	12.92	6.85	21.50	12.92	6.85
TATA Projects	10.35	-50.92	-51.36	10.35	-50.92	-51.36
Skipper Ltd	2.09	2.45	3.46	2.09	2.45	3.46
Bajaj Electricals Ltd	16.54	10.81	18.79	16.49	10.77	18.75
Patel Engineering	-6.78	1.52	3.50	-3.55	1.05	2.08

Source: Company website, company annual reports, CRISIL Consulting

Table 116: Financial Information on Net Worth and Net Asset Value (NAV) per Share of Major Companies (Consolidated FY21 to FY23)

Company Name	Net Worth (Rs. Crores)			NAV per share (Rs.)			NAV per Share (Diluted)
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023	FY2023
Transrail Lighting	572	663	771	916	595	339	339
Kalpataru Projects	3,739	4,279	4,721	251	287	291	291
KEC International	3,360	3,620	3,771	131	141	147	147
TATA Projects	1,401	2,018	2,800	115	166	169	169
Skipper Ltd	708	732	767	69	71	75	75

Company Name	Net Worth (Rs. Crores)			NAV per share (Rs.)			NAV per Share (Diluted)
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023	FY2023
Bajaj Electricals Ltd	1,578	1,705	1,907	138	149	166	166
Patel Engineering	2,320	2,384	2,888	50	50	37	37

Source: Company website, company annual reports, CRISIL Consulting

Table 117: Financial Information on Net Debt, Debt Equity Ratio and Net Debt/EBITDA of Major Companies (Consolidated FY21 to FY23)

Company Name	Net Debt (Rs. Crores)			Debt Equity Ratio			Net Debt/ EBITDA		
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023
Transrail Lighting	340	412	480	0.60	0.62	0.62	1.42	2.00	1.63
Kalpataru Projects	2,618	2,650	2,731	0.68	0.60	0.58	1.90	2.42	2.46
KEC International	1,679	2,869	3,124	0.50	0.79	0.83	1.47	3.18	3.76
TATA Projects	2,479	2,074	2,243	1.77	1.04	0.86	3.13	-19.22	-6.03
Skipper Ltd	438	566	482	0.62	0.77	0.63	3.04	3.44	2.47
Bajaj Electricals Ltd	425	-74	-342	0.27	-0.04	-0.18	1.14	-0.23	-0.79
Patel Engineering	2,071	2,001	1,541	0.87	0.82	0.52	101.20	4.02	2.47

Source: Company website, company annual reports, CRISIL Consulting

Table 118: Financial Information on Return on Net Worth and capital employed of Major Companies (Consolidated FY21 to FY23)

Company Name	Return on Net Worth			Return on capital employed		
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023
Transrail Lighting	17.8%	9.8%	13.9%	31.2%	20.8%	27.9%
Kalpataru Projects	17.7%	12.5%	9.2%	16.7%	11.8%	14.6%
KEC International	16.5%	9.2%	4.7%	27.1%	17.9%	15.7%
TATA Projects	9.0%	-30.7%	-30.4%	20.1%	-7.5%	-12.0%
Skipper Ltd	3.0%	3.4%	4.6%	10.1%	12.0%	13.8%
Bajaj Electricals Ltd	12.0%	7.3%	11.3%	17.2%	13.6%	17.1%
Patel Engineering	-12.53%	3.02%	6.35%	1.3%	11.3%	13.1%

Source: Company website, company annual reports, CRISIL Consulting

Table 119: Working Capital Days and working capital turnover ratio of Major Companies (Consolidated FY21 to FY23)

Company Name	Working Capital Days (No. of days)			Working capital turnover ratio		
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023
Transrail Lighting	125	135	114	2.93	2.71	3.21
Kalpataru Projects	73	83	70	4.98	4.37	5.19
KEC International	44	42	34	8.22	8.66	10.69
TATA Projects	59	46	47	6.21	7.90	7.75
Skipper Ltd	72	64	65	5.05	5.67	5.62
Bajaj Electricals Ltd	34	34	54	10.70	10.61	6.82
Patel Engineering	297	168	143	1.23	2.17	2.55

Source: Company website, company annual reports, CRISIL Consulting
The formulae used in the computation of the financial ratios are as follows (for consolidated as well as standalone)

- *EBITDA: Profit for the year before finance costs, tax, depreciation, amortisation, exceptional items and other income (Profit/(loss) before exceptional items and tax Less: Other Income Add: Interest/ Finance Cost Add: Depreciation)*
- *Basic earnings per share: Net Profit after Tax / Weighted Average number of Equity Shares*
- *Net worth: Equity Share capital Add: Other equity*
- *Return on net worth (in%): Net Profit after Tax/ Net worth at the end of the year*
- *Net asset value per equity share: Net worth at the end of the year / Number of Equity Shares outstanding at the end of the year*
- *Net debt: Total debt Less: cash and cash equivalent*
- *Return on Capital Employed: EBIT/Capital employed*
- *Working capital days: (Current assets Less: Current liabilities)/operating revenue * 365*
- *Working capital turnover ratio: Operating Revenue/ (Current assets Less: Current liabilities)*

8.5 Peer financial comparison-Standalone

Following tables summarise the various financial parameters considered for peer financial comparison on standalone basis. For the purpose of financial analysis, only publicly listed Indian Companies are considered.

Table 120: Financial Information on Revenue from Operations of Major Companies (Standalone FY21 to FY23)

Company Name	Revenue from Operations (Rs. Crores)			Revenue from Operations CAGR, FY2021 – FY2023
	FY2021	FY2022	FY2023	
Transrail Lighting	2,121	2,284	3,086	20.6%
Kalpataru Projects	11,359	12,407	14,337	12.3%
KEC International	11,852	12,573	15,413	14.0%
TATA Projects	12,011	13,471	16,755	18.1%
Skipper Ltd	1,582	1,707	1,980	11.9%
Bajaj Electricals Ltd	4,646	4,788	5,417	8.0%
Patel Engineering	1,719	3,030	3,817	49.0%
Bajel Projects Ltd.	-	-	540	-

Note: Bajel Projects Limited is a newly incorporated entity and its past Audited figures are not available.
Source: Company website, company annual reports, CRISIL Consulting

Table 121: Financial Information on EBITDA of Major Companies (Standalone FY21 to FY23)

Company Name	EBITDA (Rs. Crores)			EBITDA Margin (%)			EBITDA CAGR, FY2021 – FY2023
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023	
Transrail Lighting	233	207	293	11.0%	9.1%	9.5%	12.3%
Kalpataru Projects	1,145	1,080	1,278	10.1%	8.7%	8.9%	5.6%
KEC International	1,232	1,129	850	10.4%	9.0%	5.5%	-16.9%
TATA Projects	980	-142	-404	8.2%	-1.1%	-2.4%	NM
Skipper Ltd	144	168	193	9.1%	9.8%	9.7%	15.8%
Bajaj Electricals Ltd	374	324	441	8.1%	6.8%	8.1%	8.5%
Patel Engineering	505	427	454	29.4%	14.1%	11.9%	-5.2%
Bajel Projects Ltd.	-	-	223	-	-	41.2%	NA

Note: Bajel Projects Limited is a newly incorporated entity and its past Audited figures are not available.
Source: Company website, company annual reports, CRISIL Consulting

Table 122: Financial Information on PAT of Major Companies (Standalone FY21 to FY23)

Company Name	PAT (Rs. Crores)			PAT Margin (%)			PAT CAGR, FY2021 – FY2023
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023	
Transrail Lighting	102	66	109	4.8%	2.9%	3.5%	3.6%
Kalpataru Projects	631	350	532	5.6%	2.8%	3.7%	-8.2%
KEC International	646	434	180	5.5%	3.5%	1.2%	-47.2%
TATA Projects	125	-631	-860	1.0%	-4.7%	-5.1%	NM
Skipper Ltd	21	29	33	1.3%	1.7%	1.7%	24.6%
Bajaj Electricals Ltd	172	137	231	3.7%	2.9%	4.3%	15.8%
Patel Engineering	-138	56	156	-8.1%	1.8%	4.1%	NM
Bajel Projects Ltd.	-	-	1	-	-	-	-

Note: Bajel Projects Limited is a newly incorporated entity and its past Audited figures are not available.
Source: Company website, company annual reports, CRISIL Consulting

Table 123: Financial Information on Earnings per Share of Major Companies (Standalone FY21 to FY23)

Company Name	EPS-Basic (Rs.)			EPS-Diluted (Rs.)		
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023
Transrail Lighting	163.29	59.68	48.06	163.29	59.68	48.06
Kalpataru Projects	41.58	21.55	32.75	41.58	21.55	32.75

Company Name	EPS-Basic (Rs.)			EPS-Diluted (Rs.)		
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023
KEC International	25.13	16.90	7.01	25.13	16.90	7.01
TATA Projects	10.31	-51.86	-51.82	10.31	-51.86	-51.82
Skipper Ltd	2.05	2.79	3.19	2.05	2.79	3.19
Bajaj Electricals Ltd	15.05	11.93	20.05	15.00	11.88	20.01
Patel Engineering	-3.23	1.17	2.97	-1.69	0.81	1.77
Bajel Projects Ltd.	-	-	0.1	-	-	0.1

Note: Bajel Projects Limited is a newly incorporated entity and its past Audited figures are not available.
Source: Company website, company annual reports, CRISIL Consulting

Table 124: Financial Information on Net Worth and Net Asset Value (NAV) per Share of Major Companies (Standalone FY21 to FY23)

Company Name	Net Worth (Rs. Crs)			NAV per share (Rs.)			NAV per Share (Diluted)
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023	FY2023
Transrail Lighting	572	670	781	916	601	343	343
Kalpataru Projects	4,574	4,937	5,320	307	304	327	327
KEC International	3,520	3,856	3,964	137	150	154	154
TATA Projects	1,424	2,029	2,801	117	167	169	169
Skipper Ltd	708	736	767	69	72	75	75
Bajaj Electricals Ltd	1,605	1,745	1,961	140	152	171	170
Patel Engineering	2,492	2,353	2,858	54	51	37	37
Bajel Projects Ltd.	-	-	565	-	-	49	49

Note: Bajel Projects Limited is a newly incorporated entity and its past Audited figures are not available.
Source: Company website, company annual reports, CRISIL Consulting

Table 125: Financial Information on Net Debt, Debt Equity Ratio and Net Debt/EBITDA of Major Companies (Standalone FY21 to FY23)

Company Name	Net Debt (Rs. Crs)			Debt Equity Ratio			Net Debt/ EBITDA		
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023
Transrail Lighting	340	414	485	0.59	0.62	0.62	1.46	2.00	1.65
Kalpataru Projects	977	1,792	2,180	0.25	0.36	0.41	0.85	1.66	1.71
KEC International	1,591	2,329	2,634	0.45	0.60	0.66	1.29	2.06	3.10
TATA Projects	2,282	1,926	2,179	1.60	0.96	0.84	2.33	-13.61	-5.39
Skipper Ltd	438	566	482	0.63	0.77	0.63	3.04	3.37	2.50
Bajaj Electricals Ltd	418	-83	-340	0.26	-0.05	-0.17	1.12	-0.26	-0.77
Patel Engineering	1,805	1,799	1,372	0.55	0.76	0.48	3.57	4.21	3.02
Bajel Projects Ltd.	-	-	-	-	-	-	-	-	-

Note: Bajel Projects Limited is a newly incorporated entity and its past Audited figures are not available.; Bajel is a Debt free company.
Source: Company website, company annual reports, CRISIL Consulting

Table 126: Financial Information on Return on Net Worth and Working Capital Days of Major Companies (Standalone FY21 to FY23)

Company Name	Return on Net Worth			Return on Capital Employed			Working Capital Days (No. of days)		
	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023	FY2021	FY2022	FY2023
Transrail Lighting	17.8%	9.9%	14.0%	39.9%	15.5%	19.5%	125	136	115
Kalpataru Projects	13.8%	7.1%	10.0%	19.5%	12.5%	15.9%	58	110	74
KEC International	18.4%	11.3%	4.5%	21.5%	16.3%	11.4%	48	44	35
TATA Projects	8.8%	-31.1%	-30.7%	11.8%	-10.0%	-12.6%	57	44	46
Skipper Ltd	3.0%	3.9%	4.3%	9.0%	9.0%	12.0%	72	64	65
Bajaj Electricals Ltd	10.7%	7.8%	11.8%	13.9%	14.0%	19.5%	35	37	56
Patel Engineering	-5.6%	2.4%	5.4%	39.92%	15.52%	19.48%	247	128	127
Bajel Projects Ltd.	-	-	0.2%	-	-	1.9%	-	-	293

Note: Bajel Projects Limited is a newly incorporated entity and its past Audited figures are not available.
Source: Company website, company annual reports, CRISIL Consulting

8.6 Company comparables

Following table summarises the key financials for the fiscal 2023 of the comparable companies for Transrail India.

Table 127: Key financials of the comparable – Standalone (Rs. Crore)

Parameter	Transrail Lighting	Kalpataru Projects	KEC International	TATA Projects	Skipper Ltd	Bajel Projects
	FY2023	FY2023	FY2023	FY2023	FY2023	FY2023
Operating revenue	3,086	14,337	15,413	16,755	1,980	540
Net worth	781	5,320	3,964	2,801	767	656
Equity share capital	23	32	51	83	10	23
Net debt	485	2,180	2,634	2,179	482	NA
Return on net worth	14.0%	10.0%	4.5%	-30.7%	4.3%	0.2%
Revenue growth	35.1%	15.6%	22.6%	24.4%	16.0%	NA
Profit after tax	109	532	180	-860	33	1
Net profit margin	3.5%	3.7%	1.2%	-5.1%	1.7%	0.2%
RoCE	19.5%	15.9%	11.4%	-12.6%	12.0%	1.9%
NAV per share (Rs.)	343	327	154	169	75	49
EPS (Rs.)	48.1	32.7	7.0	-51.8	3.2	0.1

Source: Company website, company annual reports, CRISIL Consulting

From the above comparison, it can be observed that:

- Of the above companies, Transrail reported the highest revenue growth of 35.1%. Similarly, the net profit margins are higher than some of its peers indicating a stable profitability position.
- The company operates on a lower capital employed coupled with robust EBITDA levels resulting in a strong ROCE of 19.5% which is the highest amongst the companies disclosed above.
- Transrail commenced its T&D operations in January 2016 under the guidance of the new promoters. It has reported profits resulting in an increased net-worth on a year-on-year basis and has reached Rs.7,810 million in fiscal 2023.

- Transrail has three-decade-long experience of the management and the integrated services offered by it along with healthy relationships with customers supports business risks. It is one of the most experienced and largest T&D players in the World.
- Transrail is also backward integrated through its manufacturing of towers, poles and conductors, which supports stronger operating margins.
- Transrail is one of the few companies across the globe to have 4 manufacturing facilities of transmission towers (1,01,000 TPA), conductors (60,000 TPA) and poles (25,000 TPA) and a state-of-the-art integrated tower testing station, design capabilities, and a well experienced team capable of erecting and commissioning transmission lines up to 1200kV, distribution lines, substations and railway electrification.
- Transrail has built first ever 500 kV transmission line in Afghanistan/Central Asia
- Transrail is constructing India's longest river bridge with a length of over 10 KM (Kosi River Bridge)

- In August 2023, CRISIL Ratings has revised its outlook on the long-term bank facilities of Transrail Lighting to ‘Positive’ from ‘Stable’ and reaffirmed the rating at ‘CRISIL A’. The outlook revision reflects strong order book in the T&D segment, providing healthy revenue visibility over the medium term.

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It is India's foremost provider of data, research, analytics and solutions with a strong track record of growth, culture of innovation, and global footprint.

It has delivered independent opinions, actionable insights, and efficient solutions to over 100,000 customers through businesses that operate from India, the US, the UK, Argentina, Poland, China, Hong Kong, UAE and Singapore.

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