Crisil
Intelligence

Assessment of telecom tower, optical fibre EPC, solar energy and rural electrification markets in India

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by S&P Global

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1. Macroeconomic assessment of India

1.1 Overview of real Gross Domestic Product (GDP)

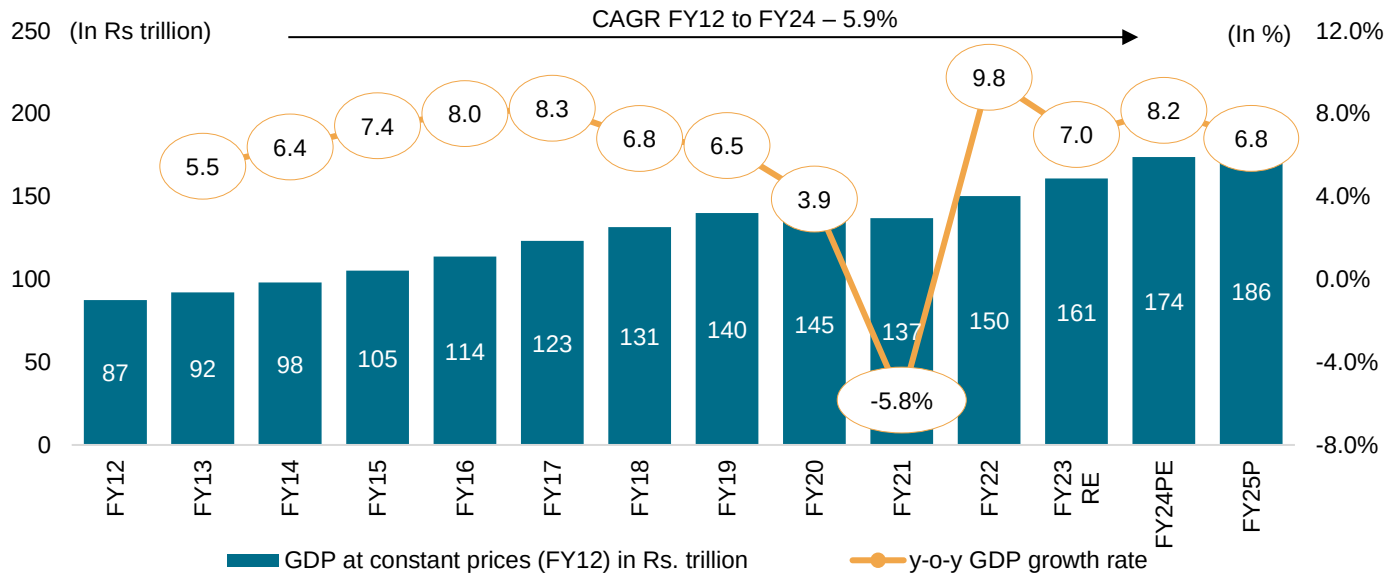
India's GDP clocked 5.9% CAGR over fiscals 2012 to 2024

The country's gross domestic product (GDP) clocked a low compound annual growth rate (CAGR) of 5.9% over fiscals 2012 to 2024 to Rs 173.8 trillion, largely due to the significant impact of Covid-19 pandemic in fiscals 2020 and 2021. The economy recovered in fiscal 2022, led by easing of pandemic restrictions and resumption of business activities.

In fiscal 2023, the GDP grew 7% on continued strong growth momentum propelled by investments and private consumption, with the share of investments in GDP at 33.3% and that of private consumption at 58.0%.

Provisional estimates of the National Statistics Office (NSO) indicate that, at 8.2%, India's real GDP growth in fiscal 2024 would be higher than NSO's second advance estimate of 7.6%. On the supply side, the manufacturing sector experienced substantial growth at ~9.9%, while agriculture grew a modest 1.4%. The government's investment push, along with easing input cost pressures for the industry, also played a major role in shoring up growth. However, growth in services has been slowing down owing to waning pent-up demand (post the pandemic), except for financial, real estate and professional services that powered ahead on the back of robust growth in banking and real estate sectors.

India real GDP growth at constant prices (new series)



RE – revised estimates, PE – provisional estimates, P – projection

Note: The values are reported by the government under various stages of estimates

Actuals, estimates and projected data of GDP are provided in the bar graph

Source: Ministry of Statistics and Programme Implementation (MoSPI), Crisil Intelligence

Crisil forecasts India's GDP to grow by 6.8% in fiscal 2025

After a strong GDP print in the past three fiscals, Crisil expects GDP growth to moderate in fiscal 2025 as fiscal consolidation could dampen growth, rising borrowing costs and increased regulatory measures could weigh on demand, the net tax impact on GDP is expected to normalise, uneven economic growth of key trade partners could affect exports and any escalation in geopolitical tensions could aggravate market volatility. On the other hand, another spell of normal monsoon and easing inflation could revive rural demand.

At an overall level, India's real GDP is expected to slow to 6.8% in fiscal 2025 compared with provisional estimates of 8.2%in fiscal 2024 due to slowing global growth, rising interest rates, waning demand for services and increasing geopolitical uncertainty. However, the manufacturing sector, investments and domestic demand could remain resilient.

Per capita income grew robustly over fiscals 2012 to 2024

India's per capita income, a broad indicator of living standards, rose from Rs 63,462 in fiscal 2012 to Rs 99,404 in fiscal 2023, at a 4.2% CAGR, led by better job opportunities that were propped up by overall GDP growth. Moreover, population growth remained stable at ~1% CAGR. According to provisional estimates, per capita net national income (NNI) at constant prices increased ~7.4% on-year to Rs 106,774 in fiscal 2024.

Per capita NNI at constant prices

	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23RE	FY24PE
Per-capita NNI (INR)	63,462	65,538	68,572	72,805	77,659	83,003	87,586	92,133	94,420	86,034	94,054	99,404	106,744
Y-o-Y growth (%)		3.3%	4.6%	6.2%	6.7%	6.9%	5.5%	5.2%	2.5%	-8.9%	9.3%	5.7%	7.4%

Note: RE: revised estimates, PE: provisional estimates

Source: Provisional estimates of annual national income, 2022-23, CSO, MoSPI, Crisil Intelligence

India's per capita GDP grows faster than the global average

Between 2018 and 2023, global per capita GDP CAGR of 3.1% was lower than that of emerging markets and developing economies of 4.4%, according to the IMF. Further, India's per capita GDP CAGR was even higher at 4.8% during the period.

GDP per capita, current prices ($)

Regions	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024P	CY 2025P	CAGR (2018-23)
Canada	46,618	46,431	43,573	52,521	55,613	53,548	54,866	57,021	2.8%
China	9,849	10,170	10,525	12,572	12,643	12,514	13,136	14,037	4.9%
Euro area	39,866	39,014	37,938	42,587	41,062	44,463	45,826	47,322	2.2%
India	1,974	2,050	1,916	2,250	2,366	2,500	2,731	2,984	4.8%
Japan	39,850	40,548	40,172	40,114	34,005	33,806	33,138	34,922	-3.2%
The United States	63,165	65,505	64,367	70,996	77,192	81,632	85,373	87,978	5.3%
World	11,472	11,518	11,111	12,527	12,894	13,359	13,836	14,368	3.1%
India	1,974	2,050	1,916	2,250	2,366	2,500	2,731	2,984	4.8%

Notes: CY – Calendar year; E – estimated; P – projected

Source: IMF, Crisil Intelligence

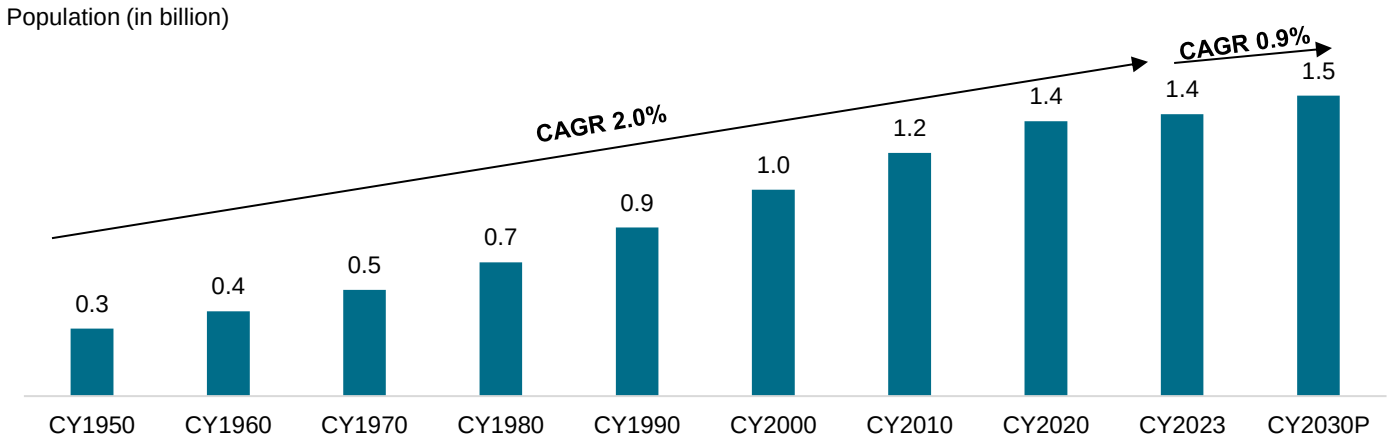
1.2 Demographic factors support domestic growth

Growing population, increasing urbanisation and a young demographic profile to strengthen India's economic growth

India's population grew to ~1.4 billion in 2023 as per World Population Prospects 2024, compared to just 0.3 billion in 1950, thereby registering a CAGR of ~2.0%.

Additionally, as per World Population Prospects 2024, the population of India is expected to remain the world's largest throughout the century and will likely reach its peak in the early 2060s at about 1.7 billion.

India's population growth



Note: P: Projected

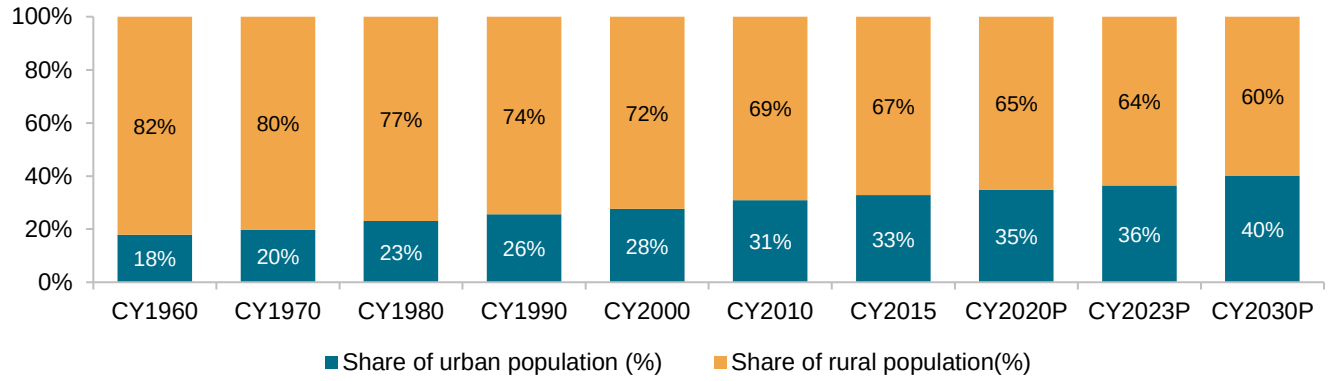
Population is the above chart as of 1st January

Source: UN Department of Economic and Social Affairs, World Population Prospects 2024, Crisil Intelligence

Further, urbanisation has also seen an uptrend growing from 18% in 1960 to an estimated 36% in 2023. This growth in urbanisation necessitates enhancements in facilities such as housing, transportation and utilities to support the increased population density. This in turn has aided in increased spends toward urban infrastructure.

Going ahead, India's urban population is expected to continue to rise on the back of economic growth. The share of urban population is projected to increase to nearly 40% by 2030, according to a UN report on urbanisation.

India's urban vs. rural population (in million)

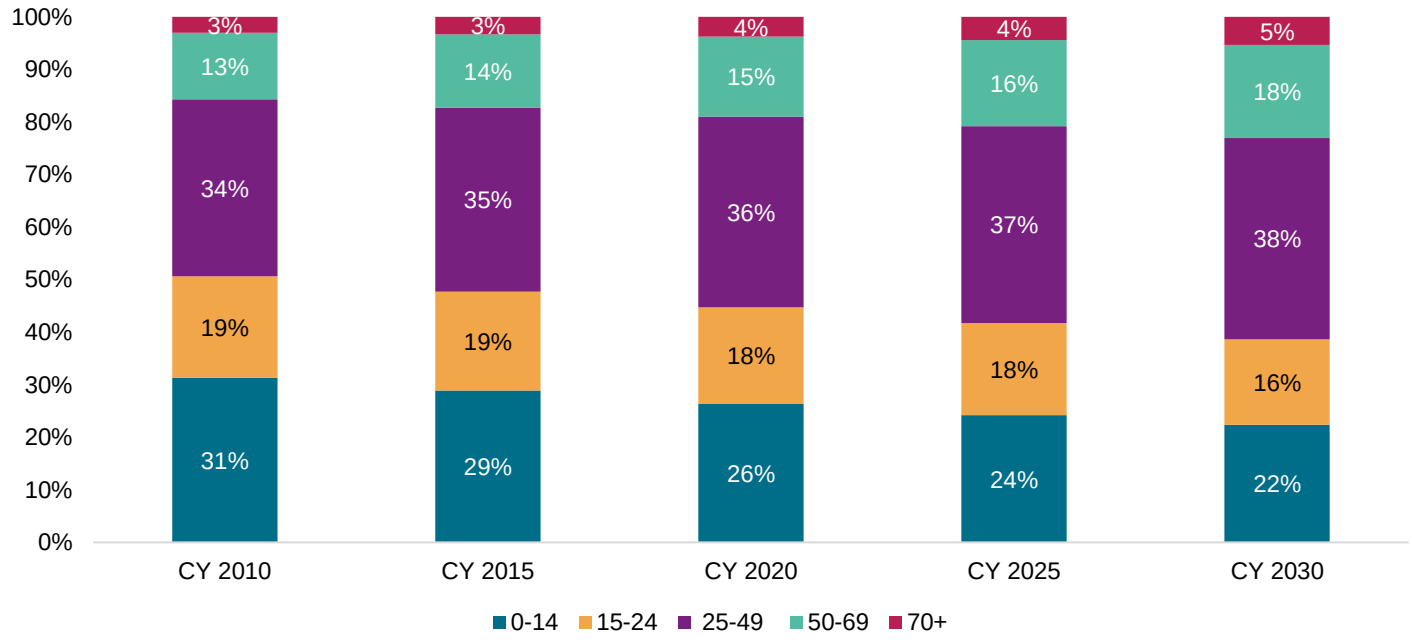


P: projected; Source: World Urbanization Prospects: The 2018 Revision, UN, Crisil Intelligence

38% of India's population projected to be below 25 years by 2030

The country's young population indicates a strong potential for an increase in household income, and basic and healthcare spending. The strong demographic dividend is expected to continue even though the proportion of Indian population below 25 years could fall from 44% in 2020 to 38% by 2030. Additionally, the share of 25-49 years is also estimated to increase from 36% in 2020 to 38% in 2030, indicating a higher mid-age working population.

Indian population by age group



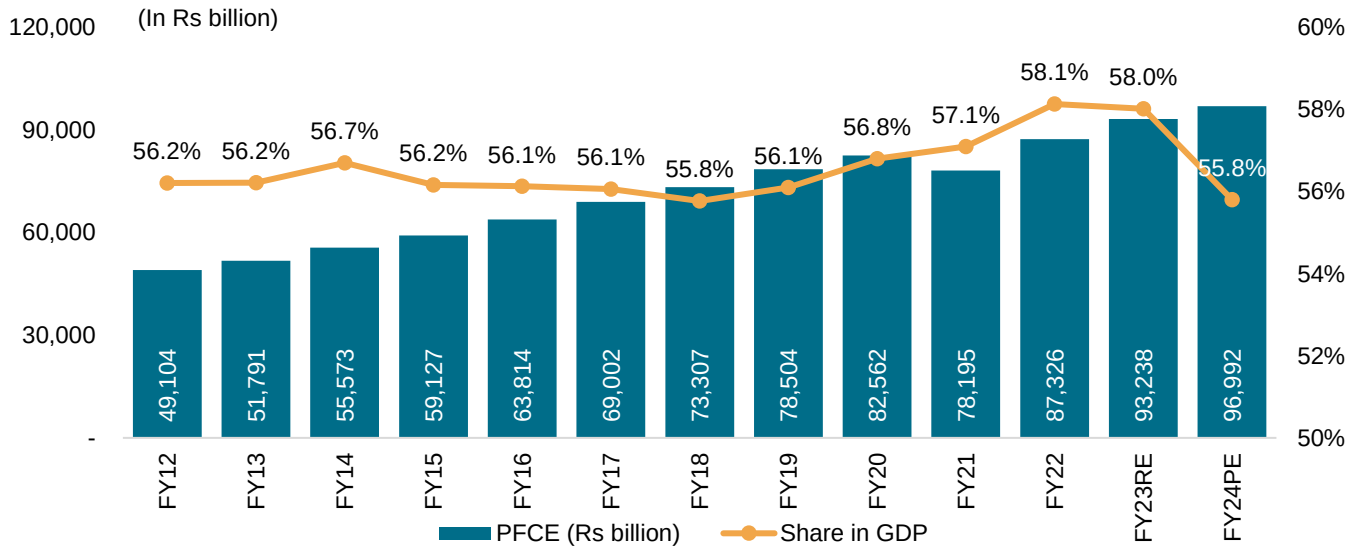
Note: P: projected

Source: UN Department of Economic and Social Affairs, World Population Prospects 2024, Crisil Intelligence

PFCE to maintain a dominant share in India's GDP

Private final consumption expenditure (PFCE) at constant prices clocked a 6% CAGR over fiscals 2012 to 2023, maintaining its dominant share in GDP of ~58.0% in fiscal 2023 (~Rs 93,238 billion in absolute terms, up 6.8% on-year). It was led by healthy monsoon, wage revisions due to the implementation of the Seventh Central Pay Commission's (CPC) recommendations, benign interest rates, growing middle age population and low inflation. As of fiscal 2024, PFCE is estimated to have increased further to Rs 96,055 billion, growing ~3% on-year and accounting for ~56% of India's GDP.

PFCE at constant prices



Note: RE: revised estimates; PE: provisional estimates
Source: MoSPI, Crisil Intelligence

The share of discretionary spending rose from 53.4% in fiscal 2012 to 59.1% in fiscal 2023, reflecting rising disposable income and spending capacity of households. In the medium to long term, a positive economic outlook and growth across key employment generating sectors (such as real estate, infrastructure and automobiles) are expected to have a cascading effect on overall per capita income. This, in turn, is expected to drive discretionary spending.

PFCE and discretionary spending growth

	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23
Share of basic spending in PFCE	46.6%	46.8%	47.3%	45.2%	42.9%	43.0%	41.7%	40.8%	40.3%	43.3%	42.2%	40.9%
Share of discretionary spending in PFCE	53.4%	53.2%	52.7%	54.8%	57.1%	57.0%	58.3%	59.2%	59.7%	56.7%	57.8%	59.1%

RE: revised estimates, PE: provisional estimates, FAE: first advance estimates

N.A – not available; PFCE breakup data is from the latest available National Account Statistics 2023; discretionary items include education, healthcare, electricity, water supply, footwear, personal care products, processed foods, alcoholic and non-alcoholic beverages, tobacco, narcotics, fuel and gas, furnishing and household equipment, vehicle and personal transportation, spending on recreation and culture, communication, restaurants and hotels, financial insurance and other financial services, and other items not elsewhere classified. The rest is contributed by basic items which include food, clothing and housing.
Source: MoSPI, Crisil Intelligence

2. Assessment of the telecom industry in India

2.1 Overview of the global telecom industry

A consolidated industry driven by economies of scale

The telecom industry is capital intensive and highly competitive, with key players undertaking mergers and acquisitions (M&As) to not only survive but also upgrade their technology, expand the customer base and enhance product diversification. Acquisitions in the sector primarily involve horizontal integration as the companies aim to gain competitive advantage by acquiring competitors. Fewer market players lead to economies of scale and a reduction in overlapping infrastructure, thereby lowering operational expenses and enabling more efficient use of capital investments. In most key countries, 2-5 telecom companies dominate the sector. A few examples are given in the table below.

Countries	Top telecom companies
Australia	Telstra, Optus, TPG Telecom, Superloop, Macquarie Telecom Group
Brazil	Claro, Telefônica, TIM
China	China Mobile, China Telecom, China Unicom
France	Orange, SFR, Bouygues Telecom, Free Mobile
Germany	Deutsche Telekom, Vodafone, O2 Telefónica
Japan	NTT DOCOMO, KDDI Corp, Softbank Corp, Rakuten Inc
Hong Kong	China Mobile Hong Kong, Hong Kong Telecommunications, SmarTone Mobile, Hutchison Telephone, 21 ViaNet
India	Bharti Airtel, Reliance Jio, Vodafone Idea, BSNL (Bharat Sanchar Nigam Limited), MTNL (Mahanagar Telephone Nigam Limited)
Spain	Vodafone Spain, Orange Spain, Movistar Telefónica, Yoiga
The United States	Verizon, AT&T, T-Mobile
The Middle East	Emirates Telecommunications Corporation, Emirates Integrated Telecommunications Company PJSC, Saudi Telecommunication Company (STC), Etihad Etisalat (Mobily), Zain

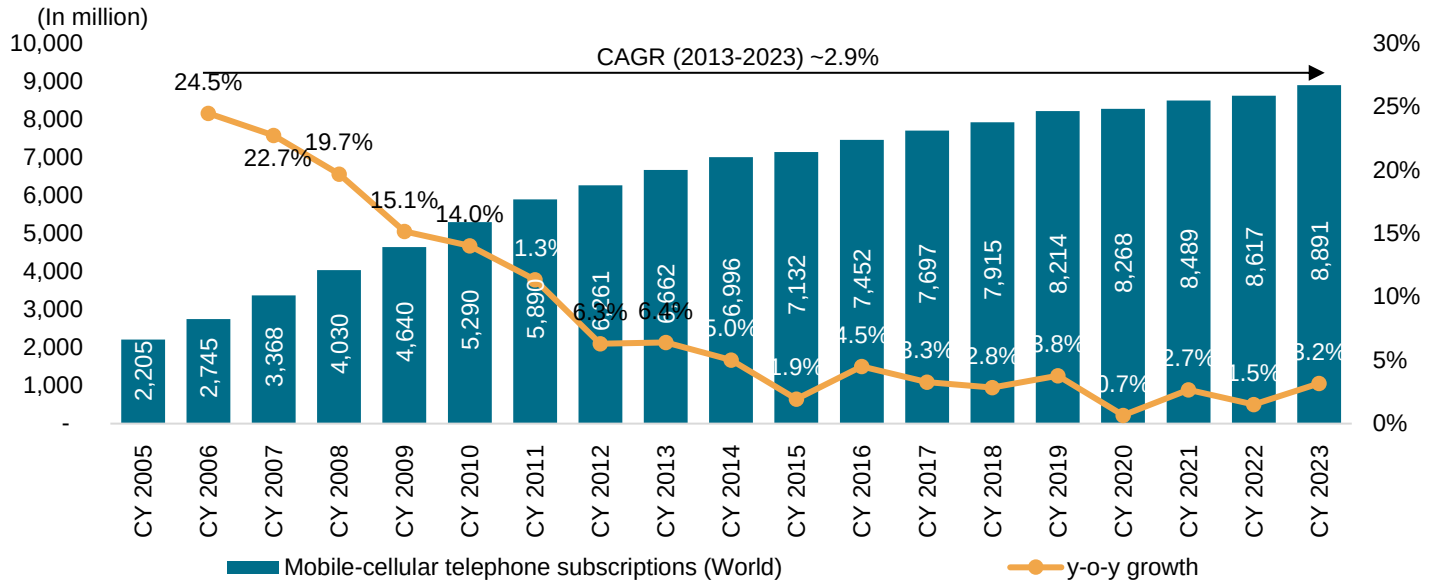
Source: Secondary research, Crisil Intelligence

Mobile subscriber base clocked a CAGR of ~3% over 2013 to 2023

Mobile cellular telephone subscribers refers to subscribers of a public mobile telephone service, which provides access to a public switched telephone network (PSTN) using cellular technology, including the number of pre-paid subscriber identity module (SIM) cards active during the past three months. Total subscribers should include all mobile cellular subscriptions that offer voice communications.

Overall mobile subscribers grew at a CAGR of ~2.9% over 2013 to 2023 and rose ~1.5% on-year to 8,891 million in 2023 from ~8,617 million in 2022.

Mobile subscriptions



CY: Calendar year
Source: International Telecommunication Union (ITU), Crisil Intelligence

China and India the top two telecom markets by customer base

China is the largest telecom market with 1,807 million wireless customers as of calendar year 2023, followed by India. Other countries in top five include US, Indonesia and Russia.

Mobile cellular subscriptions – India registered healthy growth among global peers

	Telecom customers in CY 2013	Telecom customers in CY 2022	CY 2013-2023 CAGR (%)
China	1,229	1,807	3.9%
India	886	1,143*	2.9%
US	311	386	2.2%
Indonesia	313	352	1.2%
Russia	218	245*	1.3%
Brazil	271	213	-2.4%
Egypt	100	106	0.6%
Indonesia	313	352	1.2%
Mexico	107	140	2.7%
South Africa	77	108	3.5%
Thailand	94	121	2.6%
UK	79	84	0.7%
Viet Nam	124	131	0.6%

Note: * Data as of CY 2022; CY: Calendar year
Source: ITU, Crisil Intelligence

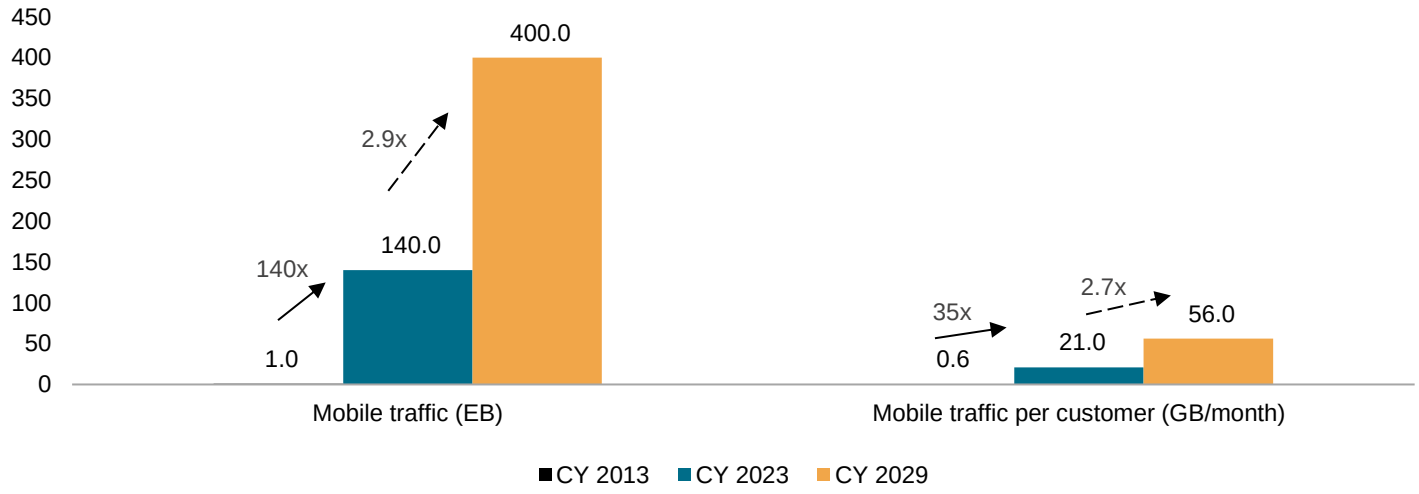
Key growth drivers

Increasing dependence on online infrastructure

Growth in the digital economy has encouraged people to rely more on digital applications for commonplace activities, leading to a rise in mobile users and data consumption. Over the past 10 years, the global mobile customer base has seen a CAGR of 2-4% across regions. Growth was higher during the pandemic.

Global mobile traffic increased from 0.6 GB/customer/month in 2013 to 21.0 GB/customer/month in 2023, logging 35x growth in data consumption. The Ericsson Mobility Report estimates an increase of 140x in mobile traffic over the past decade as global mobile data traffic increased from 1 exabyte (EB)/month in 2013 to 140+ EB/month in 2023. Factors driving data traffic growth in mobile networks include ever-increasing demand for online digital services, 4G/5G deployment across telecom markets, increased network capacity with the new generation of mobile technology, improved quality of experience and affordable plans. This is expected to fuel the overall telecom industry growth through a larger customer base and improved penetration.

Global mobile data consumption growth



CY: Calendar year
Source: Ericsson Mobility Report 2023, Crisil Intelligence

Growing demand for advanced technologies

The rollout of advanced technologies such as 4G and 5G is positively driving the global telecom industry by providing improved speed, reliability and capacity. After the rollout of 4G services in 2010, many global markets began transitioning to 5G services starting 2019.

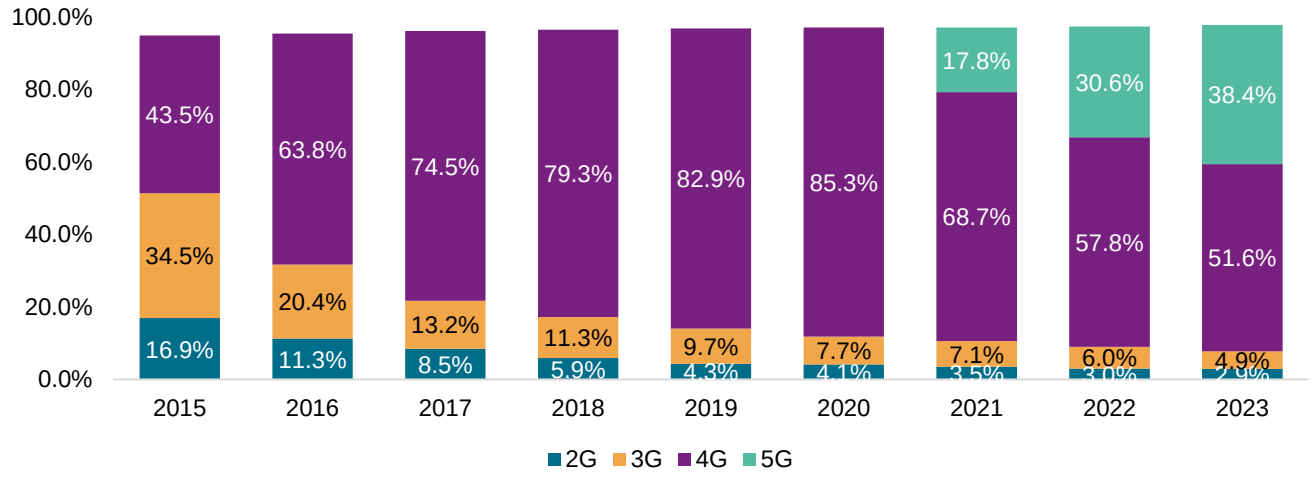
As of 2023, ~38% of the world's population was covered by 5G. The deployment of 5G not only enhances speed and capacity but also transforms the digital ecosystem by connecting machines, objects and devices with ultra-low latency. Consequently, many high-income countries are planning to switch off older-generation mobile networks in favour of new-generation networks such as 5G. For instance, most operators in the European region plan to switch off 2G and 3G networks by December 2025.

Operators are, in fact, leveraging 5G to carve out new revenue streams. Private 5G networks, network slicing and edge computing are some of the new technologies enabling this transition.

On the demand front, realisation of 5G use cases is expected over time. Voice over Long Term Evolution, for instance, took almost five years after the commercialisation of 4G — even 10 years in some international markets. A similar trend is expected for 5G. Ultra-high-definition streaming, 3D video, augmented reality/virtual reality, autonomous driving, connected ambulance and remote surgery are representative use cases of 5G that were stated in ITU-R's 5G Vision Recommendation, but have not yet become mainstream. Demand for 5G will pick up with the development and mainstreaming of the 5G ecosystem.

Overall, these advancements collectively meet the needs of end-consumers by improving service quality and creating new business opportunities, thereby positively impacting the global telecom industry.

Network coverage by type

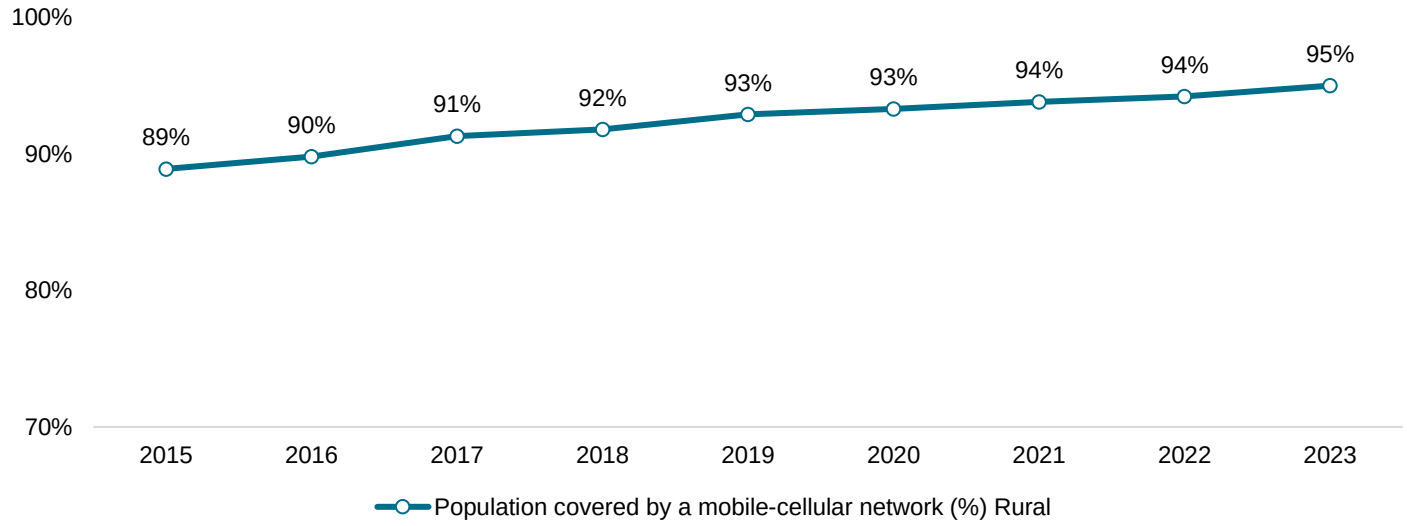


Note: Calendar years are presented in the chart
Source: ITU, Crisil Intelligence

Increasing rural penetration of mobile cellular networks

The increasing penetration of mobile cellular networks is expected to act as a catalyst for the global telecom industry. As of 2023, 95% of the rural population was covered by a mobile cellular network, compared with 100% urban population. By extending connectivity to underserved rural areas, telecom players can foster digital inclusion and support multiple services, such as education and business. Increased rural penetration may also lead to a rise in demand for e-commerce and other digital services, which will eventually result in increased data usage.

Population covered by mobile cellular networks — rural



Note: Calendar years are presented in the chart
Source: ITU, Crisil Intelligence

2.2 Overview of Indian telecom industry

Telecommunication has been playing a pivotal role in India's economic growth. It is the backbone of many industries, including e-commerce, media and entertainment, finance, information technology (IT), healthcare, transportation and logistics. The sector facilitates seamless movement of data worldwide through wired or wireless channels and significantly influences economic progress. The telecom market is constantly evolving with the integration of cutting-edge technologies over the years. This has widened the coverage of telecom services globally and made them an indispensable part of the daily lives of consumers. Telecom proved to be an essential service especially during the Covid-19 pandemic, enabling people to remain connected amid worldwide lockdowns.

The telecom industry mainly comprises wireless services or mobile services, and wireline services or fixed-line services. In India, wireless services accounted for 97.2% of the total telecom customer base as of fiscal 2024, followed by wireline services (2.8%).

Indian telecom industry growth led by wireless services

At 1,165.5 million as of fiscal 2024, wireless telecom customers accounted for 97.2% of the total telecom customer base of 1,199.3 million.

The number of wireless telecom customers rose from 904.5 million in fiscal 2014 to 1,183.4 million in fiscal 2018, before falling to 1,157.7 million in fiscal 2020 due to the closure of inactive SIMs and deactivation of SIMs that were not linked with Aadhaar. Additionally, an increase in base (entry-level plans) tariff rates by telcos made owning multiple SIMs an expensive proposition for customers, leading to SIM consolidation. Moreover, the number of customers temporarily declined during the first pandemic wave as urban areas lost 18 million customers, while rural areas gained 3 million. As lockdowns eased, the customer base recovered and exceeded pre-pandemic levels, reaching 1,181.0 million by the end of fiscal 2021. Urban areas contributed significantly to this growth as remote work, e-learning and other online services became widely prevalent.

Wireless customers fell to 1,142.1 million in fiscal 2022, led by SIM consolidation, followed by a modest increase of 0.17% to 1,143.9 million in fiscal 2023. The impact of SIM consolidation diminished by the end of fiscal 2023, resulting in a positive upswing in wireless numbers in fiscal 2024 (~1.89% on-year to 1,165.5 million subscribers). However, the overall increase was constrained by inflationary pressures.

Telecom customers in India

Customers (million)		FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	CAGR (FY14-23)
Total customers		933.0	996.5	1058.9	1194.6	1206.2	1183.5	1178.0	1201.2	1166.9	1172.3	1199.3	2.54%
Wireless	Customers	904.5	969.9	1033.6	1170.2	1183.4	1161.8	1157.7	1181.0	1142.1	1143.9	1165.5	2.57%
	% of total customers	96.9%	97.3%	97.6%	98.0%	98.1%	98.2%	98.3%	98.3%	97.9%	97.6%	97.2%	-
Wireline	Customers	28.5	26.6	25.2	24.4	22.8	21.7	20.2	20.2	24.8	28.4	33.8	1.72%
	% of total customers	3.1%	2.7%	2.4%	2.0%	1.9%	1.8%	1.7%	1.7%	2.1%	2.4%	2.8%	-
Rural	Customers	377.7	419.3	449.2	501.6	524.6	514.4	521.5	537.4	519.8	518.6	533.9	3.52%
	Share	40.5%	42.1%	42.4%	42.0%	43.5%	43.5%	44.3%	44.7%	44.5%	44.2%	44.5%	-
Urban	Customers	555.3	577.2	609.7	693.2	681.6	669.2	656.5	663.8	647.1	653.7	665.4	1.82%
	Share	59.5%	57.9%	57.6%	58.0%	56.5%	56.5%	55.7%	55.3%	55.5%	55.8%	55.5%	-

Source: TRAI, Crisil Intelligence

Wireless services have become the preferred choice because of their convenience and lower cost, resulting in stagnation in the wireline customer base. Notably, wireline services remain more popular among the urban milieu. The number of wireline customers declined on-year from fiscal 2014 to fiscal 2019. Thereafter, the trend reversed due to an increase in wired broadband penetration amid the pandemic. This was fuelled by the bundling of wired broadband, digital TV content/digital cable and wireline telephone services. As a result, the number of wireline customers increased to 28.4 million in fiscal 2023 and reached 33.8 million in fiscal 2024.

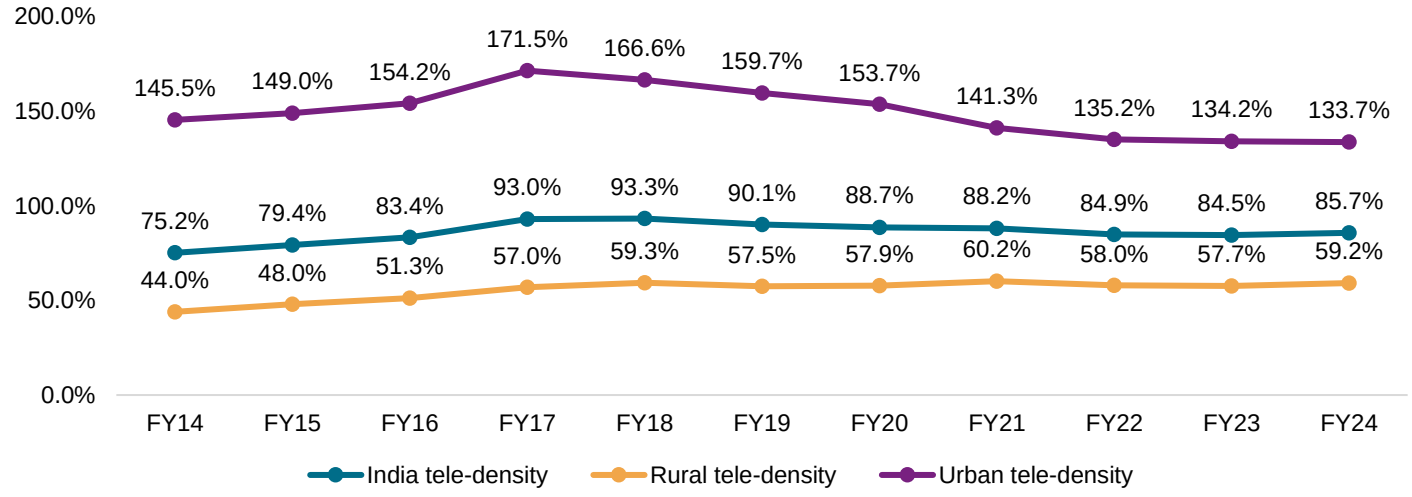
Urban telecom customers have maintained their dominance, capturing a 55.5% share as of fiscal 2024, compared with 59.5% in fiscal 2014.

Overall tele-density improved in fiscal 2024, supported by increasing rural tele-density

Growing need for telecom services, network expansion by telecom operators, and availability of services at affordable prices have been driving customer addition and, in turn, contributing to an improvement in tele-density (84.7% in fiscal 2024 vs 75.2% in fiscal 2014). Rural tele-density improved to 59.2% in fiscal 2024 from 44.0% in fiscal 2014, led by higher penetration of wireless services. Urban tele-density, on the other hand, declined to 133.7% from 145.5% over the same period due to SIM consolidation.

Rural customers grew faster than urban counterparts due to low tele-density. Notably, rural customers logged a CAGR of ~3.6% between fiscals 2014 and 2023. In contrast, urban customers exhibited a lower CAGR of ~1.8%. The difference in growth rates can be attributed to affordability of smartphones and telecom services, and continued network expansion by telecom operators. Telcos' concentrated and aggressive expansion strategies in rural areas supported rapid customer-base augmentation in these regions. Telecom revenue growth will be driven by a growing customer base and increasing rural tele-density.

Tele-density — India

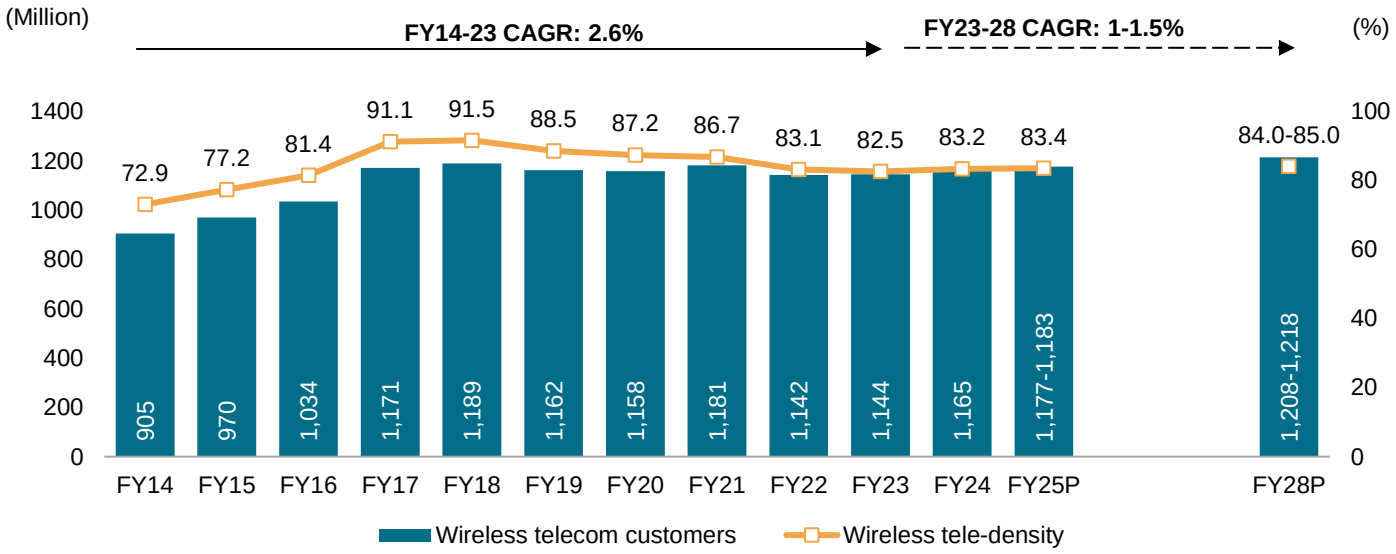


Source: DoT, TRAI, Crisil Intelligence

Expansive coverage and smartphone penetration to support growth in wireless services

Crisil Intelligence expects the wireless customer base to clock a CAGR of 1-1.5% between fiscals 2023 and 2028, driven by higher smartphone penetration, increased affordability of mobile phones, and continued demand for data and telecom services. Wireless tele-density, defined as the number of mobile/ wireless connections for every hundred individuals living within an area, stood at 82.5% in fiscal 2023 and 83.0% as of the nine months of fiscal 2024. It is expected to reach 84.0-85.0% by fiscal 2028, driven by telcos' investments in expanding coverage and the increase in smartphone penetration, particularly in rural areas.

Wireless telecom customer base



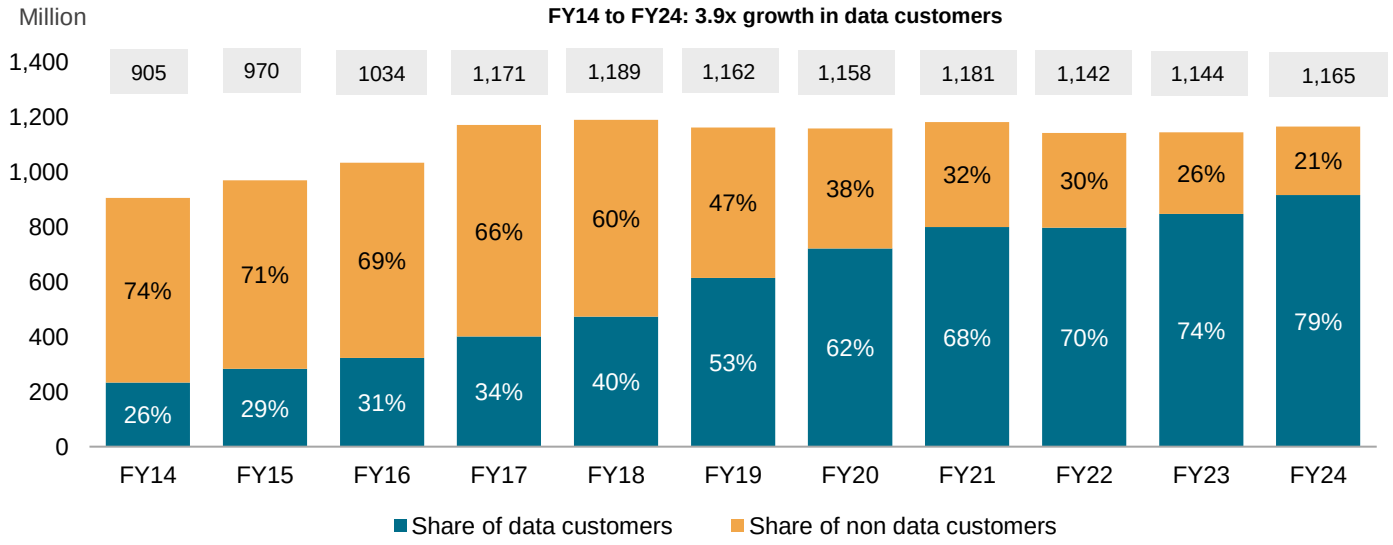
P: Projected
Source: TRAI, Crisil Intelligence

Data users and consumption grew multifold over the past decade

As of fiscal 2024, the number of internet or data customers surged 3.9x to ~916 million from 233 million in fiscal 2014, logging a CAGR of 14.6%, propelled by a sharp decline in tariffs. Subsequently, the share of data customers soared to ~79% from 26%. The increasing affordability of smartphones and a subsequent rise in smartphone adoption also supported the rise in data consumption.

Crisil Intelligence expects consistent growth in data customers, owing to the ongoing technological upgrades, proliferation of smart devices (such as smartphones), increased internet usage and gradual transition of non-data users towards data-based services. Furthermore, the affordability of data packages will widen the accessibility of data services to a larger demographic.

Data and non-data customers in the wireless telecom user base



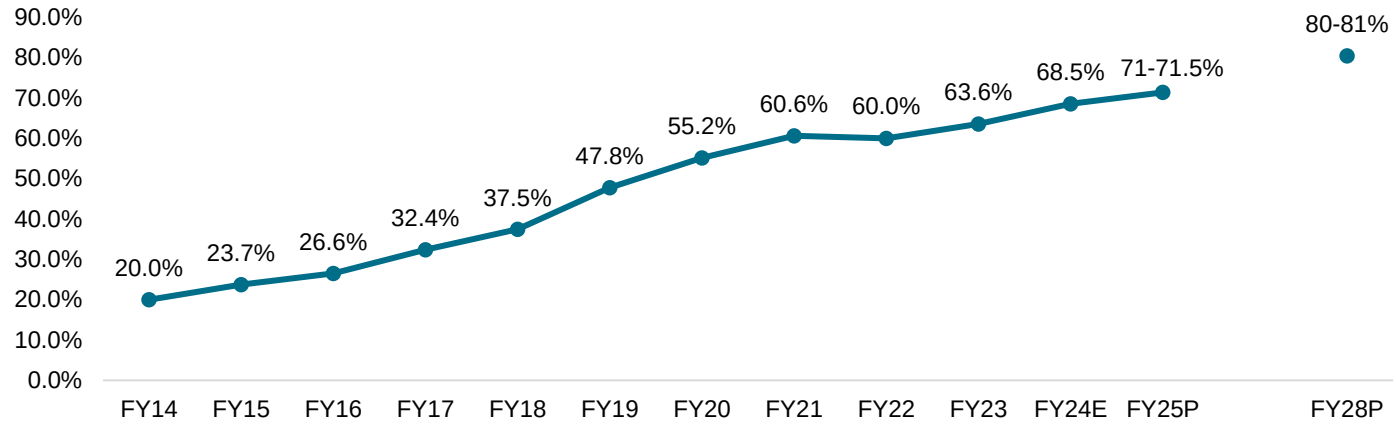
Source: TRAI, Crisil Intelligence

Revenue to be driven by 80-81% rise in wireless internet penetration by fiscal 2028

Internet users in India surged over the past few years, with internet penetration as a percentage of the total population standing at 63.6% as of fiscal 2023 (vs 20.0% as of fiscal 2014). Crisil Intelligence expects the number of wireless internet customers to be 960-970 million by fiscal 2025, constituting 71.0-71.5% of internet penetration. By fiscal 2025, we expect the majority of customers to transition from 2G and 3G data services to 4G and 5G services. This can be attributed to increased demand for data, affordable pricing of 4G services, early conversion to 5G and availability of affordable smartphones.

By fiscal 2028, wireless internet penetration is projected to reach 80-81%. The growth, though, is subject to the evolution in the data consumption landscape and increase in the average telecom service tariff.

Wireless internet penetration in India (%)



P: Projected

Internet penetration is per 100 population

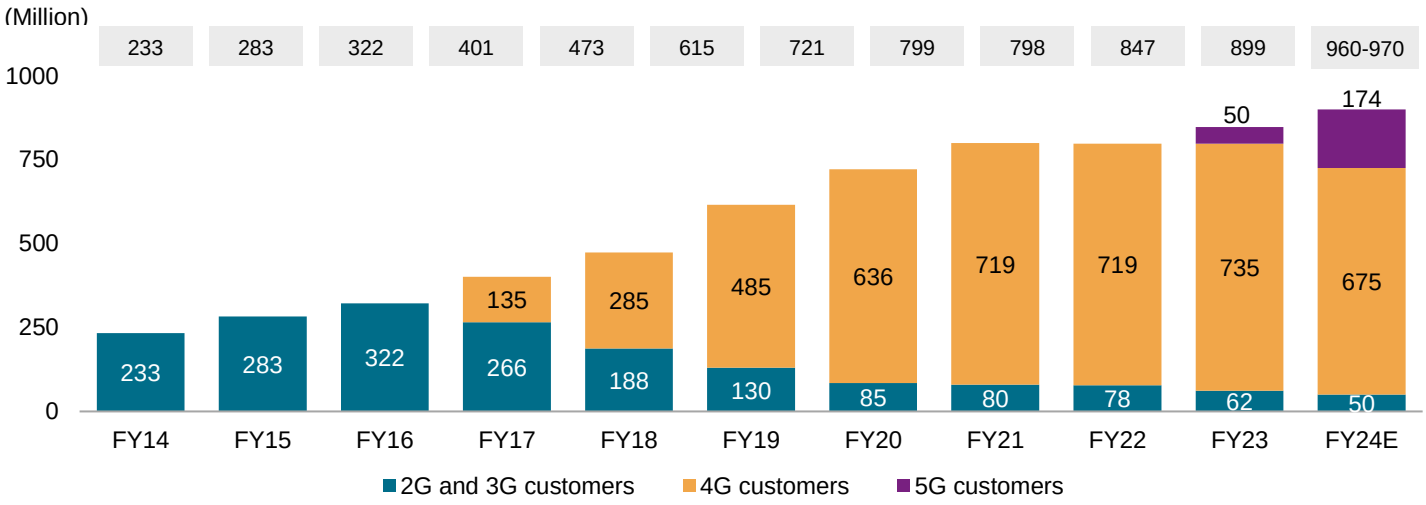
Source: TRAI, Crisil Intelligence

5G adoption to rise, fuelled by affordable 5G device options

Crisil Intelligence estimates the number of 4G customers to have been ~675 million in fiscal 2024, constituting ~75% of the internet customer base. The 5G customer base is expected to grow, with the pace of conversion largely influenced by affordable pricing of 5G devices and continued handset replacement cycle. Offering 5G introductory services for free allows customers to experience high-speed data and encourages upgrades, playing a vital role in shaping the future trajectory of customers and data usage. Jio offers free 5G for active prepaid or postpaid plans of Rs 239 or above, while Airtel offers free 5G to all postpaid and prepaid customers with unlimited packs starting from Rs 239.

In fiscal 2025, Crisil Intelligence projects ~70% of total users to be 4G-enabled and ~25-26% to use 5G, mainly in urban markets, surpassing 240-250 million users. Only a small fraction of data users will continue to rely on legacy 2G and 3G networks.

Number of customers across 2G/3G/4G/5G data



Note: Operators launched 5G services in October 2022. There is an increase in the number of 5G customers as users adopt 5G-enabled smartphones, with 5G coverage becoming more ubiquitous. The number of 5G customers could differ as 5G coverage may be intermittent.

P: Projected

Source: TRAI, Crisil Intelligence

Key emerging trends in the Indian telecom industry

- **Satellite communications:** Satellite internet or broadband is a wireless internet connection facilitated by communication satellites orbiting the earth. Offering global coverage, it is location-independent, accessible from anywhere within the satellite range, providing a versatile and widespread internet service. It can address the telecom industry's challenge of installing traditional network infrastructure in rural and remote areas with difficult terrains and other issues.

  In 2023, the government approved the Indian Space Policy 2023, which allows non-government entities to use low earth orbit and medium earth orbit satellites to provide broadband services in India. Jio Satellite Communications Ltd and OneWeb India Communications Pvt Ltd (Eutelsat OneWeb) have been provided with Global Mobile Personal Communication by Satellite licences.

  Initially, the primary focus of these companies would be on launching satellite internet services in India for enterprises. Jio presented JioSpaceFiber at the India Mobile Congress 2023, while Airtel's exhibit highlighted solutions from OneWeb India Communications Pvt Ltd. Amazon and Starlink have applied for licence for satellite internet. Satellite has the potential to bridge the digital divide by covering hitherto uncovered, remote areas, while serving the country's disaster, maritime and defence requirements.

- **5G fixed wireless access (FWA):** The emergence of 5G is facilitating a ground-breaking convergence between mobile technology and the requirements of fixed-line services and pricing. Catering to home and business needs in areas where laying and maintaining fibre is cost-prohibitive, FWA empowers network operators to provide ultra-high-speed broadband to suburban and rural regions, especially those in fibre-dark areas. FWA has the potential to overcome challenges related to last-mile connectivity of fibre infrastructure in India's rural and urban regions. The technology is based on 5G and can be used for faster monetisation of 5G services in India as well.

- **5G application development labs:** The Union Budget for 2023 revealed the government's plan to set up 100 laboratories in engineering institutions to develop applications using 5G services. The laboratories will play a crucial role in investigating possibilities across various industries, such as smart classrooms, precision farming, intelligent transport systems and healthcare. The centre made a provision of Rs 55.6 million for 5G testbed in fiscal 2024.

- **Investment in domestic telecom equipment manufacturing capabilities**: The government's production-linked incentive (PLI) scheme for mobile, telecom and networking products aims to offer financial incentives to boost domestic manufacturing and attract investments in target segments. Such initiatives will boost the availability of equipment and devices in the domestic market, catering to both demand and supply markets. This, in turn, is expected to lower import bill and drive growth in the telecom sector.

- **Green telecom:** To align with sustainability and environmental protection goals, telecom companies are transitioning towards green telecom. To reduce greenhouse gas (GHG) emissions from power consumption related to tower assets, the telecom industry is exploring solutions, such as distributed solar plants, lithium-ion storage plants and piped natural gas gensets, which will help reduce diesel consumption by towers. According to Telecom Regulatory Authority of India (TRAI), going green has become necessary for telecom operators, given that energy costs account for 25% of their operating expenses. Amid rising environmental concerns related to GHG emissions, the DoT has set up a green passport laboratory with a facility to carry out energy-efficiency testing of various telecom equipment.

- **6G vision**: Globally and in India, initial 6G networks are expected to be deployed around 2030. The government of India has prepared a Bharat 6G Vision document and constituted Bharat 6G Mission and an Apex Council. The objectives, structure and functions of the Apex Council and Bharat 6G Mission are to be completed in phase-1 and phase-2 over 2023-25 and 2025-2030, respectively. Further, Bharat 6G Alliance (B6GA) is a collaborative platform comprising the domestic industry, academia, national research institutions and standards organisations, set up to facilitate the implementation of Bharat 6G Vision. B6GA has signed a memorandum of understanding with the Next G Alliance of the

US to explore collaboration opportunities on 6G wireless technologies. Further, the government is funding the 6G THz testbed with orbital angular momentum and multiplexing. The project aims to enhance the understanding of higher millimetre wave and sub-terahertz deployment scenarios and facilitate research on optical angular momentum, a key enabling technology for implementing 6G services. Subsequently, 'ubiquitous connectivity' is a usage scenario proposed by India for inclusion in the 6G framework and now part of the International Telecommunication Union 6G Framework. With all the development, matured 6G deployment is nearly a decade away.

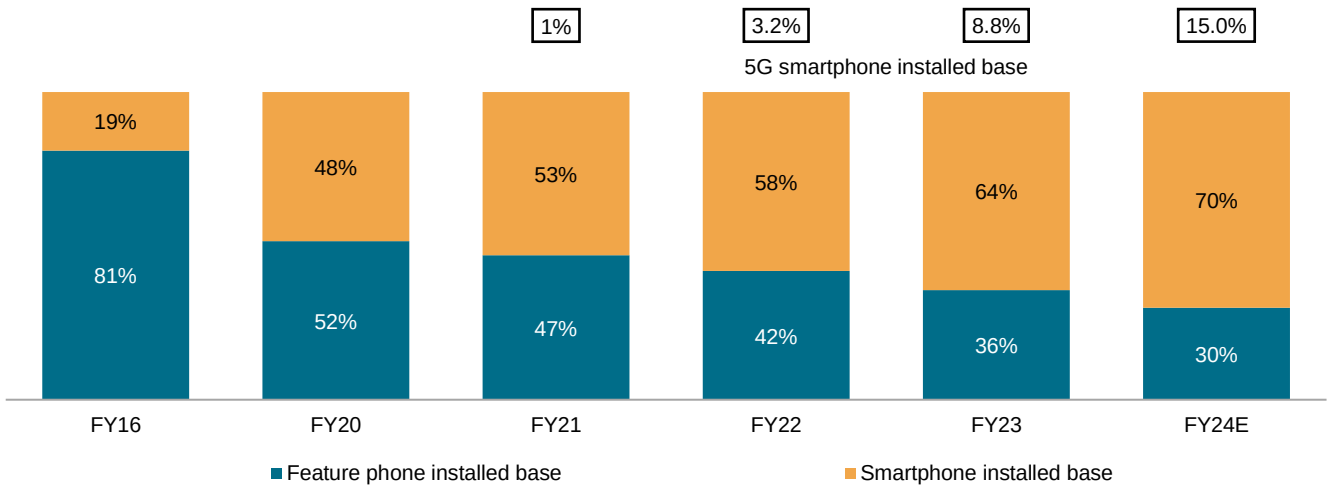
Key growth drivers of the Indian telecom industry

Rising smartphone penetration

The Indian market has evolved from a feature-phone user base to that of smartphone, with the latter projected to have constituted ~70% share in the mobile phone user base in fiscal 2024. Additionally, industry sources estimate 5G-enabled smartphones to have accounted for ~15% of the mobile phone user base in India as of fiscal 2024, compared with ~9% in fiscal 2023.

Crisil Intelligence expects the rapid 5G smartphone growth to continue, owing to improving affordability and attractive pricing. The growing mix of 5G smartphones in the overall shipments and emergence of 5G-specific use cases will augur well for telecom industry players and drive demand for 5G data services.

Smartphone share in the Indian mobile market



E: Estimated
Source: Publicly available data on smartphone and mobile shipments through various research agencies, Crisil Intelligence

Increasing data consumption

Average data consumption per user is estimated to be around ~23.1 GB/user/month in fiscal 2024 compared to data consumption of 11.3 GB/user/month, driven by higher demand for data for video and music content, social media engagements, video calling and sustained adoption of hybrid work-from-home and study-at-home practices. The expansion of 4G networks in rural areas and a steep decline in data tariffs also contributed to the increased demand of telecom services.

Converged DTH offerings

India has a high television penetration of ~65%. About 190 million households own cable or direct-to-home (DTH) connections. Of this, ~167 million households do not have wired broadband connections (assuming a household with wired broadband also owns a television). These households could have been a ready target market had broadband services been bundled with TV subscription at competitive rates. Hence, telcos are providing converged or comprehensive offerings of DTH, broadband and mobile services to attract more customers.

Key reforms and regulatory actions in the Indian telecom industry

Regulations	Development
Spectrum liberalisation	In 2015, operators were given the option to liberalise their entire administratively allotted spectrum holding in the 800 MHz and 1,800 MHz bands in a circle for the remaining validity period of the right-to-use spectrum
Discriminatory tariff	In 2016, TRAI ruled out discriminatory tariff of data services. As per discriminatory tariffs, an operator cannot charge different tariffs for data services based on the content accessed, transmitted or received by the consumer.
Retailing of spectrum, infrastructure	In May 2016, virtual network operators (VNOs) were given permission to obtain licences and offer services of a telecom operator, without owning the spectrum and related infrastructure
Telecom panel announces a 3% minimum SUC	In August 2016, the government approved a minimum spectrum-usage charge (SUC) of 3% on adjusted gross revenue (AGR) proposed by the Telecom Commission
Extension of the spectrum-payment period	In September 2017, the Telecom Commission extended the spectrum-payment duration from 10 to 16 years based on an inter-ministerial group (IMG) recommendation. It also lowered interest rates on unpaid dues by at least two percentage points, replacing prime lending rate (PLR) with marginal cost of fund-based lending rate (MCLR) (with effect from April 1, 2016) for calculating telecom operators' interest on delayed payment of licence fee and spectrum usage charges. This is aimed at alleviating the debt-laden telecom industry
Interconnect-usage charge (IUC)	The TRAI reduced the termination charges for local and national long-distance calls from 14 paise/minute to 6 paise/minute with effect from October 1, 2017
Relaxation of spectrum cap	In 2018, the spectrum holding cap was increased from 25% to 35% in a circle. The intra-band cap of 50% holding in a circle was removed, but 50% cap was also imposed on combined spectrum holdings in the sub-1 MHz band per circle
The Telecommunication Tariff (Sixty Third Amendment) Order, 2018	Under this order, if tariff is found to be predatory, the service provider will be charged an amount not exceeding Rs 5 million for each service area, provided it holds a significant market power in the service area, i.e., at least 30% share in the service area
National Digital Communication Policy, 2018	This policy facilitated the development of communication infrastructure and services to achieve inclusive social-economic growth in the country
International termination charge	In February 2018, the TRAI reduced the ITC payable by an international long-distance operator (ILDO) to the access provider on whose network the call terminates from Rs 0.53 per minute to Rs 0.30 per minute. It was again revised in May 2020 – to a range, i.e., a minimum of Rs 0.35 and maximum of Rs 0.65 per minute
Apex court on AGR definition	In October 2019, the Supreme Court ruled in favour of DoT with regard to definition of AGR revenues, resulting in telecom players being liable to pay dues of the past 14 years as per the order, including interest, penalty and interest on penalty

Regulations	Development
Moratorium on spectrum payments	In 2019, the Indian government announced a moratorium of two years on deferred spectrum payments
Scrappage of IUC	In January 2021, the TRAI scrapped the termination charges for local and national long-distance calls for all telecom operators
Spectrum auctions	The DoT initiated the formal process of auctions, scheduled to be held in March 2021. The auctions included spectrum across all bands, except 5G
Apex court slashes incumbent's plea	The Supreme Court rejected the plea of telecom operators of recalculating the AGR dues to arithmetic errors in 2021
Cabinet announces AGR relief package and other key reforms	In September 2021, the Union Cabinet approved several structural and process reforms in the telecom sector, including: Four-year moratorium on payment of statutory dues by telecom companies, both AGR and spectrum charges The definition of AGR has been rationalised by excluding non-telecom revenue of telecom companies 100% FDI in telecom through the automatic route has been approved The regime of heavy interest, penalty and interest on penalty on delayed payments of licence fees and spectrum usage charges has been rationalised The Centre will compound the interest annually instead of monthly Spectrum auction will be done for 30 years, instead of 20 years. After completing the 10-year lock-in period, the buyer will have the option to surrender by paying surrender charges Removal of additional SUC of 0.5% for spectrum sharing No SUC on spectrum acquired in future spectrum auction
SUC	In June 2022, the DoT removed the 3% floor on SUC, as it announced the weighted average of SUC to be calculated by the sum of the product of spectrum holdings and applicable SUC rate divided by the telecom company's total spectrum holdings. No SUC will be applied on spectrum auctioned in 2022.
Universal Service Obligation Fund (USOF)	USOF was started by the Government of India in 2003 to provide telecom services (including mobile services, broadband connectivity, and ICT infrastructure creation – added in 2006) for rural and remote areas in India Under USOF, some projects are allotted to various mobile service providers for providing mobile network in the country, especially in rural and remote areas. Over 2020 and 2021, projects were assigned for setting up mobile connectivity in over 8000 uncovered villages across Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Himachal Pradesh, Maharashtra, Madhya Pradesh, Odisha, Rajasthan, Uttarakhand, Uttar Pradesh, Jammu and Kashmir and Ladakh Northeast was among the key regions to receive funds for expansion of mobile networks with 26.2% share. This region has seen installation of 2,207 towers until December 2023 under the USOF scheme. In 2017, nearly 2,000 mobile towers were installed in 2,128 uncovered village and national highways in Assam and Northeast states. This has helped the telecom companies to increase their penetration in the area. In July 2022, the project for saturation of 4G mobile services in uncovered villages across the country was approved to provide 4G mobile services in 24,680 uncovered villages in remote and difficult areas. In addition, 6,279 villages having only 2G or 3G connectivity would be upgraded to 4G.

Regulations	Development
5G auctions	The DoT accepted the price cuts recommended by TRAI for the 2022 5G auctions. Also, the Cabinet permitted enterprises to run 'captive non-public networks'. Enterprises were allowed to take spectrum on lease from service providers to run private network.

Source: TRAI, DoT, PIB, Crisil Intelligence

Key challenges and risks in the Indian telecom industry

Spectrum is regulated and available through DoT auction

In India, spectrum auctions are held for 22 telecom circles and a telecom company needs to acquire spectrum in each circle to provide comprehensive coverage to its consumers. Operators are also required to acquire a unified license with authorisations for access services in each circle before they participate in auctions. So, if a new telecom company plans to launch services in a particular region, it will have to buy both a spectrum and licence for the entire circle. Further, it would have to either wait for spectrum auction or acquire a telecom company with a spectrum portfolio. Currently, acquisition costs are prohibitive, given significant consolidation in the domestic industry.

High capital investments vital for sustaining telecom services

Telecom players require substantial capital to purchase spectrum through government auctions and establish and maintain their network infrastructure. Further, the telecom industry remains susceptible to rapid technological changes, necessitating fresh investments or significant overhaul of existing networks.

The industry spent Rs 1,500 billion during the 5G auction in 2022, with Reliance Jio, Bharti Airtel and Vodafone Idea accounting for Rs 800.8 billion, Rs 430.4 billion and Rs 188.0 billion, respectively. Further, Indian telecom operators have spent nearly Rs 3,000 billion since 2014 to acquire spectrum across various bands.

The telecom sector has low average asset turnover ratio of 0.3 times (fiscals 2020-23), indicating high capex requirements on a sustained basis. Capex intensity is high and estimated at ~30% of total revenue in fiscal 2023 and ~25% in fiscals 2024 and 2025.

Even network opex was 25-30% of revenue based on the data collated for industry players over fiscals 2021-23. Thus, the telecom industry's high capital intensity acts as a strong entry barrier for new entrants.

Hurdles in establishing network coverage across India and competing with established players

India's vast landscape and rugged terrain make the process of setting up infrastructure extremely complex and expensive. Hence, new players will face several challenges in matching the coverage of established companies. A new telecom player would face many roadblocks while establishing network coverage across India. The cost per customer is higher in rural areas than urban areas due to low population density.

Economies of scale important for survival and profitability of players

Given the low average revenue per user (ARPU) compared with other similar markets, achieving economies of scale becomes essential for survival in the Indian telecom sector. The capital-intensive nature of the industry, high network deployment costs and significant investments on infrastructure development would deter a new telecom company unless it has a large customer base to justify the returns.

Consolidated market creates significant entry barriers for new entrants

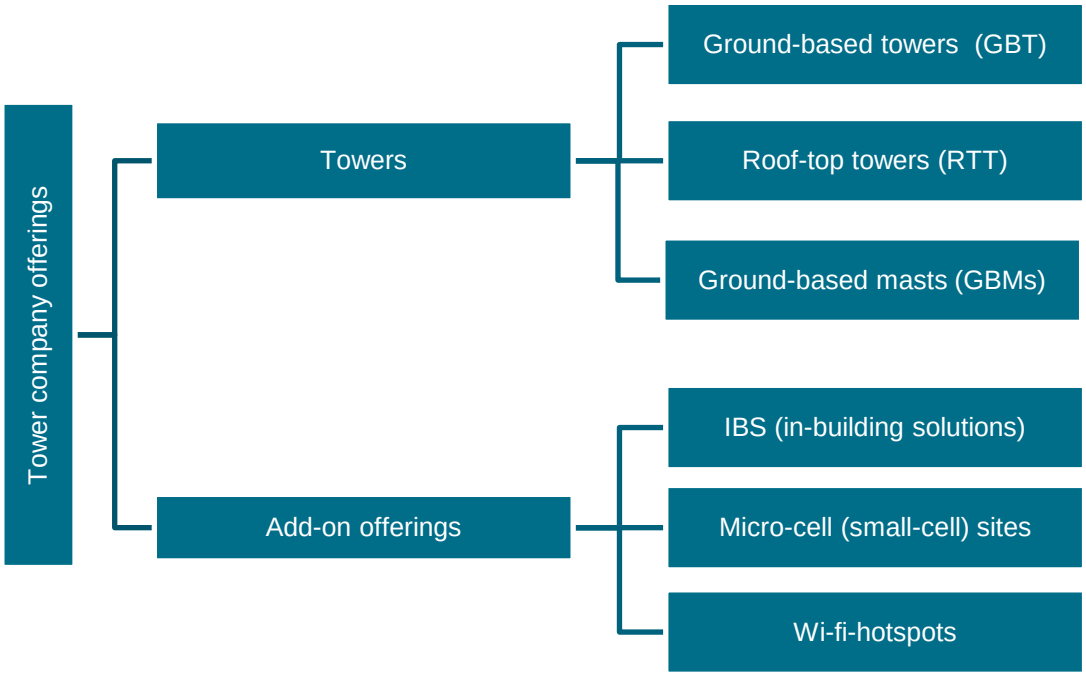
As of fiscal 2024, private access service providers, such as. Reliance Jio, Airtel and Vodafone Idea, accounted for ~92% of total wireless customers, while the reminder ~8% share was with PSUs. While Bharti Airtel and Vodafone Idea have been longstanding players in the Indian market, Reliance Jio disrupted the telecom landscape after its entry in 2016. These telecom giants, with nationwide coverage, are aggressively competing to increase their customer base and expand their network. They are strategically targeting the vast non-4G customer base in rural areas using legacy feature phones. Thus, competition extends beyond customer acquisition, and includes content bundling, collaboration with smartphone manufacturers for budget-friendly devices and intensified sales efforts through distribution channels. For a new entrant, competing against these established players is exceedingly challenging, given their extensive coverage, robust infrastructure, comprehensive spectrum portfolios, and understanding of the Indian telecom customer landscape.

3. An assessment of telecom tower industry in India

3.1 An overview of telecom tower industry

The tower segment, traditionally divided into ground-based towers (GBT) and roof-top towers (RTT), has marginally diversified into IBS (in-building solutions), micro-cell (small-cell) sites, and Wi-Fi-hotspots due to an increase in data traffic and technological advancements. These new technologies, having begun to proliferate in the Indian sub-continent on a small scale, are expected to expand their presence in the future as telecom service providers (TSPs) look to densify their existing network coverage.

Telecom towers industry – an overview



Source: Crisil Intelligence

Additionally, within telecom towers, the industry can be further subdivided on the basis of active and passive infrastructure. Passive infrastructure forms the majority at around ~70% of the capital costs of setting up a wireless network in India and includes towers, shelters, power-regulation equipment, battery back-ups, diesel generator (DG) sets, air-conditioners, fire extinguishers and security cabins required at sites where telecom towers are installed.

Telecom towers are mainly of two types – i.e., ground-based or roof-top towers, RTT and GBT. RTT requires less space compared with GBT and has lower installation cost. However, its capacity is comparatively less than that of RTT.

Additionally, space limitations on each site and overall limited availability of land for tower installation have expanded the traditional tower products to ground-based masts (GBMs) that occupy lesser space relative to GBTs and RTTs.

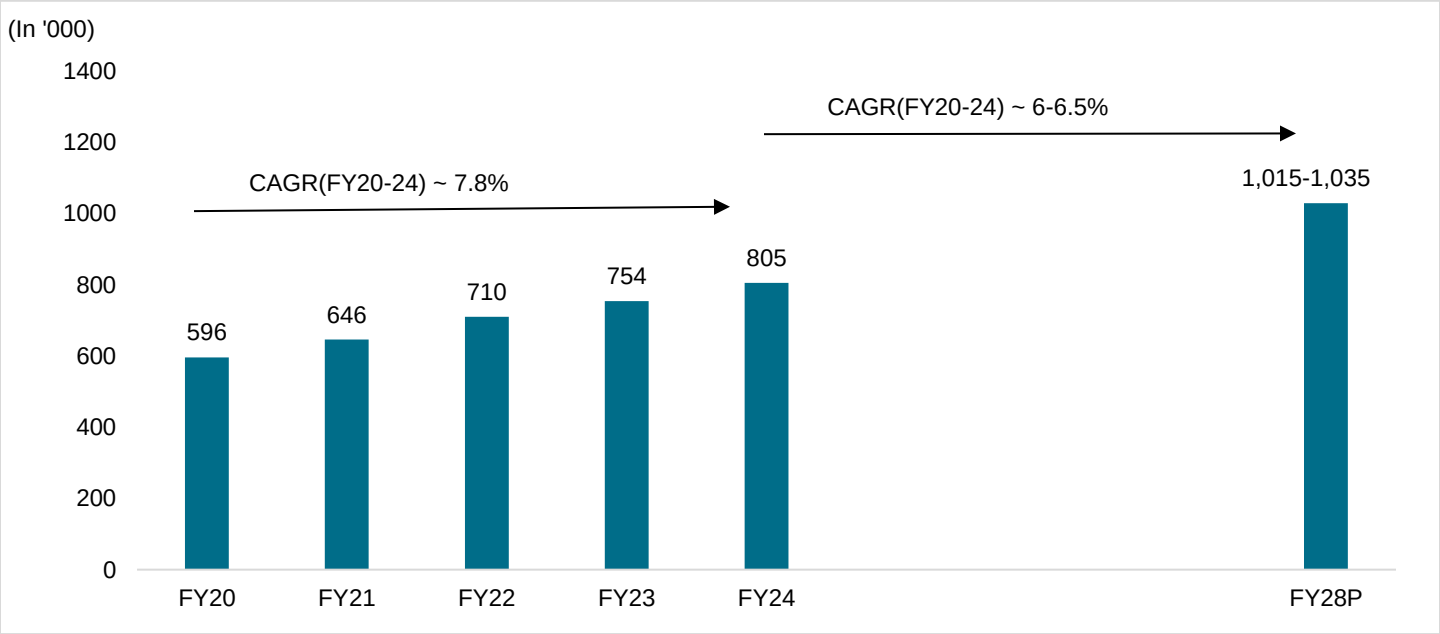
Necessity for new infrastructure to enhance connectivity driving tower demand

Telecom service providers are continuously expanding their services and acquiring new customers, translating into more infrastructure demand. The number of telecom towers as of fiscal 2024 is estimated to be about ~0.754 million compared with ~0.596 million in fiscal 2020, a CAGR of ~7.8%. The growth was supported by the expansion of network coverage on rural side, requiring installation of additional towers. Additionally, over the past five years, the rise in data traffic amid 4G and 5G services expansion, the need to improve network reach and quality, and increasing penetration of operators in rural areas have driven growth in the telecom towers industry.

Additionally, rapid urbanisation is also supporting the tower industry. Urbanisation leads to higher population density in cities, which requires more towers to handle the increased communication traffic to improve connectivity and reduce network congestion.

Moving forward, Crisil Intelligence estimates the number of towers to grow 6-5.5% between fiscals 2024 and 2028, respectively, driven by an increase in demand for BTS (Base Station Transceiver).

Number of towers in India



Source: Crisil Intelligence

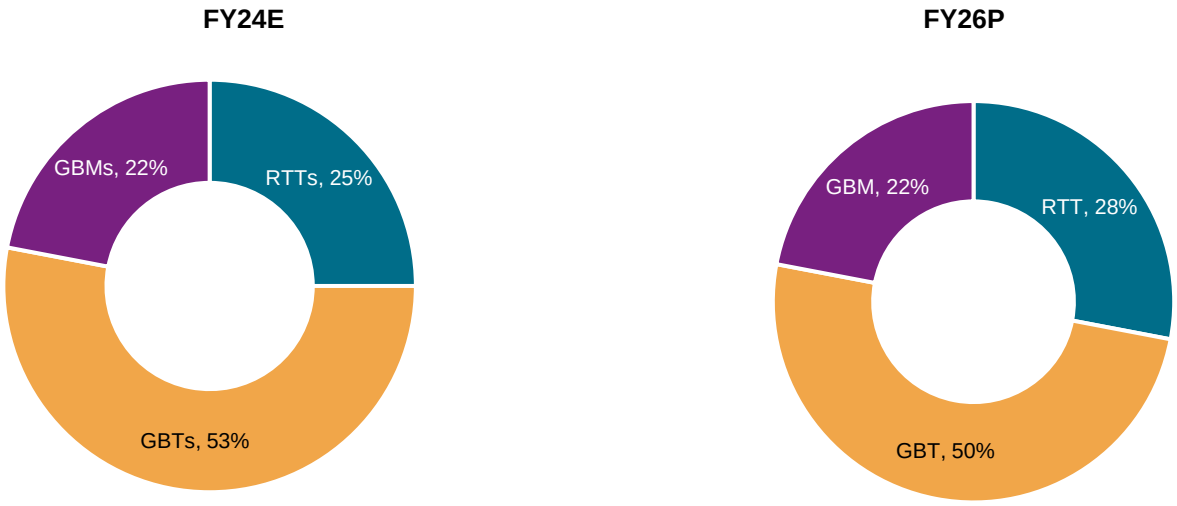
GBTs to dominate tower industry, despite a decrease in their share

As of fiscal 2024, GBTs are estimated to be dominating the overall tower industry with a share of 53%, followed by RTTs at 25% and GBMs at 22%.

However, going forward, share of GBTs is estimated to decrease owing to high capex and space constraints. The cost of building a GBT is Rs 2.5-3.0 million, more than double that of building an RTT. However, GBTs can accommodate three-five tenants, whereas RTTs can only house two-three tenants. Monopole towers are ~75% cheaper than GBTs and can house 1-2 BTSs.

This fiscal the share of GBTs is expected to decline to ~49-51%, while that of RTTs is expected to be 27-29% and GBMs' 21-23%.

Segmentation of telecom towers based on installation type



Notes: E – estimated; P – projected

GBMs: Ground based monopoles, GBTs: Ground based towers, RTTs: Rooftop towers

Source: Crisil Intelligence

3.2 Key government regulations

No provision for input tax credit

Government released sector-specific rates under the goods and services tax (GST) in May 2017.

Under the GST regime, towers are not getting the benefit of input tax credit as everything attached to the earth is considered an immovable property. Given the inability to pass on the impact of GST to telecom players, the tower players may witness a negative impact on their bottom line.

An order by the Delhi High court in 2018 had allowed central value added tax (CENVAT) credit on telecom towers and parts, including prefabricated shelters, which were in dispute. The tax authorities was of the view that on the ground of 'immovable' nature of equipment, the tower firms did not qualify for input tax credit.

National Digital Communications Policy 2018

The DoT released the draft national telecom policy, rechristened National Digital Communications Policy (NDCP) 2018, for consultation on May 1, 2018.

Key provisions in the draft policy related to towers and allied services are:

- It facilitates fibre-to-the-tower programme to enable fiberisation of at least 60% base stations thereby speeding up the migration from 2G/3G to 4G/5G
- Extends incentives and exemptions for the construction of telecom towers
- Promotes deployment of solar and green energy for telecom towers
- Creates a broadband readiness index for states/ union territories to attract investments and address and accelerate right of way (RoW) challenges

Currently, less than one-fourth of the towers are fiberised in India compared with more than three-fourth in major economies, such as China and the US. Fiberisation will quicken expansion of the Internet of Things (IoT) ecosystem to 5 billion connected devices.

On 11 August 2022, the DoT had sought TRAI's recommendations on creation of a new category of license, Telecom Infrastructure License (TIL); the terms and conditions for according such license; applicable license fee etc. under Section 11(1) (a) of the TRAI Act 1997. In response, the regulator released recommendations on telecommunication infrastructure sharing, spectrum sharing and spectrum leasing on 24 April 2024.

Ambiguity in RoW implementation impacts tower rollouts

However, RoW has been an issue for the telecom sector participants in India. Delays because of variable and complex procedures across states, non-uniformity in levies and obtaining approvals from the forest department, railways and National Highway Authority of India have greatly impacted planning and rollouts of towers and fibre laying across the country.

RoW rules introduced in November 2016 are yet to bring benefits to the telecom sector owing to lack of clarity and hesitancy of some states. The rules should have expedited the deployment of underground (optical fibre) and over ground (mobile towers) infrastructure in India. They rationalise administrative expenses for fibre across the country to a maximum of Rs 1,000 per km and for overhead towers at a maximum of Rs 10,000 per application.

Additionally, as per the Right of Way (Amendment) Rules, 2023, licensees are allowed to deploy telecom infrastructure over a private property without approval from the concerned government authority. This will boost tower additions going forward and hasten the creation of 5G infrastructure in the country.

According to the dashboard on the RoW portal, as of May 2024, 34 states/union territories have been on-boarded, with 53,364 applications received so far, out of which 19,330 were approved, 17,042 rejected, 21,564 pending, and 1,854 sent back. This is creating huge impediments in installation of mobile towers and, in turn, affecting quality of service according to the Tower and Infra Providers Association (TAIPA).

Infrastructure status accorded to telecom towers

The government accorded infrastructure status to telecom towers in 2012, which meant the segment will get all the benefits the infrastructure sector enjoys, including priority electricity connection. Also, to avoid any disruption in communication, it was specified that BTSs could not be sealed or electricity supply to them disconnected without approval of the respective telecom enforcement, resource and monitoring cell of the DoT in case of radiation-related issues.

Regulations regarding health impact spread of towers

Different state government agencies follow different approval procedures for setting up telecom towers. Also, the state governments have certain reservations when granting approvals for telecom towers in residential areas on account of health concerns. This could delay expansion plans of tower companies.

The DoT fixes standards for exposure limits of radio frequency field emissions from BTSs, monitors their compliance, addresses all radiation-related technical issues and seeks Standing Advisory Committee for Frequency Allocation's (SACFA) clearance for frequency allocation.

Multiple government bodies have placed restrictions on new tower constructions, on grounds that they pose health hazards and congest the skyline. Operators emitting more than approved levels of radiation are fined Rs 1,000,000 per BTS. According to the new rules, tower companies have to submit a compliance certificate within 15 days of switching on a telecom tower. In addition, many towers, especially in urban areas, face danger of being declared illegal. This poses a major challenge for tower companies while considering investments in new towers.

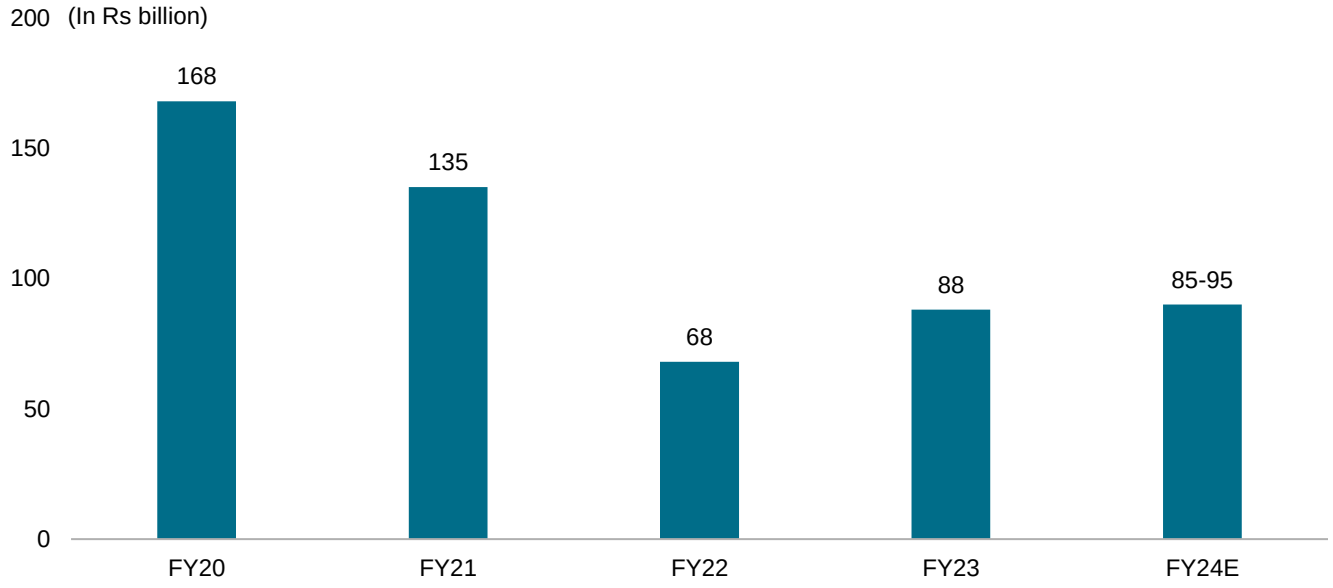
3.3 Capex to moderate in near term

The telecom tower business is capital-intensive as it entails setting up of towers, upgrading them to accommodate new tenants and improving efficiency by upgrading to more efficient technology/ power sources. Companies incur an upfront capital cost for the construction of mobile towers. The cost depends on the type of tower — GBT or RTT or monopole. The cost of building a GBT (Rs 2.5-3.0 million) is more than double that of an RTT. Monopole towers cost ~75% lesser than a GBT and can house 1-2 BTSs. Apart from construction capex, players also need to spend on maintenance, the addition of tenants and making sites diesel-free after installation.

The telecom tower industry witnessed exponential growth in construction and upgradation capex over fiscals 2016-2021 owing to massive network expansion and the 4G rollout. During the period, over ~1,100,000 BTSs were cumulatively added to roll out 4G services. During fiscals 2021-2024, ~698,000 BTSs were added.

However, going forward, capex is expected to moderate as telcos are currently focusing on replacing 2G and 3G tenancies with 4G tenancies. 4G BTSs will see a slower growth and 5G BTSs are expected to increase as the telecom operators strive to widen the subscriber base for 4G and 5G services. While players will likely use alternative technologies such as small cells and multiple-input and multiple-output (MIMO) to augment the tower capacity, the need for speedy 5G deployment will result in the installation of incremental towers and BTSs with 5G capability resulting in construction capex.

Capex in telecom tower sector



Note: E - estimated

Crisil's forecast is based on the expansion of operators, estimated mix of GBTs and RTTs, capex required to build a tower, and incremental capex needed to maintain it. But it does not include the capex incurred by telcos to build their captive towers.

Source: Crisil Intelligence

Passive telecom infrastructure market estimated at ~Rs 1,652 billion between fiscals 2025-28

Telecom tower companies set up an entire range of passive infrastructure to be used by telecom operators to offer services to their subscribers. Passive infrastructure refers to equipment such as towers, shelters, power regulation equipment, battery back-ups, diesel generator (DG) sets, air-conditioners, fire extinguishers and security cabins required at sites where telecom towers are installed.

Passive infrastructure does not play any role in carrying wireless signals, but it is a vital part of the network as it ensures the operationality of active components. Though passive infrastructure is independent of the type of communication technology being used, the extent of its installation is determined by the number of operators mounting their base stations at a particular site.

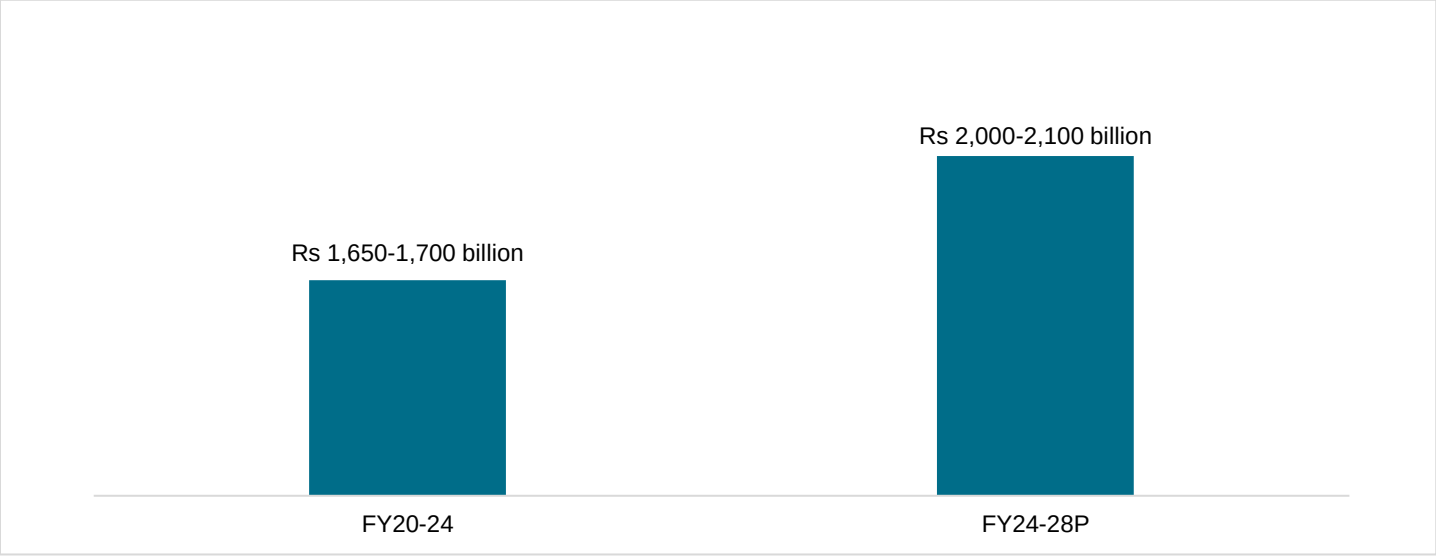
Some of the key passive infrastructure products are:

Product	Description
Shelter	An enclosure that houses the BTS and other equipment at tower sites. The shelter keeps the equipment at tower sites protected from the vagaries of the external environment and reduces the amount of sunlight coming into the room where the BTS is housed.
Power management system	The system performs the functions of handling power fluctuations, phase selection and lightning & surge protector
Air conditioning systems	It is used to cool down the temperature within the shelter.
Battery back-up	It provides back-up during short term disruptions of power supply
Diesel generator set	It provides back-up power supply in case of prolonged disruptions of electricity supply

Source: Crisil Intelligence

Between fiscals 2020-2024, passive telecom infrastructure market size in India is estimated at Rs 1,650-1,700 billion (cumulative) and is projected to increase moving forward to ~Rs 2,000-2,100 billion between fiscal 2023-2028.

Passive telecom infrastructure market in India



Source: Crisil Intelligence

4G rollout by BSNL, 5G expansion by private players to aid tower industry

The telecom industry has seen significant disruption over the past few years as the market shrunk to four players in fiscal 2021 from eight in fiscal 2018. However, a steady increase in tower additions owing to a surge in data and voice usage, 2G/3G to 4G migrations, 4G network expansion by BSNL and 5G rollout plans by the other private players are estimated to aid the telecom tower industry going forward.

The government approved the first revival package for BSNL/MTNL in 2019, which amounted to Rs 690 billion. It stabilised the companies. In 2022, the government approved the second revival package worth Rs 1.64 trillion, which provided financial support for capex, viability gap funding for rural landlines, financial support for destressing the balance sheet and settlement of AGR dues, merger of BBNL (Bharat Broadband Network Limited) with BSNL, etc. As part of the Atmanirbhar Bharat mission, BSNL has planned for deployment of 100,000 4G sites across the country. With upgrading of 4G equipment to 5G, BSNL will make its entry into 5G services as well.

As part of the revival strategy, the Union Cabinet approved the third revival package for BSNL in June 2023 with the total outlay of Rs 890.5 billion, including allotment of 4G/5G spectrum for BSNL through equity infusion. Subsequently, BSNL had issued purchase order to Tata Consultancy Services (TCS) for the supply and commissioning of 4G indigenous core and 100,000 4G BTSs across the country for a total cost of Rs 190 billion.

The consortium of TCS (for software support and system integration), CDOT (for core technology) and Tejas (for the radio network) was selected by BSNL for implementing its 4G project. TCS is the lead partner. The proof of concept was successfully conducted by the consortium in BSNL's Ambala and Chandigarh networks.

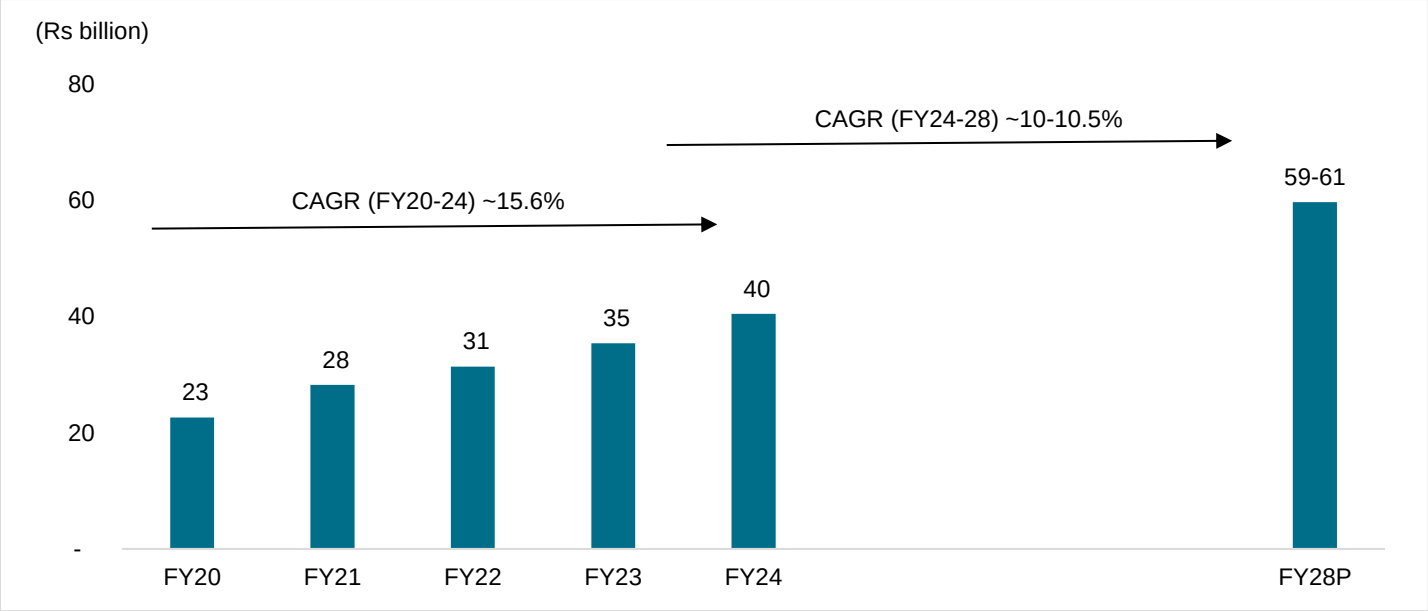
Market of maintenance of telecom towers to rise on back of tower additions

Tower companies incur a considerable amount of capex to maintain different towers and ensure their smooth functioning. A tower consists of various components that need regular servicing to increase the life of the tower and prevent disruptions. Hence, they incur capex to maintain and service the equipment such as DG sets, air-conditioners and electrical equipment.

Maintenance capex is usually incurred on towers (and related infrastructure) that are two-three years old. Further, the existing towers will likely warrant higher maintenance expenses. The allocation for repairs and maintenance is likely to rise in proportion with the rise in overall capex.

As of fiscal 2024, telecom tower maintenance industry stood at ~ Rs 40 billion, up from Rs 23 billion in fiscal 2019. During this period, the industry had registered a CAGR of ~15.6% majorly driven by high number of tower additions. Moving forward, industry growth is expected to moderate to ~10%-10.5% due to slow down in tower addition.

Telecom tower maintenance market size in India



Note: The aforementioned market size includes only maintenance expenditure incurred related to tower. It does not encompass operating expenses like rent, power and fuel, etc.

Source: Crisil Intelligence

Key entry barriers for the telecom tower industry

Parameter	Description
High capital requirement	The sector demand huge capital expenditures into land acquisition, construction and erection of tower and the periodic maintenance.
Regulatory and policy hurdles	The sector requires multiple approvals from the central, state and local authorities such as environmental clearances, land use, permissions, and structural safety etc. The telecom towers have to comply with stringent regulations such as radiations norms, safety and other certifications. Navigating the regulatory landscape for new entrant is extremely difficult
Economies of scale by established players	Existing players have a long-standing relation with the stakeholders of telecom tower industry including the tower operators and telecom companies. These players can execute the construction within timelines while effectively managing cost overruns and operational challenges as they already have a reliable vendor and supplier ecosystem. All these parameters make it difficulty of new entrant to compete on cost and quality.
Dependence on a small set of stakeholders for demand	The larger share of demand for the telecom tower comes from either the government or consolidated telecom industry. Acquiring projects from these stakeholders require aggressive bidding, strong technical, financial and operational capabilities with illustrious past credentials. This aspect favours the established players compared to the new entrants.

Source: Crisil Intelligence

Key challenges and risk factors

3.3.1.1 RoW yet to bring benefits to telecom tower industry

Introduced in November 2016, the RoW rules did not bring any benefit to the telecom sector as they lacked clarity and many states remain hesitant to comply. The rules could have been a key enabler for expediting the deployment of underground (optical fibre) and overground (mobile towers) infrastructure in the country. They aim to rationalise administrative expenses across the country to a maximum of Rs 1,000 per km for fibre and a maximum of Rs 10,000 per application for overhead towers.

However, delays as a result of variable and complex procedures across states and non-uniformity in levies greatly impacted the planning and rollouts of towers and fibre laying across the country. The NDCP 2018 advocates establishment of a National Digital Grid by creating a National Fibre Authority; establishing Common Service Ducts and utility corridors in all new cities and highway road projects; creating a collaborative institutional mechanism between the Centre, states and local bodies for common RoW; standardising costs and timelines; and removing barriers to approvals. However, the implementation will remain a key monitorable. In April 2022, the DoT launched a centralised RoW portal, Sugam Sanchar (translated as accessible connectivity), which will provide single-window clearance for stakeholders to apply and track applications. According to the dashboard on the portal, 34 states/ union territories have been onboarded, with 53,364 applications received so far, of which 27,942 have been approved, 15,287 rejected, 7,553 pending, and 2,582 sent back.

3.3.1.2 Loading of sites hurt revenue generating potential of towers

A loaded site implies that a single telecom operator has installed more than one BTSs on a single tower. Telecom tower players offer discounts to telecom service providers to install multiple BTSs on the same tower. A loaded BTS commands a much lower rent (~50% of the actual rent that a single tenant pays), and hence, impacts revenue generation for the tower company.

Going forward, the industry is expected to witness loaded sites to account for a higher proportion of incremental tenancies, as operators look to improve the quality of service to retain subscribers. This will be done by installing capacity BTSs at sites that already have coverage BTSs. Capacity BTSs help reduce congestion in select areas and improve network efficiency. However, they will mostly be loaded on to existing BTSs, thus hurting the revenue generation of tower players.

3.3.1.3 Consolidation, entry of a new captive player hurt industry

Consolidation of telecom players is a key risk for tower companies as it results in the loss of overlapping tenancies. Although, this risk is somewhat offset by consolidation among the tower companies.

Consolidation in the telecom industry has not only resulted in a shift in the bargaining power in favour of the TSPs but also in a loss of certain tenants/ tenancies. As a result, telecom players are bargaining aggressively for competitive rates for new tenancy additions. Entry of captive tower companies with sizable towers is expected to have pressured rent revenue and margin in the industry.

3.3.1.4 Zoning may cause speed bumps in tower rollouts

Multiple government bodies are placing restrictions on the construction of telecom towers (a practice called zoning) as they are considered a health hazard. Mobile tower radiation in India is governed by guidelines drawn from recommendations of the International Commission on Non-Ionising Radiation Protection. All operators are required to get their BTSs certified for radiation. Operators emitting more than the approved levels of radiation must pay a fine of Rs 1,000,000 per BTS.

There is still uncertainty about which all areas are permitted for tower installation. Towers are not allowed to be installed on government buildings, hospitals, defense areas, etc. Controversies about health hazards with respect to the emissions from towers compound the difficulties.

3.3.1.5 Active Infrastructure sharing

Traditionally, telecom players shared only towers (passive infrastructure). However, with newer concepts such as radio access network sharing and after the DoT permitted active infrastructure sharing in 2008, operators may increasingly begin sharing BTSs, back haul and even base service stations (BSCs). This has led to significant savings in terms of capital and operating expenditure for operators but has also reduced the tenancy for tower players. In NDCP-2018, there was a proposal to expand coverage of Infrastructure Providers Category-I (IP-1) infra sharing and its outcome remains a key monitorable. This has enabled a significantly enhanced scope of services for IP-1 and provides passive as well as active infrastructure services to enhanced service providers, including TSPs.

However, sharing active infrastructure is a technically complex process, as network planning can vary significantly across operators and locations. Globally, too, active infrastructure sharing has not been very successful.

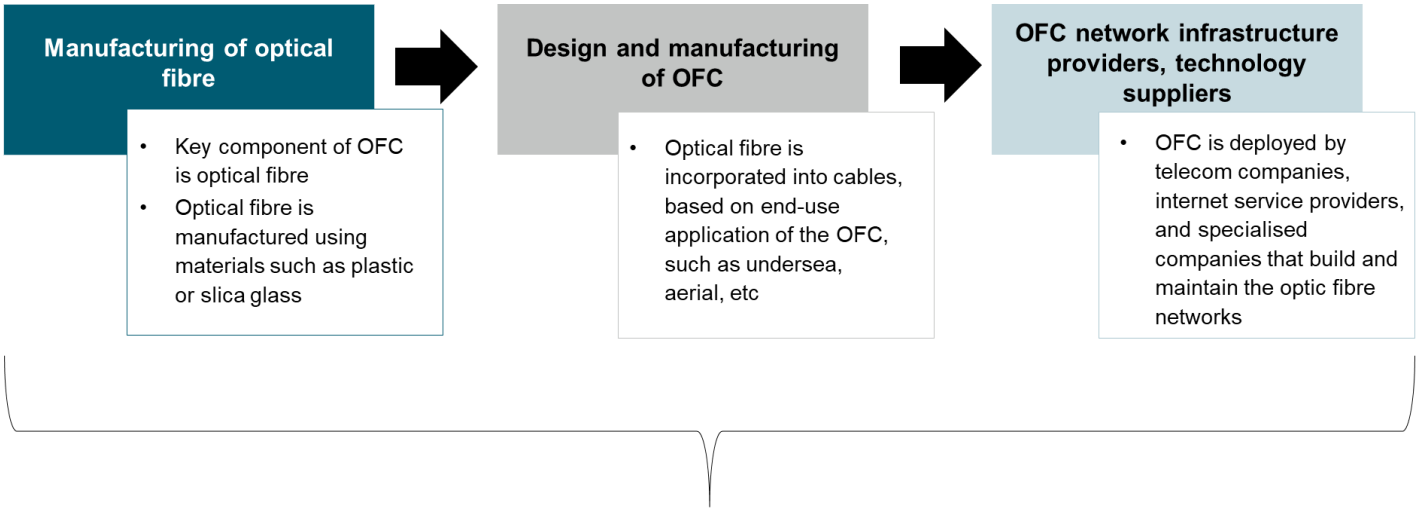
4. Assessment of optical fibre EPC industry in India

4.1 Overview of EPC industry

The optical fibre cable (OFC) industry is a vital cog of the telecom industry, supporting a large digital ecosystem with high-speed internet and robust data transmission capacity.

In fact, the OFC industry involves numerous stakeholders across the value chain, starting from raw material suppliers to the final deployment and maintenance of OFC networks.

Value chain of OFC industry



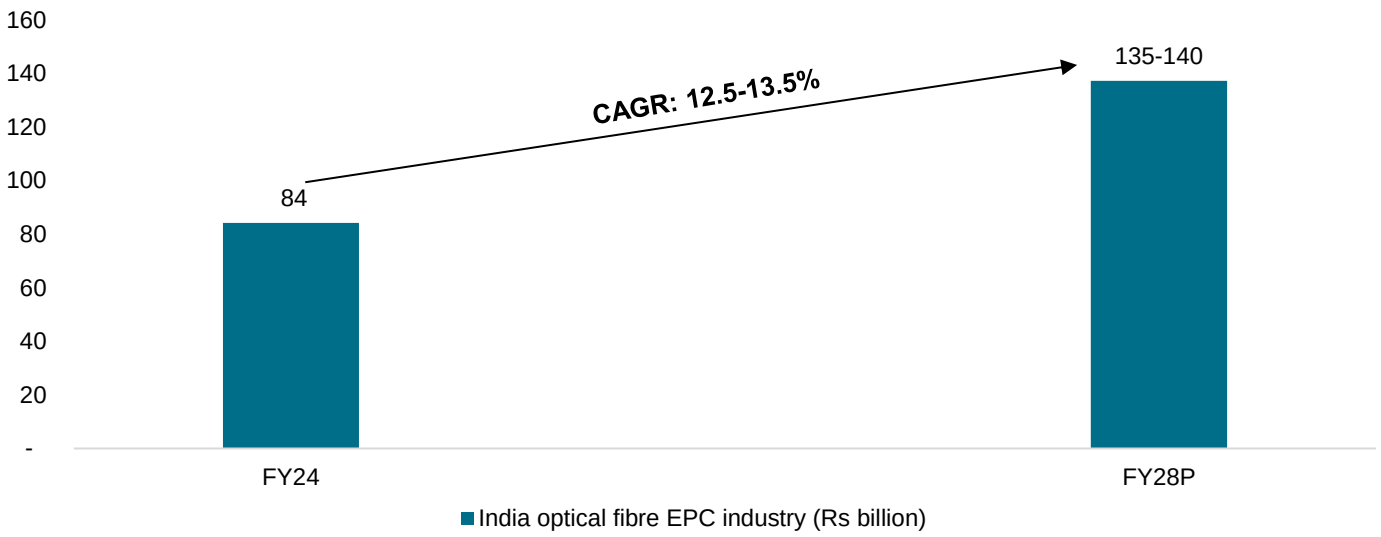
Source: Industry, Crisil Intelligence

Optical fibre EPC industry in India seen at Rs 135-140 billion by fiscal 2028

The Indian optical fibre EPC industry is defined according to service offerings, such as optical fibre laying and roll-out, network deployment, and system integration across end-use sectors, such as telecommunications, defence, railways, smart cities, IT, and enterprises, etc. In fact, the optical fibre network is the backbone of the burgeoning digital economy of India.

The industry, which was estimated at ~Rs 84 billion as of fiscal 2024, is expected to grow to Rs 135-140 billion by fiscal 2028, which is a CAGR of 12.5-13.5%, supported by drivers such as digital transformation across sectors, growing 5G coverage and infrastructure, fibre to the home (FTTH), government schemes and policies (BharatNet, Digital India, Smart Cities, Fiberisation targets, etc), and systems and network modernisation across sectors such as defence, railways, etc.

Optical fibre EPC industry in India



P – projected

Note: The industry size includes optical fibre EPC projects implemented by third-party service providers and excludes optical fibre network deployment by an entity through its group companies

Source: Industry, Crisil Intelligence

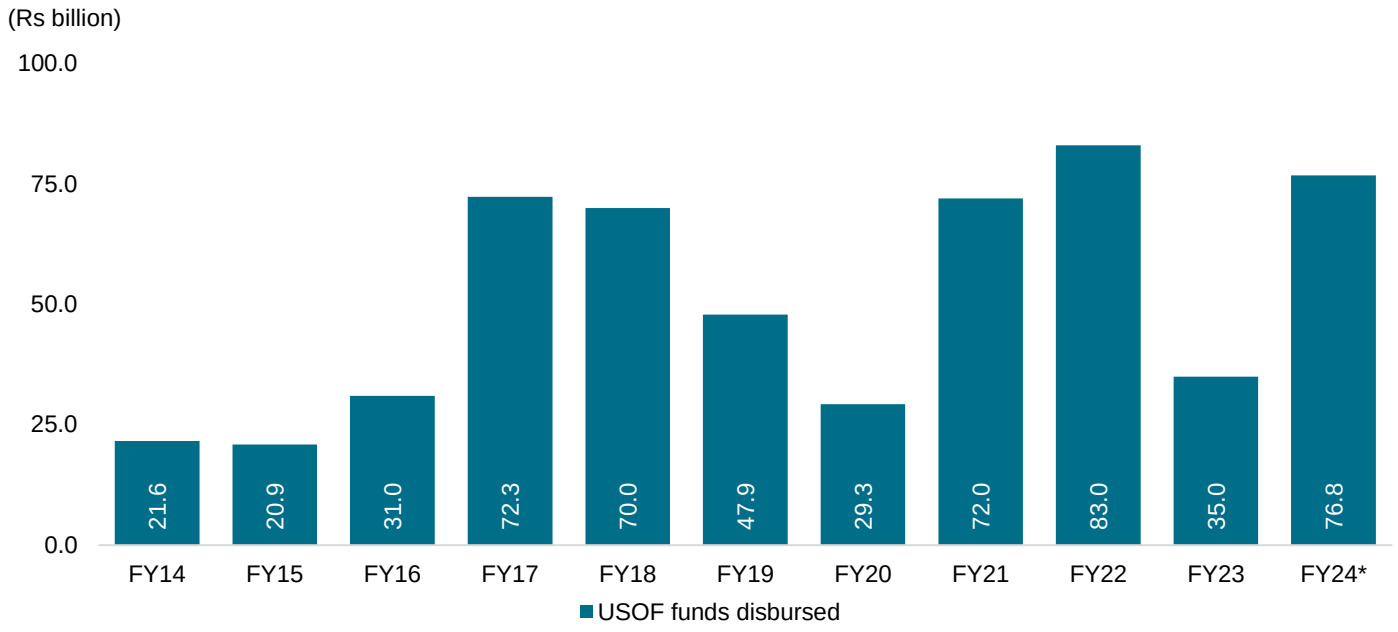
Government schemes and regulations to support optical fibre EPC industry

4.1.1.1 Capital allocation to USOF and DoT projects to aid growth

The industry's growth is aided by government investments in the telecommunications sector. Between fiscals 2017 and 2024, union budget allocation towards the DoT logged a CAGR of 22.3%, led by higher allocation towards USOF and DoT projects, including towards the domestic industry incentivisation schemes (such as PLI) and wireless planning and coordination. For fiscal 2024, Rs 975.8 billion was allocated to the telecommunication ministry, which is ~2% of the overall budget and up 19% on-year. Of this, Rs 530.0 billion was infused in BSNL.

The USOF fund was started by the Government of India in 2003 to provide telecom services (including mobile services, broadband connectivity and information and communication technology (ICT) infrastructure creation, added in 2006) for rural and remote areas. Under the fund, some projects are allotted to various mobile service providers to facilitate mobile network, especially in rural and remote areas. Additionally, ~Rs 560 billion was cumulatively disbursed starting from fiscal 2014 until December 2023 under various projects.

USOF funds disbursal



* As on December 31, 2023

Source: Universal Service Obligation Fund, Department of Telecommunications, Ministry of Communications, Government of India, Crisil Intelligence

Also, allocation towards the Digital India programme, which includes electronic governance, capacity building and skill development, manpower development, promotion of electronics and IT hardware manufacturing, and promotion of digital payments, among others, has seen a cumulative investment of ~Rs 290 billion since fiscal 2017, with ~Rs 48 billion budgeted for fiscal 2024

4.1.1.2 NHAI's Digital Highways presents major opportunities for the industry

The National Highways Authority of India aims to develop ~10,000 km of OFC infrastructure across the country by fiscal 2025. The implementation of the OFC network and Digital Highways will be done by developing integrated utility corridors along national highways.

For the development of Digital Highway, a stretch of ~1,367 km along the Delhi-Mumbai expressway and 512 km along the Hyderabad-Bengaluru corridor have been identified as pilot routes. A three-metre-wide dedicated utility corridor to lay OFCs is part of the 246 km-long Delhi–Dausa–Lalsot section of the Delhi-Mumbai expressway. The network will aid the provision of internet connectivity to remote areas and new telecom technologies, such as 5G and 6G.

The network will be leased out on a fixed-price allotment mechanism on an 'open for all' basis through a web portal to eligible users. The OFC allotment policy is being finalised in consultation with the DoT and the TRAI.

4.1.1.3 BharaNet scheme to significantly boost optical fibre connectivity across Indian villages

The government's BharatNet project is one of the biggest rural telecom projects globally. It is scheduled to be implemented in a phased manner in all gram panchayats (~0.25 million) in the country for access to broadband connectivity to all telecom service providers.

The total funding of the scheme (phase-I approved in 2011 and phase-II in 2017) is Rs 420.68 billion (exclusive of Goods and Services Tax, octroi and local taxes). Since inception and as on December 31, 2023, a total of Rs 398.25 billion was disbursed under the project.

As of July 2024, 2,12,778-gram panchayats are connected through the BharatNet project and 6,86,963 km of OFC has been laid. Additionally, as on May 5, 2024, 10,22,018 FTTH connections had been commissioned and 104,574 wi-fi hotspots installed to ensure last-mile connectivity.

In 2023, the Cabinet approved an outlay of Rs 1.39 trillion for BharatNet, the government's project for last-mile connectivity across 6.4 lakh villages in the country. This outlay is significantly more than that of Rs 420.68 billion of phases 1 and II combined.

Further, in February 2024, BSNL rolled out a Rs 650 billion tender for phase III, which represents a major opportunity for domestic optical networking product suppliers, such as Sterlite Technologies, HFCL, Birla Cable, Vindhya Telelinks, etc.

4.1.1.4 National Broadband Mission targets 70% fiberisation in India's telecom industry by fiscal 2025

By fiscal 2025, the National Broadband Mission targets to fiberise 70% of India's BTS, ideal for the efficient rollout of 5G services. However, with fiberisation at 35.11% in India as of June 2022, ~0.3 million km must be covered nationally in fiscals 2024 and 2025. Hence, to achieve the remaining target, telecom operators will have to spend Rs 1,250 billion on incremental BTS for 5G.

But the pace is increasing. The total length of optical fibre laid as on June 30, 2023 was 3,726,577 km compared with 2,812,627 km as of end-September 2022. The government envisages fiberisation to be increased up to 5.0 million km by fiscal 2025, while targeting 1.5 million tower fiberisation.

Meanwhile, as of July 2022, the OFC network of ~1 million route km laid by public sector undertakings BSNL, BBNL, RailTel Corporation of India Ltd, MTNL, GAIL (India), and ~573,000 telecom towers installed by TSPs were mapped on the PM GatiShakti National Master Plan portal.

4.1.1.5 Strong government support to BSNL

As part of its commitment towards enhancing services in the telecom sector, the government has from time-to-time infused capital into BSNL for it to remain relevant against private competitors for implementing the latest technologies.

In 2019, the government approved the first revival package for BSNL/MTNL worth Rs 690 billion. In 2022, with the approval of the second revival package of Rs 1.64 trillion, state-run entities gained financial support for capex, viability gap funding for rural landlines, financial support for de-stressing the balance sheet, and settlement of adjusted gross revenue dues and merger of BBNL with BSNL. In June 2023, the third revival package for BSNL with the total outlay of Rs 890.47 billion was approved.

4.1.1.6 Amendments to RoW rules and GatiShakti Sanchar portal for faster 5G rollout and fiberisation

In August 2022, the government released amendments in the Indian Telegraph Right of Way (RoW) Rules, 2016 to facilitate faster and easier deployment of telecom infrastructure. Subsequently, the average time for approval of RoW applications reduced to 16 days in July 2022 from 435 days in 2019. In addition, certain revisions to the processing fees were part of these amendments. The administrative fee for laying overground optical fibre was limited to Rs 1,000/ km. Also, as per the amendments, the street infrastructure may be utilised at a nominal cost of Rs 100/annum to install

overground optical fibre. Further, if the telecom licensee is laying cables using horizontal directional digging technology and not digging a full trench, then restoration charges apply only for the pits and not for the entire route.

The government has also launched the GatiShakti Sanchar portal for the Centralised RoW approvals. The portal is now functional with all 36 states/union territories onboard and integrated with the Ministry of Railways, Ministry of Road Transport and Highways, and Ministry of Defence-Director General of Military Operations.

The portal acts as a common single point for RoW permissions to lay OFCs and erect mobile towers to be used by TSPs as well as infrastructure providers to aid faster infrastructure development, which will enable quicker 5G deployment.

4.1.1.7 Government is providing public wi-fi service through PM-WANI

To expedite the expansion of broadband internet services, the government introduced the Prime Minister Wi-Fi Access Network Interface (PM-WANI) in 2020. The public wi-fi service is available across the country through public data offices, and has 182,034 wi-fi hotspots, including 100 train stations spanning 22 states.

In August 2022, the government introduced a 5-P model (people-panchayat-public-private-partnership) to broaden the reach of the PM-WANI scheme, extending its coverage to the country's rural areas and hinterlands. This model emphasises on collaboration between people, local governance bodies (panchayats), and public and private entities to facilitate the implementation of the PM-WANI initiative in remote and rural regions.

4.2 Key trends and drivers of optical fibre EPC industry

Parameter	Description
Increasing demand for bandwidth	The growing demand for high-speed internet, driven by applications such as video streaming, cloud computing and 5G networks, has significantly increased the demand for optical fibre infrastructure.
5G deployment	The rollout of 5G requires robust and high-capacity optical fibre networks to support the increased data traffic, low latency requirements and connectivity demands of 5G technology.
Data centre connectivity	The expansion of data centres and the adoption of cloud services have driven the need for high-speed, reliable and low-latency connectivity solutions, making optical fibre infrastructure essential.
FTTH deployment	The push for broadband connectivity directly to residences and businesses is driving the deployment of FTTH networks. Governments and service providers are investing in optical fibre to enhance internet access and speeds.
Smart cities and IoT connectivity	The development of smart cities and the increasing number of IoT devices are driving the demand for robust and scalable optical fibre networks to support the connectivity requirements of various smart applications.
Advancements in optical fibre technology	Ongoing advancements in optical fibre technology, such as higher data transmission speeds and improved efficiency, are influencing the EPC industry. These developments aim to enhance the overall performance and capacity of optical fibre networks.
Fiber optic network security	With increasing reliance on optical fibre networks, there is a growing emphasis on implementing security measures to protect these networks from cyberthreats and ensure data integrity.
Global connectivity projects	Initiatives and projects focused on enhancing global connectivity, such as undersea cable systems, are driving the demand for optical fibre EPC services to lay and maintain the necessary infrastructure.

Source: Crisil Intelligence

4.3 Key risks and challenges

Some of the key risks and challenges faced by the industry are:

Parameter	Description
Regulatory and permitting challenges	Complex regulatory requirements and permitting processes can lead to delays and increase project execution costs. Navigating the different regulations in various regions can be a significant challenge.
Cost overruns	Unforeseen construction challenges, changes in project scope, unavailability of RoW, and fluctuation in material or labour costs can lead to cost overruns, impacting project profitability.
Supply-chain disruptions	The optical fibre EPC industry is dependent on a global supply chain for equipment and materials. Disruptions such as equipment and material shortages, transportation issues or geopolitical factors can impact the timely delivery of components.
Technological changes and obsolescence	Advancements in deployment technology can render existing techniques obsolete. EPC companies need to adapt to new technologies and ensure that the deployed optical fibre networks remain competitive and meet evolving standards.
Cybersecurity risks	Optical fibre networks are vulnerable to cybersecurity threats. Ensuring the security of the networks against hacking, data breaches and other cyberthreats are critical challenges for the industry.
Environmental impact and sustainability	EPC companies may face challenges related to environmental regulations and sustainability concerns. Balancing the need for expanding networks along with minimising environmental impact is a growing consideration.
Weather and natural disasters	Construction projects are susceptible to weather-related disruptions and natural disasters. Extreme weather conditions, such as hurricanes, earthquakes or floods, can cause delays and damage to infrastructure.
Quality control and performance assurance	Ensuring the quality and performance of the optical fibre networks is crucial. Issues related to network reliability, signal loss or other performance problems can lead to costly rework and also damage the company's reputation.
Skilled labour shortage	The optical fibre EPC industry requires skilled labour for designing, installation and maintenance. Shortage of skilled workers in specific regions can lead to project delays and increased labour costs.

Source: Crisil Intelligence

Key entry barriers

Parameter	Description
High capital requirement	The sector demand huge capital expenditures into advanced equipment and technology for laying the optical fibre infrastructure and network maintenance. In cases where the project cycle is long, the players need to have strong financial resources.
Vertically integrated players	Players in the sector manufacture optical fibres and at the same time provide EPC service. This essentially reduces the costs for these players. Such players pose high threat to new entrants and the larger set of competitors
Dependence on a small set of stakeholders for demand	The larger share of demand for the optical fibre network deployment comes from either the government, consolidated telecom industry or the burgeoning data centre industry. Acquiring projects from these stakeholders require strong technical, financial and operational capabilities with illustrious past credentials. This aspect favours the established players compared to the new entrants.

Source: Crisil Intelligence

5. Overview of solar renewable energy sector in India

5.1 Overview of solar capacity addition in India

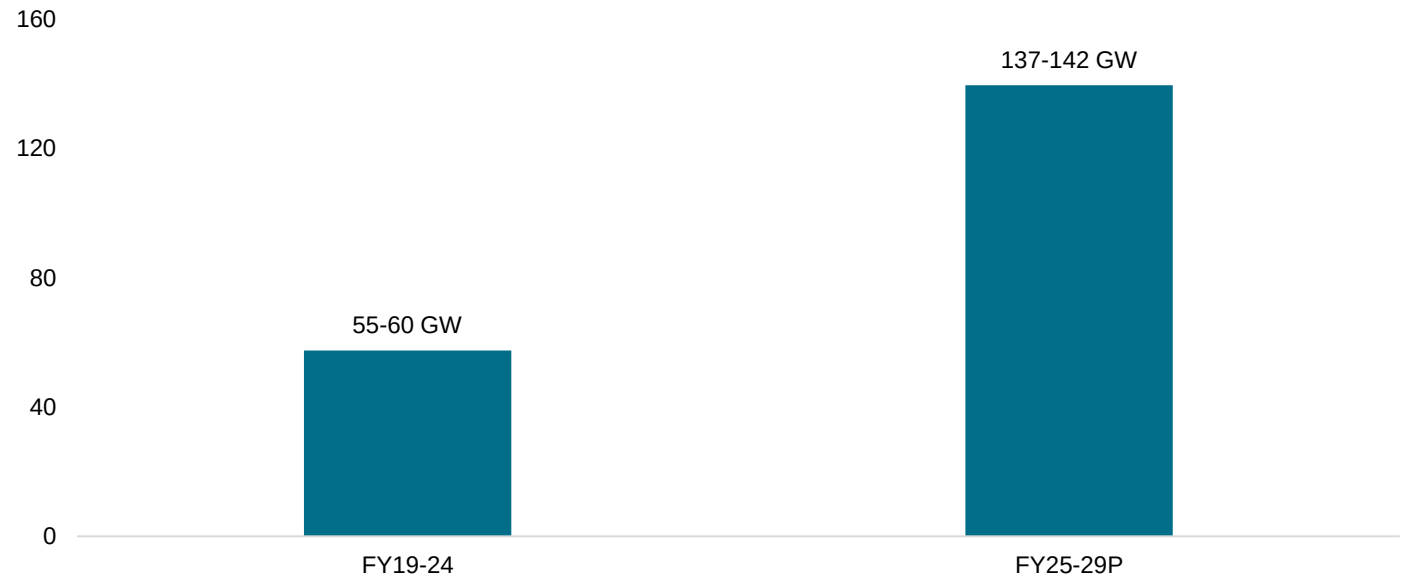
Solar energy can be converted to electricity in two ways — PV devices or solar cells and solar power plants. Solar cells convert sunlight directly into electricity, while concentrated solar power plants indirectly generate electricity when heat from solar thermal collectors is used to heat a fluid, which produces steam that is used to generate power.

Solar capacities of 55-60 GW added over fiscals 2019 to 2024

Solar power capacities of 55-60 GW were added between fiscals 2019 and 2024. Although the government's impetus for solar power has been supportive over the past 2-3 years, the past few fiscals have seen policy incoherence with instances of PPA renegotiation/bid cancellations, additional duty investigations on solar inputs, revision of GST to 12% from 5% and a change in the customs duty classification of solar cells and modules. These factors have restricted solar capacity addition in India.

However, moving forward, Crisil Intelligence foresees a surge in solar power capacity, reaching 137-142 GW over fiscals 2025 to 2029, significantly surpassing the 55-60 GW added between fiscals 2019 and 2024. This growth would primarily be spurred by robust government backing, demonstrated through an aggressive tendering strategy. Key catalysts would include technological advancements (e.g., floating solar and module efficiency), affordable financing and supportive policies.

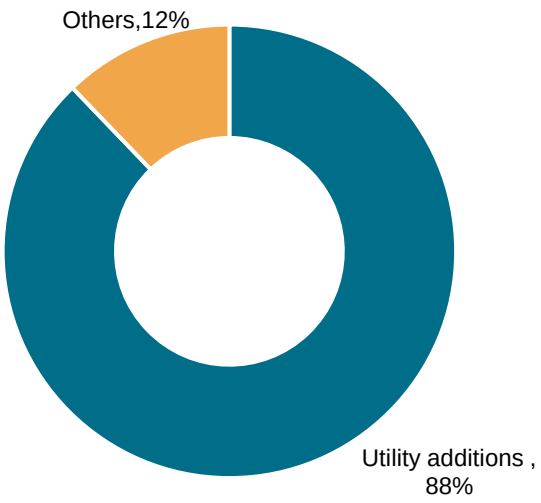
Solar capacity addition



Source: Crisil Intelligence

Utility additions estimated to account for 53% of the total capacity additions

Sources of solar capacity addition (FY24)



In fiscal 2024, utility projects are estimated to have accounted for ~53% (open access utility scale and competitive bidding utility scale) of the total capacity additions. Within utility projects, additions through competitive bidding utility scale formed the dominant share of 74%, followed by ppen access utility scale at 14%. Remaining 35% of the overall solar capacity additions include sources like solar rooftop, etc.

Additionally, production for green hydrogen is expected to start from fiscal 2026 with production of 0.5-1 million tonnes of production, which can lead to further upside of solar capacity. However, since developers may tie-up via grid / open access and not go to the captive route generation under this segment will remain a monitorable.

Source: Crisil Intelligence

5.2 Overview of solar rooftop installations in India

Rooftop projects are small-scale solar photovoltaic (PV) installations on roofs of buildings (detailed view of the operating models at the end of this section). Rooftop projects may or may not be connected to the grid. The government had proposed to achieve 100 GW of solar energy by 2022, of which, 40 GW was proposed to be added under rooftop-based solar systems. This was extended to fiscal 2026.

Rooftop solar projects have attracted interest from players in the entire solar value chain, ranging from module manufacturers (Tata Power Solar, Waaree Energies, Vikram Solar, etc.) to system integrators (Rays Power, Jackson Engineers) and independent power producers (Welspun Solar, Azure Power, SunEdison, Mahindra Solar, etc.) owing to falling costs and favourable regulatory policies in key states (net metering, exemption on electricity duty, wheeling and cross-subsidy charges).

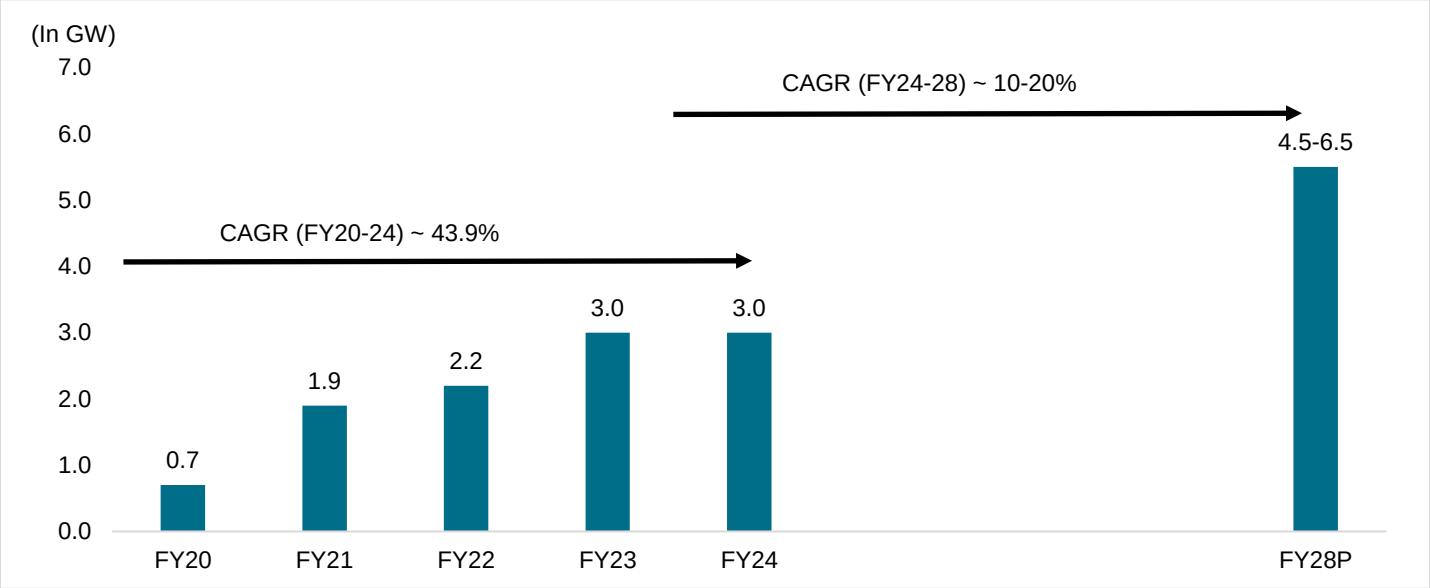
However, from a pan-India perspective, roadblocks hindering the growth of the segment include the higher cost of rooftop projects compared with utility-scale, limited availability of finance for rooftop projects, lack of uniform policies across the states, weak infrastructure of power distribution companies, divergence between state policies and the regulatory commission, and cheaper solar power available from ground-mounted projects. Additionally, although the MNRE has entrusted the Solar Energy Corporation of India (SECI) with the implementation of large-scale, grid-connected rooftop PV projects, with subsidy support from the National Clean Energy Fund (NCEF), the release of subsidy has been delayed by more than six months in some cases.

Solar rooftop additions to increase moving forward

Crisil estimates that ~ 12.5 GW of rooftop capacity was installed till May 2024, with ~593 MW added in two months of fiscal 2025 against 620 MW in two months of previous fiscal. Overall, cumulative solar rooftop additions between fiscals 2020 and 2024 are estimated at ~10.8 GW. The expansion of the market can be attributed to several factors, including increased consumer awareness, advancements in technology, and proactive subsidy initiatives implemented by both central and state governments. Additionally, global solar module prices have reached a historic low, standing at just USD 0.18 per watt-peak in June 2024, which is expected to stimulate growth in solar power capacity.

Moving forward, capacity addition per year is estimated to reach to 5.5-6.5 GW by fiscal 2028 on back of supportive government schemes and increasing awareness.

Solar roof capacity addition



Source: Crisil Intelligence

Commercial and industrial, both B2B segments, to drive solar capacity addition

Given lower capital costs, rooftop projects have become attractive for industrial and commercial consumers. In particular, the net-metering scheme under which power generated can be consumed captively and the balance/excess sold to the grid, is attractive for consumers paying tariffs upwards of Rs 4.5 per unit to discoms.

The cost of generating solar power from rooftop projects is estimated to be Rs 3.5-4.5 per unit (without availing accelerated depreciation). Many businesses are installing on-site solar panel systems to generate their own renewable energy. The energy generated through solar power can then be used to generate electricity, as well as in other operational functions such as heating water, etc. This will not only help companies in being energy-independent but will also help them in saving electricity costs.

Additionally, commercial and industrial consumers are best placed to claim the accelerated depreciation benefits and increase their project returns/reduce generation costs. This group includes all high-tension consumers and commercial consumers such as malls, hospitals, government establishments and high-consumption group residential complexes.

Since rooftop solar installations are profitable for C&I consumers, states with more loads under this category are expected to witness higher additions. Thus, Gujarat, Maharashtra and Tamil Nadu, which had over 50% of annual sales in this category, will drive additions.

The higher the discom tariffs, the more favourable the economics of rooftop projects. Consequently, consumers in states such as Maharashtra and Tamil Nadu, where average tariffs range between Rs 8 and 9 per unit, would drive additions.

There are newer models also, known as virtual metering and group metering, which have gained commercial acceptance. While virtual net metering enables customers to have their bills compensated for a solar project situated elsewhere in the jurisdiction of the discom, group net metering can help a consumer owning several premises within the same area adjust their power bill for all the premises combined against the solar power generated at a single premise he owns.

B2B use cases of solar energy

B2B use case	Description
Reduced electricity dependency on external sources	Businesses can generate electricity through solar energy which can help them in reducing their dependence on external electricity sources. Additionally, it will also help them in reducing the electricity costs, while ensuring sustainability.
Efficiently running the business operations	Solar energy can also help the companies in running their operations sustainability. For example, businesses are utilising solar energy for heating water and reduce their reliance on boilers. Additionally, growing use of energy intensive technologies like Artificial Intelligence (AI), etc is leading to increased energy requirements by data centres. Due to this, technology companies are using renewable power sources to run their operations in a more sustainable manner
Providing accessibility to remote location	Renewable energy, including solar energy can provide accessibility to power/ energy in remote areas, where setting up of conventional energy infrastructure like electric grid is not feasible. Hence, integrating renewable energy can help in maintaining reliable electricity supply in the remote areas
Powering machines	Solar energy can power small scale rural businesses through solar powered machines like photocopy machines, refrigerators, blacksmith blower machine

Source: Crisil Intelligence

Key entry barriers

Parameter	Description
Capital intensive sector	Setting up a solar plant requires high capital for procurement of solar modules, inverters and other critical components. Securing financing is also difficult as the lenders prefer players with established record on account of the long payback period.
Technology and expertise	Designing the solar plant requires know how of the latest and advance solar technologies and specialised skill for integration of the plant with grid systems and energy storage solutions. These aspects maybe lacking in new entrants
Economies of scale and skilled workforce	Economies of scale enables the established players to procure and construct without cost overruns. This allows the established players to quote lower costs for the project. Established players have skilled professionals for design, management and construction. They also have lower attrition
Supply chain and Vendor relationships	The sector has an import dependency for critical components of the solar plants. Established players are adept in managing the challenges of supply chain such as currency fluctuations, import duties, logistics etc. The have a long standing relationships with vendors ensuring competitive pricing and timely delivery.

Source: Crisil Intelligence

5.3 Key reforms and regulatory actions in the Indian telecom industry

5.3.1.1 Jawaharlal Nehru National Solar Mission (JNNSM)- JNSM Phase I

JNNSM was launched as part of India's National Action Plan on Climate Change (NAPCC) in 2010. This mission aims at establishing solar power in India. The mission was launched with a target of 20 GW grid connected solar power generation capacity by 2022. However, in June 2015, this target was increased to 100 GW. The 100 GW solar power capacity has been divided into rooftop solar electricity generation (40 GW) and large and medium-scale grid-connected solar projects (60 GW). Some other goals of the mission include:

- 20 million sq m of solar thermal collector area
- Creation of favourable conditions for developing solar manufacturing capability in the country
- Supporting R&D and capacity building activities to achieve grid parity by 2022

Under the first phase of the JNNSM, 450 MW was tendered out in two batches — 150 MW (Batch I) and 300 MW (Batch II) — in addition to which, 470 MW was offered under the solar thermal technology. Most of these projects are currently operational.

5.3.1.2 JNNSM Phase II

A key feature under Phase II was the viability gap funding (VGF) - capital subsidy, which was introduced to reduce the cost of renewable energy to make it more attractive for power purchase to state distribution utilities. MNRE also established SECI as the executing agency under Phase II.

Batch I

Under Phase II Batch-1, the MNRE issued revised guidelines for setting up 750 MW of grid connected solar PV) projects based on VGF. Under this scheme, in October 2013, the government floated a tender for 750 MW grid-connected solar projects, for which, Power Purchase Agreements (PPAs) were signed in March 2014. The commissioning schedule of these projects was 13 months from the signing of the PPAs (i.e. by April 2015), which got extended for two months. The tender was divided into two parts: Domestic content requirement (DCR) and open category. The DCR category (375 MW) mandated procurement of indigenously manufactured cells and modules for crystalline and thin film technology whereas no restriction was placed under the open category (375 MW). Some aspects of the policy included:

- SECI signed a PPA for a period of 25 years with the project developers. A fixed tariff of Rs 5.45 per unit was to be paid to the developer for a period of 25 years if accelerated depreciation was not availed and Rs 4.75 per unit in case accelerated depreciation was availed.
- The commissioning timeline was 13 months from the date of signing of the PPA, which was the same as under JNNSM Phase I. In case of delay, the performance bank guarantee of Rs 2 million per MW along with earnest money deposit of Rs 1 million per MW (converted into performance guarantee once the PPA is signed) was to be encashed by SECI as penalty depending on the extent of delay.
- Selection of projects for allotment started from the lowest bidder (L1) and went up to the level where 750 MW was fully allocated or the L1 bid plus 10% was reached.
- VGF was provided to the developer up to a maximum of 30% of the project cost or Rs 25 million per MW, whichever was lower.

Batch II

Under Batch II of Phase II, 15,000 MW of grid-connected solar PV plants were to be implemented in three tranches by NTPC Ltd/NVVN as follows:

- Tranche I – 3,000 MW (2014-15 to 2016-17)
- Tranche II – 5,000 MW (2015-16 to 2017-18)
- Tranche III – 7,000 MW (2016-17 to 2018-19)

All tranches included bundling for solar power with unallocated thermal power made available by the Ministry of Power. The PPAs would be signed by NVVN/NTPC, which, in turn, would sell the bundled power to state utilities. Some aspects of the policy included:

- The bidding would be state-specific and conducted through e-bidding. The projects would be awarded with PPAs signed at fixed levelised tariffs for 25 years with winners.
- The tariff bid could not be higher than the applicable tariff on the day the bids were received as fixed by the State Electricity Regulatory Commission (SERC) for the state where the projects are to be set up or the Central Electricity Regulatory Commission (CERC), whichever was applicable.
- Under the solar park scheme, the host state would provide land for setting up the projects, ensure project connectivity and purchase a major proportion of the bundled power.
- The developer would have the option of scaling up the capacity of the plant; however, any excess generation beyond the capacity utilization factor (CUF) range as laid down in the PPA, would be purchased at a notional support price of Rs 3 per unit.

In order to ensure payment security for the projects awarded under Tranche I, NTPC created a payment security/working capital fund with an estimated corpus of Rs 28 billion. The fund would be sufficient to cover three months' payments for the bundled capacity of 4.5 GW (3GW solar + 1.5 GW thermal power) awarded under this scheme.

However, the total capacity under Batch II has been curtailed to only Tranche I owing to significant decline in solar tariffs to below the Rs 3 per unit mark. This meant bundling of power was not required. Accordingly, subsequent allocations were curtailed.

Batch III and IV

NSM Phase II, Batch III included setting up of 2,000 MW of solar power projects with VGF support. Under this scheme, a tariff of Rs 4.43 per kWh or the discounted tariff as provided through the bidding process, would be considered for a tenure of 25 years by entering into a PPA with SECI. Power from these projects would, in turn, be sold to various bulk consumers/ state utilities by SECI at Rs 4.50 per kWh/discounted tariff plus margin (including trading margin of 7 paisa per unit).

Batch IV involved setting up of 5,000 MW solar PV projects. The maximum tariff payable to solar project developers was fixed at Rs 3.93/ kWh with a provision for VGF support. SECI would enter into a PPA for 25 years with the successful bidders for the allocated capacity under this scheme. The main features common across both the policies were:

The bid tariffs reduced substantially under this batch of NSM on account of multiple factors as listed below:

- Availability of infrastructure (land + transmission) under the solar park mechanism
- Lower payment delay/default risk associated with central trading agencies. DISCOMs were under a huge financial burden and would delay payments for RE consumers, but payments under the NVVN and SECI schemes were on time.
- Availability of strong payment security mechanism in the form of letter of credits and payment security fund, etc.

5.3.1.3 Ultra-Mega Solar Parks

In December 2014, the MNRE introduced a scheme to establish a minimum of 25 solar parks and Ultra Mega Solar power projects, adding over 20 GW of installed solar power capacity, which was later increased to 40 GW to develop a minimum of 50 solar parks of 500 MW and above capacity each by the financial year 2019-20. Later, in July 2018, the MNRE extended the timeline to develop solar parks and ultra-mega solar projects totalling 40 GW from 2019-20 to 2021-22.

The central government provides financial support for the construction of these solar parks. According to the MNRE, such projects can be set up by any Central Public Sector Undertaking (CPSU), state PSU, other state government organisations, or their subsidiaries or a joint venture between two or more entities. The developer is required to complete the project within two years, otherwise the state government is liable to take back the allotted land. The MNRE also added that Ultra Mega Renewable Energy Power Parks (UMREPPs) are not profit-making activities, and hence a maximum of 16% return on equity would be allowed.

5.3.1.4 Off-grid applications

In case of off-grid applications of solar power, 30 per cent capital subsidy and/or 5 per cent annual interest-bearing loans have been approved for general category states. Capital subsidy of up to 90 per cent of the benchmark project cost is available for the special category states of Sikkim, Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

5.3.1.5 State solar policies and incentives provided by state governments

Till 2011-12, only Gujarat and Rajasthan had a state solar policy. Post the success of Gujarat state solar policy, various states such as Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh and Telangana have also announced solar policies and have invited bids to set up solar projects in the past few years.

State wise details of key states

State	Policy
Gujarat state solar policy	The state government has also launched a Rs 140 billion 'Gujarat Aatma Nirbhar' package to support solar power projects. Some of the salient features of the policy are as follows: • Installation capacity targets will be based on RPOs defined by GERC from time to time. The minimum size of a megawatt scale project will be 1 MW, and that of a kW scale project will be 1kW • PPA will remain operational for a period of 25 years • State will facilitate solar rooftop PV systems with net metering on government, residential, industrial, and commercial buildings. State in collaboration with the central government, MNRE, and MoP will undertake measures to provide solar powered pump sets through subsidy support • Developer will be responsible for obtaining the land for the project • Electricity duty on solar consumption will be subject to provisions of the Gujarat Electricity Act, 1958 as amended from time to time

State	Policy
Haryana state solar policy	The state had announced its solar policy in March 2016 and the draft of a new policy was released in April 2021. Some of the important policy highlights are as follows: • DISCOMs may procure power from distributed solar projects up to 2 MW capacity at pre-fixed levelised tariff as determined by HERC, subject to the spare capacity available at the nearest substation. According to the RPO, 20% of the targeted solar power purchased by DISCOMs will be reserved for such small generators below 2 MW capacity • The state government may facilitate the lease or sub-lease of panchayat land at reasonable rates through any government agency or directly through the panchayat for setting up solar projects for a minimum period of 30 years • 10% exemption on total applicable tax will be provided for the industry and commerce department, Haryana for setting up manufacturing units of devices and equipment related to solar power • Ground-mounted solar project installation with storage will be promoted and given preference in granting approvals. The preference will also be given in the tariff if purchased by the Haryana Power Purchase Centre (HPPC) • PPA will remain operational for a period of 25 years
Karnataka state solar policy	The state solar policy came into effect from June 1, 2011, and was revised in September 2013. The state's current solar policy will remain in effect from 2014 till 2021. Under the policy, the state aims to add solar generation of 2,000 MW by 2021. The policy was most recently amended in October 2019. Some of the important policy highlights are as follows: • Solar projects will be allowed a commissioning period of 12 months from the date of signing PPA and private solar parks will be allowed 18 months for completion whereas solar thermal projects would be allowed a longer period of 24 months • Minimum capacity of solar PV power project will be 3 MW in terms of solar PV and the maximum capacity will be 10 MW. The minimum capacity will be 5 MW in terms of solar thermal project • For the promotion of integrated solar parks, the maximum capacity has been increased to 100 MW at a single location against earlier guidelines, which stated the minimum capacity for the private solar park as 25 MW. However, this is subject to an overall limit of 200 MW/ taluk and will not include projects implemented on solar rooftops • A net worth of 30% of the capital cost (to be determined by the Karnataka Electricity Regulation Commission (KERC) from time to time) has been mandated for captive and group captive projects. This was not mandatory before to the amendment

State	Policy
Maharashtra renewable energy policy (Incentives for solar projects)	The government of Maharashtra has finalised its renewable energy policy in 2015, in which it has targeted to install 7500 MW of solar projects across Maharashtra by FY 2022. Further, the state believes that ~2500 MW of solar projects would be utilised by Maharashtra for meeting its RPO compliance and projects would come up under the public private partnership with Mahagenco. Of the 2500 MW of PPP projects, ~10% of 250 MW capacity would be set up on the canals, lakes and other irrigation projects. The remaining 5000 MW of solar projects could be utilised by developers for setting up capacities. Some of the salient features of the policy are: • Deemed non-agricultural (NA) status for solar projects to be set up under the policy • Concessions to be provided under the Maharashtra land acquisition act. Fifty percent discount to be provided for land/lease rentals of land having capacity up to 2 MW • Fifty percent concession on the land charges/lease rentals for government land required for setting up solar module manufacturing line • Concessional charges for acquiring the no objections certificate (NoC) from pollution control board • Open access/captive/third party sale/REC based projects are allowed. Open access allowed for interstate and intrastate transmission of power under the ambit of MERC regulations
Tamil Nadu state solar policy	The state solar policy came into operation on 4 February 2019 and will remain valid until superseded or modified by another policy. It has set a target of 9000 MW by 2023 and 40% of this target will be earmarked for consumer category solar energy system. Some of the salient features of the state's solar policy are: • Consumer category solar energy will be exempted from electricity tax for two years • State will facilitate and support research in the solar energy sector and also collaborate with multi-lateral agencies • An inter-departmental monitoring and coordination committee will be constituted • Awareness creation, education and capacity building in the state
Rajasthan state solar policy	The policy will be effective from 18 December 2019. It has set up a target of 30 GW of solar energy projects by 2024-25. Some of the important policy highlights are as follows: • PPA will remain operational for a period of 25 years • Minimum capacity of 5 MW for both solar thermal and solar PV projects. Maximum capacity of10 MW will be allowed for solar PV projects and 50 MW for solar thermal projects • Power evacuation transmission infrastructure will be made through the transmission and distribution network being maintained by RVPN and DISCOMs, respectively. • Captive users will be exempted from payment of the electricity duty • Policy initiatives related to manufacturing solar energy equipment in Rajasthan: – MSME policy benefits to be given to manufacturers – Land allotment in industrial area at a 50% concessional rate – Full exemption from electricity for 10 years – Investment subsidy on SGST to equipment manufacturers, wherein 90% of SGST be due and deposited for 10 years – 100% exemption from stamp duty • Policy also aims to develop 33 district quarters as 'Green Energy Cities' over the next five years by installing 300 MW solar rooftop systems

State	Policy
Karnataka state solar policy	The state solar policy came into effect on 1 June 2011 and was revised in September 2013. The state's current solar policy will remain in effect from 2014 till 2021. Under the policy, the state aims to add solar generation of 2,000 MW by 2021. The policy was most recently amended in October 2019. Some of the important policy highlights are as follows: • Solar projects will be allowed a commissioning period of 12 months from the date of signing the PPA and private solar parks will be allowed 18 months for completion while solar thermal projects would be allowed a longer period of 24 months • Minimum capacity of a solar PV power project will be 3 MW in respect of solar PV and the maximum capacity will be 10 MW. Minimum capacity will be 5 MW in respect of solar thermal project • For promotion of integrated solar parks, the maximum capacity has been increased to 100 MW at a single location against earlier guidelines, which stated the minimum capacity for the private solar park as 25 MW. However, this is subjected to an overall limit of 200 MW/ taluk and will not include projects implemented on solar rooftops • A net worth of 30% of the capital cost (to be determined by the KERC from time to time) has been mandated for captive and group captive projects. This was not mandatory prior to the amendment

Source: Crisil Intelligence

5.3.1.6 The REC option - an alternative for renewable energy generator

The Centre has laid down solar-specific renewable purchase obligations (RPOs) within the overall RPO target to push demand for the relatively expensive solar power. It has specified that 10.25 per cent of the overall power consumption must be met by solar power by 2022. However, enforcement of RPOs is a critical factor for the sector's development.

To facilitate the purchase of solar power by states, which have little or no solar power potential, solar renewable energy certificates (RECs) have been introduced. Hence, a solar power generator has the option to choose between two business models:

- Sign PPAs with state utilities and SECI/NTPC under state solar auctions or central solar auctions, respectively
- Sell the power at average pooled power cost (APPC) to the state utility or, to the third parties at mutually agreed price or on a merchant basis. The environmental attribute is sold separately as an REC

In an order dated June 17, 2020, Central Electricity Regulatory Commission (CERC) removed the floor price of RECs and reduced the forbearance (maximum) price from Rs 2,400 to Rs 1,000 for solar RECs. This decision was led by maturing of REC market in India that reduced the need for having a floor price.

5.3.1.7 SECI ISTS connected tranches

The Solar Energy Corporation of India (SECI) has launched separate Inter-State Transmission System (ISTS) connectivity scheme with several tranches of allocation. Under the same, nine tranches have been released so far, allocating ~10.84 GW of projects. The latest ISTS project auctioned was 2000 MW ISTS Tranche IX in June 2020, which attracted a record low bid tariff of Rs 2.36 per unit.

The projects to be selected under this scheme can be installed anywhere in India, but must be connected directly to the central PGCIL ISTS system. The minimum voltage for interconnection at the ISTS will be 132 kV.

5.4 Key growth drivers and trends

Growth drivers	Description
 **Increased consumer awareness**	Growing awareness among the consumers about the benefits of solar energy, including environmental sustainability along with favourable government initiatives by the government, has led to an increase in adoption of solar solutions at the residential level. In January 2024, a boost was provided to the residential rooftop segment with the launch of PM Surya Ghar Yojana that aims to solarise 10 million households.
 **Technological advancements**	Advances in solar technology has proven itself as a catalyst for the industry. Technological improvements such as improved solar efficiency of solar panels and energy storage solutions have made power generation through solar energy more viable and attractive. Technological improvements in renewable energy projects along with battery storage can provide a firm power supply for a longer duration in both on-grid and off-grid applications, helping utilities and consumers meet energy requirements efficiently and in an environment-friendly manner.
 **Availability of multiple funding options**	The entry of large global players and financially strong Indian conglomerates has intensified competition in the sector. In this scenario, innovative finance avenues such as green bonds, masala bonds (rupee-denominated green bonds), pension funds as investors, and Infrastructure Investment Trusts (INVITs) are available to mitigate this risk. These alternative financing options provide opportunities to secure funding for solar projects at favourable terms.
 **Supportive policies**	The government is encouraging cash-rich PSUs to set up renewable energy projects. NTPC has already commissioned a total of over ~2,120 MW of capacities, allocated ~5 GW, and tendered a further ~1 GW, under various schemes. It has a target to install ~35 GW of renewable energy capacities by fiscal 2028. Similarly, NHPC had allocated 2 GW of projects in 2020, while the Indian Railways has committed to 20 GW of solar power by 2030. In addition, state initiatives such as the Telangana State Renewable Energy Development Corporation Ltd (TSREDCO) aims to install solar panels on 500 school buildings, promoting decentralised electricity generation and mitigating power shedding issues in the state, are contributing to the sector's growth in various regions of India.

Source: Crisil Intelligence

5.5 Key challenges and risks

Volatility in module prices	Counterparty risk	Technology and input risk	Supply-demand mismatch	Infrastructure risk	Capital-intensive nature	Changing regulations
						

Source: Crisil Intelligence

5.5.1.1 Volatility in module prices

Accounting for 50-60% of capital cost, the price of solar modules is a crucial factor and can significantly impact project returns. Since India relies heavily on imported modules from China, the United States and southeast Asia, any volatility in global prices can impact Indian developers significantly. In some cases, module prices have started increasing even as developers anticipated a dip in prices while placing tariff bids. Moreover, solar modules and inverters are imported in US dollars, increasing the risk of exchange rate fluctuations.

The GST rate for specified renewable energy devices and parts for their manufacture has also been increased from 5% to 12% starting September 30, 2021.

5.5.1.2 Counterparty risk

In the ever-evolving landscape of India's power sector, counterparty risk remains a critical concern for project developers, particularly in renewable energy (RE). The weak financial position of state discoms has led to payment delays and defaults, causing apprehension among developers. While efforts such as UDAY (Ujjwal Discom Assurance Yojana) initially provided relief to discoms, lack of operational improvements has reversed the progress, again burdening them with debt.

Strengthening PPAs to mitigate counterparty risk is crucial. This can be undertaken by including provisions for off-takers to provide letters of credit (LC) and factoring in interest on delayed payments by the buying entity. While the central government introduced a mandatory provision of LCs by state utilities prior to purchasing power from generators in August 2019, the impact was limited due to implementation challenges on the ground. Developers can also mitigate risk by diversifying their portfolios through multiple PPAs with different discoms, considering various parameters.

5.5.1.3 Technology and input risk

Generation in any solar project relies on various factors, including solar irradiance, the quality of solar modules, the design of the plant, and construction quality. However, module degradation is an important factor affecting performance. Power generation capacity declines irreversibly in all solar panels due to degradation. However, in cases where the modules are of poor quality or the installation and design are inadequate, the degradation and decline in generation can be higher.

Use of poor-quality solar modules, which do not comply with standards such as IEC 61215, 61730, ANSI/UL 1703 and CAN/CSA 61730, poses a significant threat to generation due to higher failure rates. Poor generation performance negatively impacts the equity internal rate of return (IRR) of solar projects.

However, there are instances where companies supplying cheaper and sub-standard modules are financially weak, leading to bankruptcies of large players in the past. In such cases, all warranties and guarantees become null and void. To mitigate the impact of both module underperformance and supplier bankruptcy, developers can purchase corresponding insurance. However, this would increase the operating costs for the project.

5.5.1.4 Offtake risk and supply-demand mismatch

Solar power generation relies entirely on the solar irradiance that reaches the Earth's surface. Solar energy generation is inherently variable and depends on weather conditions such as clouds, dust storms, fog and more. As a result, the availability of solar power on the grid can fluctuate. When combined with variable consumer demand, it can lead to a demand-supply mismatch, potentially causing blackouts. To manage this, discoms and state load dispatch centres are authorised to issue instructions to developers to curtail generation as needed. In the past, grid constraints in Rajasthan and Tamil Nadu resulted in significant back-down of grid power in 2016-17.

However, at times, discoms may use this provision excessively to curtail renewable energy generation when they choose not to procure power, causing losses for developers. Such incidents of back-down occur more frequently in certain states, raising concerns about the reliability of offtake agreements. To address this issue, developers have the option to seek relief by petitioning the respective state electricity regulatory authority.

Solar tariffs have historically been higher than the APPC of discoms. This creates offtake risk for older solar projects, particularly considering the sluggish growth in power demand and the weak financial health of discoms.

To mitigate offtake risks, it is crucial to strictly enforce the concepts of ‘deemed generation’ and ‘must-run’ benefits. Under these provisions, developers are appropriately compensated for power not supplied due to grid unavailability, and there are prohibitions on backing down solar power due to higher tariffs.

5.5.1.5 Infrastructure risk

The risk associated with infrastructure arises from the inadequate availability of land and transmission infrastructure for solar projects. Land acquisition poses challenges due to the small average land holdings in India. Hence, acquiring large tracts of land in a single location requires the involvement of multiple stakeholders, resulting in slower project execution.

Delays in constructing evacuation systems for solar projects also contribute to infrastructure risk. Right-of-way issues (RoW) may arise when constructing transmission lines to the nearest evacuation substation. Additionally, obtaining permissions and approvals from discoms, transmission companies, load dispatch centres and chief electrical inspectors for constructing evacuation systems can further delay projects.

Both land and transmission risks can be mitigated by setting up projects in solar parks, which offer land with clear titles and pre-existing transmission infrastructure for solar projects. Solar parks also provide additional facilities such as roads, water, drainage and electricity during construction, reducing the burden on project management and accelerating project completion.

5.5.1.6 Capital-intensive nature

Given the capital-intensive nature of solar power projects, the availability of funding at competitive rates is crucial. Funding risk can arise due to weak investor sentiment, a rising interest rate regime, currency depreciation or any policy changes that impact fundraising.

In the past, high domestic interest rates, lower re-payment tenure and inadequate and delayed capital subsidy have increased the minimum tariffs required to achieve healthy IRRs.

5.5.1.7 Changing regulations

Frequent policy changes and lack of clarity would also lead to hesitance among global investors to enter / fund the sector. This is highly detrimental to the sector’s growth, which requires significant equity over the coming years to continue supporting additions. For example, the ALMM order, which applies to bids submitted after April 10, 2021, mandates the use of domestic modules for government/government-assisted projects/projects under government schemes and programmes. Government agencies, including the central and state governments, CPSUs, PSUs and central and state organisations, pose a challenge to developers when it comes to procuring modules. However, ALMM is in abeyance until March 2024.

Additionally, the Supreme Court's order to lay transmission lines underground in the habitat areas of the great Indian bustard presents a significant challenge for developers. This requirement entails additional expenses for converting overhead lines, which could impact under-construction renewable projects in Rajasthan and Gujarat. The developers have requested the Supreme Court to reconsider the order and restrict the coverage to the bustard’s priority habitat areas. The Supreme Court ultimately ordered the developers to install bird diverters by the July-end 2022.

6. Overview of rural electrification market in India

6.1 Overview of market

Focusing on rural electrification, the Government of India incorporated REC Limited (Rural Electrification Corporation of India) as a company under the Companies Act in 1969. Its main objective was financing rural electrification schemes in the country. The mandate/object clause of REC was expanded from time to time. In 2022, it was expanded to tap emerging business opportunities in the logistics and infrastructure sector.

Additionally, government schemes such as Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) and Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya) have been launched to achieve electrification of rural households. Both have played a role in achieving the same.

Further, the government issued a 'New Solar Power Scheme for Particularly Vulnerable Tribal Groups (PVTG) Habitation/ Villages' under PM JANMAN (Pradhan Mantri Janjati Adivasi Nyaya Maha Abhiyan). This scheme will cover electrification of all un-electrified PVTG households by providing off-grid solar systems where electricity supply through grid is not techno-economically feasible. In addition, the scheme aims to provide solar lighting in 1500 multi-purpose centres (MPCs) in PVTG areas where electricity through the grid is not available. Rs 5.15 billion has been provided under the scheme, which provides for electrification of households through standalone solar home lighting systems where households are scattered and through solar mini grid for a cluster of Households.

Key government schemes related to electrification

6.1.1.1 Integrated Power Development Scheme (IPDS)

The government launched the Integrated Power Development Scheme (IPDS) in December 2014. Under this, a range of works were executed, such as distribution infrastructure projects to strengthen sub-transmission and distribution networks in urban areas, metering of distribution transformers / feeders / consumers in urban areas, IT enablement works, enterprise resource planning; smart metering; gas insulated sub-stations; and real-time data acquisition systems (RT-DAS).

Central funding is being provided to reduce aggregate technical and commercial (AT&C) losses. Funds have also been sanctioned under IPDS for underground (UG) cabling and aerial bunched (AB) cables and metering, which help reduce AT&C losses.

System strengthening and distribution (ST&D) projects covering 547 circles in 33 states/UTs have been taken up under the scheme. Out of these, distribution system strengthening works in 546 circles have been successfully completed.

The government also recently launched the reforms-based and results-linked Revamped Distribution Sector Scheme (RDSS) for distribution utilities and a scheme for additional borrowings. Both have linked financial incentives to reform in the areas of AT&C loss reduction and reliability of power supply. Hence, funds are released only when reforms are undertaken.

6.1.1.2 Deen Dayal Upadhyaya Gram Jyoti Yojana- DDUGJY

The government launched the Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) in December 2014 for strengthening the electricity distribution system through-

I. To separate agriculture and non-agriculture feeders to facilitate Discoms in the judicious rostering of supply to agricultural & non- agricultural consumers
II. Strengthening and Augmentation of Sub Transmission & Distribution infrastructure in rural areas and
III. Metering at Distribution Transformers, Feeders and consumers end in rural areas

The components I and II of the scheme has an estimated budgeted outlay of ~Rs 430 billion and component III of the scheme has as estimated outlay of ~393 billion. The work under DDUGJY included setting up new substations, separation of agriculture and non-agriculture feeders, augmentation of old substations adding 850000 ckt of HT&LT lines, adding transformers, and electrification of villages across the country. For villages where grid connectivity was neither feasible nor cost-effective, the electrification was done through off-grid modes. The erstwhile Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) was subsumed under DDUGJY.

Under DDUGJY, and thereafter under Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya), all states declared electrification of all villages on April 28, 2018 and all willing households on March 31, 2019 respectively. While a total of 18,374 villages were electrified under DDUGJY, 28.6 million households were electrified under the aegis of Saubhagya, including additional households in two tranches that became willing after March 31, 2019 but were unwilling for electrification earlier.

6.1.1.3 Sahaj Bijli Har Ghar Yojana – Saubhagya

Sahaj Bijli Har Ghar Yojana – Saubhagya, was launched in October 2017, focusing on last-mile connectivity and providing electricity connections to all the unelectrified households in the country. The scheme is one of the world's biggest universal electrification initiative, to be implemented with the collaborative efforts of the Centre and states. It is a concurrent programme to DDUGJY. The scheme outlay is Rs 163.20 billion, including gross budgetary support of Rs 123.20 billion. REC is the nodal agency to operationalise the scheme. The scheme aimed at providing:

- Last-mile connectivity and electricity connections to all unelectrified households in rural areas
- Last-mile connectivity and electricity connections to all remaining poor unelectrified households in urban areas. Non-poor urban households are excluded from this scheme
- Solar photovoltaic-based standalone system for unelectrified households located in remote and inaccessible villages/habitations, where grid extension is not feasible or cost-effective

Since the launch, as on March 31, 2021, all states have reported 100% electrification of all the willing unelectrified households, identified before March 31, 2019. The states reported 28.2 million households had been electrified. Further, 4.43 lakh additional households have been electrified under DDUGJY.

As such, as on March 31, 2022, 28.6 million households (including tribal households) have been electrified since the launch of Saubhagya. The scheme stands closed.

6.1.1.4 Revamped Distribution Sector Scheme- RDSS

The government launched the RDSS to improve the quality and reliability of power supply to consumers through a financially sustainable and operationally efficient distribution sector. The scheme has an outlay of Rs. 3.04 trillion, having gross budgetary support of Rs 976.31 million from the central government from fiscal 2022 to fiscal 2026. The RDSS has universal coverage and is mainly focused on strengthening of sub-transmission and distribution network of project areas for the benefit of consumers.

Under the RDSS, the central government is further supporting states in electrifying households missed out under Saubhagya. In addition, all identified PVTG households under PM-JANMAN for on-grid electricity connections will be eligible for funding under the RDSS.

As of February 2024, proposals for 4.96 lakh household electrification works have been sanctioned under the RDSS for Uttar Pradesh, Rajasthan and Andhra Pradesh at a cost of Rs 8.13 billion. Further, under PM-JANMAN, on-grid electrification of 87,863 households in 7,113 habitations has been sanctioned as of February 2024.

Summary of a few power schemes focused on rural electrification

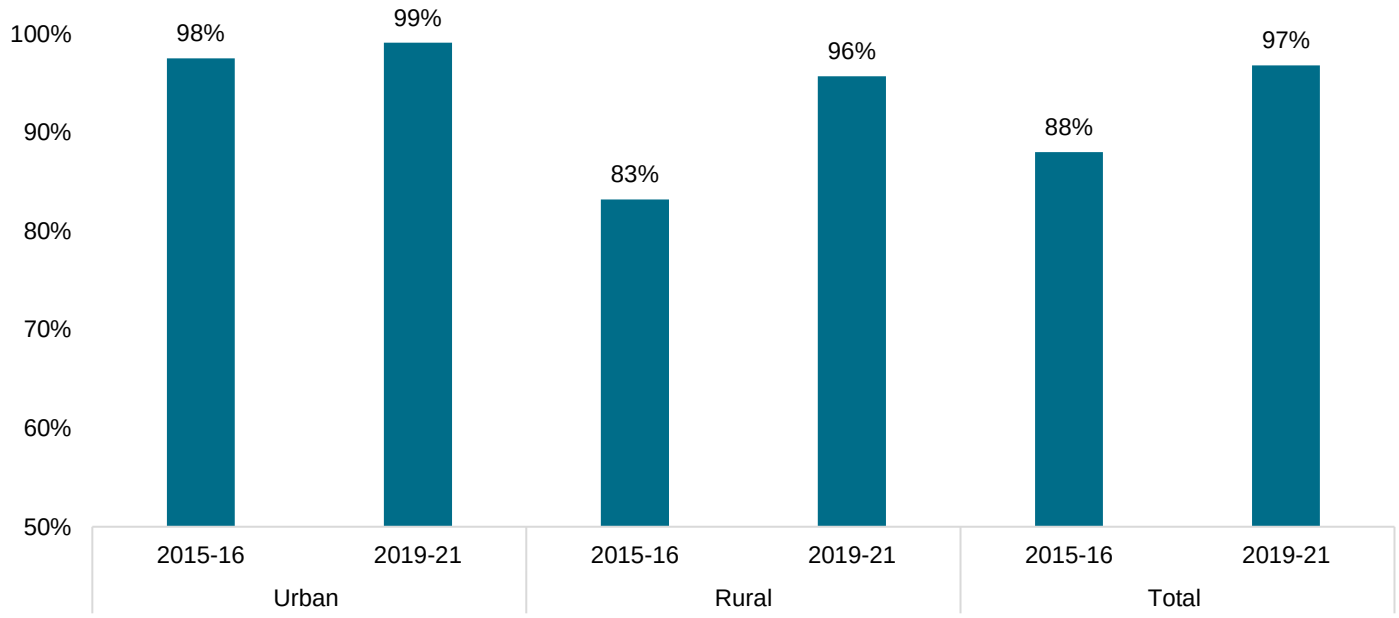
Scheme	Start year	Gross Budgetary Support	Description
Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY)	Dec, 2014	Rs 823 billion	Government of India launched DDUGJY for strengthening the distribution systems including separation of agriculture and non-agriculture feeders, strengthening and augmentation of sub-transmission & distribution infrastructure, metering of distribution transformers/ feeders/ consumers and electrification of villages across the country. Erstwhile Rural Electrification scheme of Govt. of India has been subsumed in DDUGJY as a separate rural electrification (RE) component.
Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya)	Oct, 2017	Rs 163 billion	Saubhagya was launched by Government of India in October, 2017 with the objective to achieve universal household electrification throughout the country. Under this scheme, electricity connection was provided to all willing un-electrified households in rural areas and all willing poor un-electrified households in urban areas. The electrification was carried out by State DISCOMs / Power Departments with funds provided by the Central Government under the Scheme.
Revamped Distribution Sector Scheme (RDSS)	Jul, 2021	Rs. 3.04 trillion over fiscals 2021-22 to fiscals 2025-26.	RDSS was launched to help DISCOMs improve their operational efficiencies and financial sustainability by providing result-linked financial assistance to DISCOMs to strengthen supply infrastructure based on meeting pre-qualifying criteria and achieving basic minimum benchmarks. The main objectives of RDSS are: • Reduction of AT&C losses to pan-India levels of 12-15% by FY 2024-25. • Reduction of ACS-ARR gap to zero by FY 2024-25. • Improvement in the quality, reliability, and affordability of power supply to consumers through a financially sustainable and operationally efficient distribution sector.

Source: Ministry of Power, PIB, Crisil Intelligence

Every village and household has been electrified in India

As per latest National Family Health Survey Data (NFHS-5), 99% of the urban population lived in electrified households during 2019-21 compared with 98% in 2015-16. There was a notable increase in the rural population living in households with electricity, from ~88% in 2015-16 to 96% during 2019-21. The combined increase in the rural and urban electrification has resulted in an overall national electrification rate of ~97% between 2019-21 compared with 88% in 2015-16.

Population living in households with electricity (%)



Source: National Family Health Survey (NFHS), PIB, Crisil Intelligence

As of January 2024, every village and household has been electrified. The availability of power in rural areas has increased from 12 hours in 2015 to 20.6 hours and in the urban areas it has increased up to 23.8 hours. Additionally, as of 2023-24, peak demand has increased by 12.7% to 2,43,271 MW from 2,15,888 MW during same period previous year and all India peak shortage has reduced to 1.4% (3,340 MW) with respect to 4.0% (8,657 MW) during the same period previous year.

This improvement in the average availability of power in rural areas as well as reduction in the peak shortage underscores growth in transmission infrastructure and efficient service delivery mechanisms through multiple government schemes including DDUGJY, Saubhagya and RDSS.

Key growth drivers and trends

Growth driver	Description
Increasing government focus on rural electrification	Government programmes such as DDUGJY and Saubhagya have played a crucial rule in increasing the rural electrification to ~96% in 2019-21 from 83% 2015-16. Additionally, the government also launched the RDSS, which will help in electrification of remaining households as well as improving the quality and reliability of power supply
Expansion of renewable energy sources	The growth in the renewable energy sources along with technological advancements in energy storage solutions has made renewable energy more feasible. By fiscal 2029, RE capacity is expected to account for 50-55% of the installed capacity of 700-710 GW due to strong renewable energy addition
Focus on sustainable development goals	India's commitment to achieving the United Nations Sustainable Development Goals, particularly SDG 7 which is to do with affordable and clean energy, is providing impetus for accelerating rural electrification efforts

Source: Crisil Intelligence

Key entry barriers

The rural electrification sector demands a strategic approach where the players need to blend strong technical expertise, financials strength and operational adaptability.

Parameter	Description
High capital requirement	The sector demand huge capital expenditures into equipment and technology for setting up transmission lines, transformer and other power infrastructure. Rural electrification projects likely involve a long gestation period and possibly delays in payment settlement due to financial constraints faced by the DISCOMs, leading to increase in working capital requirements.
Dependence on government projects	The sector is driven by demand generated by the government schemes and policies. Electrification projects are allotted through a competitive tendering process where the bidder has to portray technical and financial capabilities as per the project's requirement. This leads to majority of projects being won by established players. This causes high entry barriers for new entrant as they need to compete on cost efficiency, execution capabilities and past credentials.
Technical and operational challenges	Rural electrification projects involve difficult terrain and remote geographies. This causes challenges in terms of logistics, project execution, and challenges in mobility of skilled workers. All these factors add to the project cost and demands experienced EPC players for efficient execution. These projects also involve management of socio-political challenges. The project may face resistance from the local community. The management of these factors is also crucial.
Supply chain and Vendor management	Large scale electrification projects involve complex supply chains and vendor management. Oversights and lack of reliability can lead to project delays and cost overruns. This is one of the factors where established players have an edge over the new entrants since they have a long running relation with their vendor ecosystem.

Source: Crisil Intelligence

Overview of the key challenges and the risk factors in the sector

6.1.1.5 Fuel availability

Fuel accounts for a large proportion (75-80%) of the operating cost of thermal power plants (~80% of conventional power installed base). Historically, over 2011-14, domestic coal availability has been a major issue since non-coking coal production grew merely 1.7% owing to stringent environmental regulations. This, in turn, adversely impacted the returns of players.

However, over the past 18-24 months, coal production has increased, with faster clearances and land acquisition. Additionally, the government push has encouraged Coal India Ltd to boost thermal coal production, coupled with a rise in captive coal production by thermal power generators. This led to higher dispatches to the power sector, at 21.5% on-year growth in fiscal 2022 and 8.5% on-year growth in fiscal 2023.

6.1.1.6 Timely project execution

Power projects are highly capital-intensive and have a long gestation period. Therefore, completion of projects in a timebound manner is critical for developers to avoid huge time and cost overruns. In the past, thermal power projects have witnessed significant cost overruns on account of delays in receipt of clearances, land acquisition and financial closure. In fact, in certain projects, cost overruns have been as high as 67%, resulting in project cost escalating to Rs 75 million per MW as compared with the initially envisaged Rs 45 million per MW.

Hydropower projects have also been crippled due to execution challenges such as securing necessary approvals (environmental and forest clearances), land acquisition and relocation of people habitant in the area, inadequate infrastructure for power evacuation and logistical issues. Moreover, any delay in the commissioning date of projects further raises its cost. This escalates the power tariff, thereby increasing power purchase cost for discoms, which are reluctant to buy costly power from such projects.

6.1.1.7 Changes in emission norms

Coal-based plants need to adhere to the emission norms as prescribed by the Ministry of Environment, Forest & Climate Change. There is additional capital expenditure associated with the equipment to be installed for keeping emissions below prescribed levels. Thus, any revisions in such norms have a cost impact on the generators.

In December 2015, government notified the revised standards for coal-based thermal power plants in the country, which aimed to minimise pollution and limit water usage. The standards were made stringent for recent plants, compared with earlier ones and most stringent for plants to be set up in future. Upgradation of ESP (electrostatic precipitator), installation of a flue gas de-sulphurisation (FGD) plant, modification of combustion system, upgrading cooling towers to reduce specific water consumption, etc., would escalate the capital cost of coal-based plants by Rs 1.5 - 2 million per MW if land is available for the expansion to equipment. However, if adequate land is not available, cost could be higher for the same. Although the capital expenditure incurred towards these modifications would be passed on to discoms, it would be subject to approval from respective regulatory commission and PPA clauses. Thus, changes in emission norms have a moderate impact on power generation projects.

6.1.1.8 Regulatory and policy issues

The Electricity Act, 2003, promoted competition in the power sector and provided for the de-licensing of thermal power generation. Also, while power deficit levels were as high as ~8.4% in fiscal 2006, the power generation segment was given thrust through competitive bidding (Case-I and Case-II) for PPAs and allocation of coal blocks/ signing of letter of assurance (LoA) for coal supply. As a result, the share of the private sector in the total installed capacity (thermal) witnessed the strongest traction.

However, after the cancellation of coal block allocation in September 2014, a number of plants were stalled due to want of fuel. Although the latest coal linkage policy (SHAKTI) notified in May 2017 aims to resolve this bottleneck, it has added a clause of providing discount on existing PPA tariffs, which would hurt project returns. Also, denial of compensatory tariff on account of international price changes, cancellation of PPA bids, backing down of wind and solar generation despite its 'must-run' status, and renegotiation of PPAs are some of the key risks the power generation sector is facing.

7. Overview of battery energy storage and lithium-ion battery in India

7.1 Overview of BESS market

Overview of ESS industry

Energy storage systems (ESSs) are used to exchange power with the grid and can be categorised based on the energy form ultimately stored. There are several energy storage technologies, broadly classified as mechanical, thermal, electrochemical, electrical and chemical storage systems. Mechanical storage technologies include pumped storage hydro (PSH), compressed air energy storage (CAES) and flywheels. Thermal storage includes ice-based storage systems, hot and chilled water storage, molten salt storage, and rock storage technologies.

Within the electrochemical category, which includes technologies that use different chemical compounds to store electricity, the most common are lead-acid batteries, high-temperature sodium batteries, flow batteries, zinc-based batteries, and Li-ion batteries. Electrical storage systems also include super-capacitors and superconducting magnetic energy storage (SMES), while chemical storage typically uses electrolysis to produce hydrogen as a storage medium which can subsequently be converted to energy in various modes, including electricity (via fuel cells or engines), heat and transportation fuel (power-to-gas).

Types of ESS

Mechanical	• Pumped storage hydro • CAES • Flywheel
Electrochemical	• Lead-acid batteries, advanced lead acid (lead carbon, bipolar lead acid) • Lithium batteries • Flow batteries (ZnBr, Vn Redox) • Sodium batteries (NaS, Na-$NiCL_2$)
Thermal	• Sensible: Molten salt, chilled water • Latent: Ice storage, phase change materials • Thermochemical storage
Electrical	• Supercapacitors • Superconducting magnetic coil Energy Storage (SMES)
Chemical (hydrogen)	• Power-to-power (fuel cells, etc.) • Power-to-gas

Source: Ministry of New and Renewable Energy (MNRE), Crisil Intelligence

ESSs include battery energy storage system (BESS), concentrated solar power (CSP) thermal energy storage in molten salt form, CAES, mechanical energy storage system (MESS), etc. These systems help align the overall demand-supply dynamics, especially for renewable energy, which has a varied energy source. By storing excess energy during peak production times, a battery system ensures consistent power supply even during unavailability of natural resources such as sunlight or water.

Overview of BESS

A battery energy storage system (BESS) is an electrochemical device that charges (or collects energy) from the grid and discharges that energy at a later time to provide electricity or other grid services when needed.

The battery system comprises the battery pack, which connects multiple cells to appropriate voltage and capacity; the battery management system (BMS); and the battery thermal management system. The BMS protects the cells from harmful operation, in terms of voltage, temperature and current, to achieve reliable and safe operation and balances varying cell states-of-charge (SOCs) within a serial connection. The battery thermal management system controls the temperature of the cells according to their specifications in terms of absolute values and temperature gradients within the pack. The inverter system, also called power conversion system, converts the DC power to AC power while discharging and converts the AC power to DC power while charging the batteries.

Benefits of BESS

Benefits	Description
Grid stability	A BESS stores the excess energy that is produced during peak production time, which can be released during low demand period. This consistent flow of energy/ power helps in proper functioning of the grid and allows to maintain an optimal balance of power/energy demand and supply.
Power backup	As BESS can store excess energy within itself, it helps in providing a reliable power backup in areas with frequent power outrages or in facilities that require continuous power supply.
Potentially reduced carbon footprint	Deploying a BESS can also help in reducing carbon footprint by storing electricity, which can be used during high demand/ peak demand times.

Source: Crisil Intelligence

Types of BESS

Several battery chemistries are available or under investigation for grid-scale applications, including lithium-ion, lead acid, redox flow, nickel cadmium, and sodium sulphur. Battery chemistries differ in key technical characteristics and each battery has unique advantages and disadvantages.

Battery type	Round-trip efficiency	Life span	Advantages
Lithium-ion battery	88-90%	10-15 years	High specific energy and high load capabilities with power cell
Sodium-sulphur battery storage	75-85%	10-15 years	Low-cost potential: Inexpensive raw materials and sealed, no-maintenance requirement
Nickel-cadmium battery	60-80 %	10-15 years	Rugged, high cycle count with proper maintenance
Vanadium redox flow battery	70-75%	5-10 years	Long service, versatility
Lead-acid battery	70-75%	3-6 years	Low-cost and simple manufacture, low cost per watt-hour

Note: Round-trip efficiency, measured as a percentage, is a ratio of the energy discharged from the battery to the energy put into the battery
Source: CEA; handbook on energy storage system by ADB, December 2018; Crisil Intelligence

7.2 BESS capacity in India

As per National Energy Policy 2023 (NEP 2023), capacity of 8,640 MW or 34,720 MWh is estimated to be added between 2022 and 2027 in the BESS segment. The highest capacity addition is expected in solar energy at ~38,890 MW.

The overall capacity addition is expected to be further augmented between 2027 and 2032, during which 38,564 MW or 201,500 MWh is estimated to be added in the BESS segment. The other segments that are also expected to have notable additions are solar, wind, and coal + lignite at 179,000 MW, 49,000 MW, and 25,480 MW, respectively.

Segment-wise capacity additions

Segments	Hydro	PSP	Solar*	Wind*	Biomass#	SHP#	Nuclear$	Coal + lignite	BESS (MW/MWh)
Capacity addition required during 2022-27									
Under construction	10,462	2,700	92,580	25,000	2,318	352	6,300	25,580	-
Additional capacity requirement	-	-	38,990	7,537	0	0	-	-	8,680/ 34,720
Total capacity addition	10,462	2,700	131,570	32,537	2,318	352	6,300	25,580	8,680/ 34,720
Capacity addition required during 2027-32									
Under construction	1,032	80	-	-	2,500	250	2,400	1,320	
Additional capacity requirement	8,700	19,160	179,000	49,000	-	-	4,200	24,160	38,564/ 201,500
Total capacity addition	9,732	19,240	179,000	49,000	2,500	250	6,600	25,480	38,564/ 201,500

Note:

*As per MNRE, 117.58 GW of solar and wind capacity (under construction or bid out) was planned for 31.03.22, out of which 10.87 GW has been added during 2022-23 till 31.12.22.

Assumed Planned Capacity of Biomass and SHP during 2022-27 and 2027-32

$ Nuclear projects of 8700 MW are under construction of which 6300 MW are considered to be commissioned during 2022-27 and 2400 MW are considered to be commissioned during 2027-32. Additionally Nuclear projects totaling to 7000 MW are in principle approval stage of which 4200 MW capacity is likely to yield benefit during the year 2027-32

Source: CEA, Crisil Intelligence

India's largest solar-battery project launched in Chhattisgarh

In 2024, Solar Energy Corporation of India Limited (SECI), under the aegis of MNRE, has successfully commissioned India's largest BESS, which stores energy using solar energy. The 40 MW/ 120 MWh BESS with a solar photovoltaic (PV) plant, which has an installed capacity of 152.32 MWh and dispatchable capacity of 100 MW AC (155.02 MW peak DC), is located in Rajnandgaon, Chhattisgarh. The energy would be purchased by the state of Chhattisgarh, thus contributing to meeting the peak energy demand of the state using green electrons as well as towards its renewable purchase obligations.

The project using solar panels and battery storage represents a monumental leap forward in generation and use of renewable energy. The project utilises battery storage for storing solar energy when the sun is shining and using it later during hours of peak demand in the evening, for meeting the electricity demand in the state. The project has deployed bifacial modules, which reflect the light from the ground, thus generating more electricity than monofacial modules and setting a new standard for large-scale renewable energy projects.

Regulatory and policy framework related to energy storage systems

Viability gap funding (VGF)

For establishment of BESS projects, costs are a challenge in the initial years because volumes are low. Therefore, VGF becomes essential for supporting initial uptake of BESS by consumers. To decrease the levelised cost of storage and make BESS a viable option, it has been proposed to offer VGF to an initial few BESS project. The VGF may be up to 40% of the capital cost of the project, with the condition that the project must be commissioned within 18 to 24 months. With the proposed VGF, the levelised cost of storage can be managed at affordable levels. Considering the cost of energy for charging BESS, the total cost of energy from BESS would be comparable to the price in the power exchanges during the peak demand periods. Thus, with the proposed VGF, BESS would become a viable option for peak power management. The scheme is further expected to support development of the ecosystem for BESS and help reduce cost with subsequent large-scale expansion of BESS capacity.

The VGF for development of BESS Scheme, with an initial outlay of Rs.94 billion, including a budgetary support of Rs.37.6 billion, signifies the government's commitment to sustainable energy solutions.

PLI scheme: National Programme on Advanced Chemistry Cell Battery Storage

In June 2021, the Ministry of Heavy Industries (MHI) launched a Production-Linked Incentive (PLI) scheme for the manufacturing of advanced chemistry cell (ACC) battery storage of 50 GWh capacity, which includes more than 10 GWh grid-scale battery storage. Out of the 50 GWh capacity, 30 GWh capacity has already been allotted through a competitive bidding process as of December 2023. The PLI-ACC scheme has an outlay of Rs 181 billion.

The PLI scheme would encourage investment in domestic manufacturing of cells for grid-scale applications, reduce dependency on imports, and reduce cost of BESS in the future.

High import duty protects domestic market

Manufacturers of power storage systems do not receive direct incentives. The high duties and taxes, set at 10%, imposed on imported power storage equipment act as a deterrent to cheaper imports. Additionally, the Goods and Services Tax (GST) rate for most power storage products is 18%. The customs duty for imported cobalt matt, which is used for further processing, stands at 5%. Although this can be viewed as a positive, its benefits will only be realised once domestic battery manufacturing capacities are established. However, in terms of raw materials, the government has categorised imported cobalt, nickel and lead used in the production of power storage equipment under the 5% import duty bracket.

Environmental compensation funds for battery waste management

The Ministry of Environment, Forest and Climate Change, Government of India, published the Battery Waste Management Rules, 2022, in August 2022, to ensure environmentally sound management of waste batteries. The rules cover all types of batteries, viz. electric vehicle (EV) batteries, portable batteries, automotive batteries and industrial batteries. The rules function based on the concept of Extended Producer Responsibility (EPR), where the producers (including importers) of batteries are responsible for collection and recycling/refurbishment of waste batteries and use of recovered materials from wastes into new batteries. EPR mandates that all waste batteries are to be collected and sent for recycling/refurbishment, and it prohibits disposal in landfills and incineration.

The rules promote setting up of new industries and entrepreneurship in collection and recycling/refurbishment of waste batteries. Mandating the minimum percentage of recovery of materials from waste batteries under the rules will bring new technologies and investment in the recycling and refurbishment industry and create new business opportunities. Prescribing the use of a certain amount of recycled materials in making new batteries will reduce the dependency on new raw materials and save natural resources.

Based on the ‘polluter pays’ principle, environmental compensation will be imposed for non-fulfilment of EPR targets, responsibilities and obligations set out in the rules. The funds collected under environmental compensation shall be utilised in collection and refurbishing or recycling of uncollected and non-recycled waste batteries.

Waiver of ISTS charges on transmission of electricity generated from solar, wind pumped storage plant and BESS

In June 2021, the Ministry of Power had extended the waiver of ISTS charges on transmission of electricity generated from solar and wind sources for projects to be commissioned up to June 30, 2025 Further, the order promotes the development of solar, wind, Hydro Pumped Storage Plant (PSP) and Battery Energy Storage System (BESS), trading of RE in the power exchanges and seamless transmission of RE power across the states. The waiver of inter-state transmission charges on transmission of the electricity generated from solar and wind sources of energy that was available to solar and wind projects commissioned up to 30th June 2023 has now been extended till 30th June 2025.

The waiver of Inter- State transmission system (ISTS) charges has also been allowed for Hydro Pumped Storage Plant (PSP) and Battery Energy Storage System (BESS) projects to be commissioned up 30th June 2025. This will promote the Hydro Pumped Storage Plant (PSP) and Battery Energy Storage System (BESS) projects for meeting the balancing requirement of the grid caused due to large scale integration of Renewables in the Electricity Grid ie around 450 GW by 2030.

National Mission on Transformative Mobility and Battery Storage

The Government of India approved setting up of a National Mission on Transformative Mobility and Battery Storage in March 2021 to drive clean, connected, shared, sustainable and holistic mobility initiatives.

The mission will develop strategies for transformative mobility and Phased Manufacturing Programme (PMP) for EVs, EV components and batteries. PMP will focus on battery, raw materials, electrochemistry, end-of-life treatment, cell manufacturing, modules and battery packs. It would support setting up of large-scale, export-competitive integrated batteries and cell-manufacturing giga plants in India, as well as localise production across the entire EV value chain. The mission’s objective is to coordinate with relevant central ministries/ departments and states in integrating various initiatives for mobility transformation in India.

Key growth drivers and trends of the BESS industry

Growth drivers	Description
Cost reduction	As per NEP 2023, the cost of BESS has been reducing significantly, making it one of the preferred options for deployment. As discussed above, BESS has the advantage of balancing the grid against load fluctuations, intermittency in generation, etc.
Government focus	The Government of India's increasing focus on the BESS industry is expected to positively impact the overall growth of BESS. The government has launched multiple initiatives, including the PLI scheme of ACC batteries, VGF for BESS, and waiver of ISTS charges for BESS projects. The Ministry of Power has also released the National Framework for Promoting Energy Storage Systems, to encourage the adoption of energy storage for ensuring an environmentally sustainable and financially viable power sector.
Increasing share of renewable energy in overall energy capacity	India has set a target to achieve 50% cumulative installed capacity from non-fossil fuel-based energy resources by 2030 and has pledged to reduce the emission intensity of its GDP by 45% by 2030, based on 2005 levels. This transition towards renewable energy is expected to aid the growth of BESS, which is crucial to store excess energy generated during peak production times and supply it during periods of high demand/ low production to ensure uninterrupted supply.

Source: CEA, Crisil Intelligence

7.3 Overview of lithium-ion battery industry in India

Lithium-ion (Li-ion) batteries are a type of BESS. They are suitable for both small- and large-scale electricity storage in power generation. Li-ion battery chemistries have the highest energy density and are considered safe. No memory or scheduled cycling is required to prolong battery life. Li-ion batteries are used in electronic devices such as cameras, calculators, laptop computers, and mobile phones, and are increasingly being used for electric mobility.

Benefits of Li-ion batteries

Benefits	Description
High specific energy	Li-ion batteries have high specific energy, which makes them a convenient choice for devices that require extended use without frequent charging.
Long cycle and extended shelf life; maintenance-free	Li-ion batteries have long cycles, ensuring endurance to numerous cycles of charge and discharge before significantly losing energy, which also ensures extended shelf life. Additionally, these batteries are comparatively maintenance-free, eliminating the need of periodic upkeep, which further enhances the convenience of the end-consumer.
High capacity and low internal resistance	With high capacity, Li-ion batteries can store significant amounts of energy, thereby supporting longer operational times for devices. Additionally, because of their low internal resistance, energy losses are also reduced, which translates into better efficiency.
Short charge times	Li-ion batteries have reasonably short charge times, which significantly reduces downtime for devices and vehicles. This attribute makes Li-ion batteries a convenient choice for portable devices such as laptops and mobile phones. The ability to quickly charge, combined with high capacity, enhances overall consumer convenience.

Source: Crisil Intelligence

Key growth drivers and trends of Li-ion battery industry

7.3.1.1 Falling cost of Li-ion batteries

Due to technological innovations and improved manufacturing capacity, Li-ion chemistries have experienced a steep decline in prices since inception.

Additionally, the industry is continuously evolving and is in the process of improving capacity, power, size, reliability and safety for applications involving both EVs and power generation. This is expected to further aid the growth of the industry.

7.3.1.2 Increasing demand for EVs in India

In India, the increasing acceptance of EVs has led to a surge in their demand. EVs are a significant end-use case of the Li-ion battery. As consumers become more environmentally conscious, EV demand is expected to increase further. Additionally, the Government of India has launched the FAME scheme to encourage the adoption of EVs and build the associated charging infrastructure, which is expected to increase the share of EVs in overall automobile sales to ~30% in the country by 2030. This growing market will directly boost demand for Li-ion batteries.

7.3.1.3 Shift towards clean energy solutions

India's installed generation capacity, which stood at 356 GW at the end of fiscal 2019, is expected to reach ~480 GW in fiscal 2025 on the back of healthy renewable capacity additions (including solar, wind, hybrid and other renewable sources), even as additions in coal and other fuels have declined. In fiscal 2025, renewables are expected to account for ~36% of the installed capacity, up from ~22% in fiscal 2019. Meanwhile, coal-based capacity is expected to taper to ~45%. By fiscal 2029, renewable energy capacity is expected to account for 50-55% of the installed capacity of 700-710 GW.

India’s transition towards renewable energy such as solar, wind and hydro has led to higher demand for BESS. As per NEP 2023, Lithium-ion batteries currently offer superior performance and dominate the global BESS market. Hence, this push towards green energy solutions such as solar and wind power necessitates efficient battery storage solutions, including Li-ion batteries.

7.3.1.4 Growing demand for consumer durable products

India’s expanding per capita income has led to higher discretionary spending by households. This, along with increasing dependence on the online ecosystem, has resulted in an increase in consumer durable products in the country. Li-ion batteries are a convenient choice for consumer electronics products due to their properties such as high capacity, low internal resistance, and good coulombic efficiency.

Hence, increasing demand for consumer durable products is expected to positively influence demand for Li-ion batteries.

8. Competitive assessment of passive telecom infrastructure and maintenance providers in the telecom tower industry in India

In this section, Crisil has analysed some key passive telecom infrastructure and maintenance providers in the telecom tower industry in India. The list of competitive peers considered in this section is not exhaustive but indicative. Only players providing passive telecom infrastructure and related maintenance services within a comparable revenue range have been considered in this section.

Data has been obtained from publicly available sources, including annual reports available in the public domain/ filed with the Registrar of Companies (RoC), investor presentations of listed players, regulatory filings, rating rationales, and/or company websites and social media pages. Financials in the competitive section have been re-classified by Crisil, based on annual reports available in the public domain/ filed with the RoC and financial filings by the relevant players. Financial ratios used in this report may not match with the reported financial ratios by the players on account of Crisil's standardisation and re-classification.

8.1 Overview of key players

Company name	Year of incorporation	International Presence	Business overview
Bondada Engineering Limited	2012	N.A.	Bondada Engineering Ltd (BEL) has more than 12 years of experience and is engaged in the business of providing engineering, procurement and construction ("EPC") services and operations and maintenance ("O&M") service to players operating in telecom and solar energy industry.
Delta Electronics India Private Limited	2008	Yes*	Delta Electronics India Private Limited (DEIPL) is the wholly owned subsidiary of Delta Thailand and has more than 16 years of experience in India. The company is one of the providers of ICT infrastructure and a player of industrial automation, display solutions, UPS, DC fans and blowers, components, bio-medical, LED lighting, automotive electronics, and renewable energy products.
Dinesh Engineers Limited	2006	N.A.	Dinesh Engineers Limited (DEPL) has ~18 years of experience in providing passive communication infrastructure in India, including construction, laying and maintenance of optical fiber network, installation of telecommunication towers, operational and maintenance of optical fiber network and towers, leasing of own optical/dark fiber networks.
Exicom Tele-Systems Limited	1994**	Yes*	Exicom Tele-Systems Limited is headquartered in India and has ~30 years of experience. It is a power management solutions provider through two business verticals of critical power solutions business and electric vehicle supply equipment ("EV Charger(s)") solutions.
Pace Digitek Limited	2007	Yes	The company operates across telecom, energy and ICT business segments. The company manufactures DC

Company name	Year of incorporation	International Presence	Business overview
			supplies, SMPS, Power Interface Units, Batteries, AMF Panels, and Rectifier Modules etc. It also provides services as a EPC and O&M player for large turn key Telecom passive projects, Telecom site utilities, OFC network projects & ICT/Smart City projects. The company has a pan India presence and ~18 years of experience. The company also provides EPC services for solar plants and battery energy storage solutions. Pace Digitek's subsidiary Lineage Power Pvt Ltd manufactures, supply and installs integrated power management systems in telecom sites.

Note: The information provided above is only indicative and not an exhaustive list of business offerings of the respective companies

*As of fiscal 2023

**The Company was incorporated as "Himachal Exicom Communications Limited", a public limited company under the Companies Act, 1956, pursuant to a certificate of incorporation issued by the Registrar of Companies, Punjab, Himachal Pradesh and Chandigarh on May 9, 1994. The name of the Company was changed to "Exicom Tele-Systems Limited", pursuant to a resolution passed by our Shareholders on August 6, 2008, and a fresh certificate of incorporation consequent upon change of name issued by the RoC on August 11, 2008.

Source: Company websites, annual reports available in the public domain/ filed with the RoC, Crisil Intelligence

Key services and offerings

Company name	Passive telecom infrastructure			Energy	
	Tower construction	OFC related services[1]	Telecom tower related services[2]	Energy storage solutions (ESS)	Other energy solutions[3]
Bondada Engineering Limited	✓	✓	✓	✗	✓
Delta Electronics India Private Limited	✗	✗	✓	✓	✓
Dinesh Engineers Limited	✓	✓	✓	✗	✗
Exicom Tele-Systems Limited	✗	✗	✓	✓	✓
Pace Digitek Limited	✓	✓	✓	✓	✓

Note: The information provided above is only indicative and not an exhaustive list of business offerings of the respective companies

1Includes services like OFC construction, OFC network roll-out, operation & maintenance of OFC network

2 Includes services related to telecom towers like maintenance services, power solutions, etc.

3 Includes EV related services, charging solutions, renewable energy EPC solutions, etc

The above list is an indicative and not an exhaustive representation of the company's offerings

Source: Company websites, Crisil Intelligence

8.2 Financial overview

Key financial parameters

Operating Income (FY21-24)

Company	Unit	FY21	FY22	FY23	FY24	CAGR (FY21-23)	CAGR (FY22-24)
Bondada Engineering Limited	Rs Mn	2,870.9	3,341.3	3,705.9	8,007.6	13.6%	54.8%
Delta Electronics India Private Limited	Rs Mn	13,223.5	15,799.8	23,226.8	N.A.	32.5%	N.A.
Dinesh Engineers Limited	Rs Mn	3,932.1	4,011.9	4,144.4	N.A.	2.7%	N.A.
Exicom Tele-Systems Limited	Rs Mn	5,133.3	8,436.1	7,086.8	10,385.0	17.5%	11.0%
Pace Digitek Limited	Rs Mn	5,794.5	4,142.5	5,162.6	25,114.3	-5.6%	146.2%

Note: Numbers are reclassified as per Crisil standards and may not match company reported numbers

N.A.: Not available

Financials for all the players are on consolidated basis except for Delta Electronics India Private Limited

Exicom Tele-Systems Limited fiscal 2024 numbers based on quarterly financials and may not be comparable with the previous years

Source: Company annual reports available in public domain/ filed with the RoC, Crisil Intelligence

Operating Profit Before Depn. Interest and Taxes (OPBDIT) (FY21-24)

Company (Rs million)	Unit	FY21	FY22	FY23	FY24	CAGR (FY21-23)	CAGR (FY22-24)
Bondada Engineering Limited	Rs Mn	163.1	198.7	300.8	685.3	35.8%	85.7%
Delta Electronics India Private Limited	Rs Mn	937.6	543.4	1,622.1	N.A.	31.5%	N.A.
Dinesh Engineers Limited	Rs Mn	971.6	1,253.6	1,264.7	N.A.	14.1%	N.A.
Exicom Tele-Systems Limited	Rs Mn	326.2	688.7	531.9	1,309.9	27.7%	37.9%
Pace Digitek Limited	Rs Mn	504.7	380.2	346.3	4,212.2	-17.2%	232.8%

Note: Numbers are reclassified as per Crisil standards and may not match company reported numbers

N.A.: Not available

Financials for all the players are on consolidated basis except for Delta Electronics India Private Limited

Exicom Tele-Systems Limited fiscal 2024 numbers based on quarterly financials and may not be comparable with the previous years

Source: Company annual reports available in public domain/ filed with the RoC, Crisil Intelligence

Profit after tax (PAT) (FY21-24)

Company (Rs million)	Unit	FY21	FY22	FY23	FY24	CAGR (FY21-23)	CAGR (FY22-24)
Bondada Engineering Limited	Rs Mn	92.1	101.4	167.4	447.3	34.8%	110.1%
Delta Electronics India Private Limited	Rs Mn	366.5	115.7	623.9	N.A.	30.5%	N.A.
Dinesh Engineers Limited	Rs Mn	507.1	678.7	661.3	N.A.	14.2%	N.A.
Exicom Tele-Systems Limited	Rs Mn	34.5	51.4	63.7	639.2	35.9%	252.8%
Pace Digitek Limited	Rs Mn	189.0	118.1	128.8	2,277.5	-17.5%	339.2%

Note: Numbers are reclassified as per Crisil standards and may not match company reported numbers

Financials for all the players are on consolidated basis except for Delta Electronics India Private Limited

N.A.: Not available

Exicom Tele-Systems Limited fiscal 2024 numbers based on quarterly financials and may not be comparable with the previous years

Source: Company annual reports available in public domain/ filed with the RoC, Crisil Intelligence

Key ratios (Fiscal 2023)

Company	OPBDIT%	PAT%	ROCE%	ROE%	Gearing ratio
Bondada Engineering Limited	8.1	4.5	21.5	24.3	1.0
Delta Electronics India Private Limited	7.0	2.7	4.7	3.7	0.3
Dinesh Engineers Limited	30.5	16.0	22.0	16.2	0.2
Exicom Tele-Systems Limited	7.5	0.9	9.2	3.2	0.6
Pace Digitek Limited	6.7	2.5	6.3	3.8	0.6

Note: Numbers are reclassified as per Crisil standards and may not match company reported numbers

Financials for all the players are on consolidated basis except for Delta Electronics India Private Limited

Formulae used in the above table are as follows:

OPBDIT % = OPBDIT / operating income

PAT % = PAT / operating income

RoCE = Profit before interest and tax (PBIT) / [total debt + tangible net worth]

RoE = PAT / tangible net worth

Gearing Ratio= Total Debt/ Tangible Net worth

Exicom Tele-Systems Limited fiscal 2024 numbers based on quarterly financials and may not be comparable with the previous years

Source: Company annual reports available in public domain/ filed with the RoC, Crisil Intelligence

Key ratios (Fiscal 2024)

Company	OPBDIT%	PAT%	ROCE%	ROE%	Gearing ratio
Bondada Engineering Limited	8.6	5.6	35.0	36.1	0.4
Exicom Tele-Systems Limited	12.6	6.2	21.8	14.0	0.0
Pace Digitek Limited	16.8	9.1	53.7	48.8	0.8

Note: Numbers are reclassified as per Crisil standards and may not match company reported numbers

Financials for all the players are on consolidated basis except for Delta Electronics India Private Limited

Formulae used in the above table are as follows:

OPBDIT % = OPBDIT / operating income

PAT % = PAT / operating income

RoCE = Profit before interest and tax (PBIT) / [total debt + tangible net worth]

RoE = PAT / tangible net worth

Gearing Ratio= Total Debt/ Tangible Net worth

Exicom Tele-Systems Limited fiscal 2024 numbers based on quarterly financials and may not be comparable with the previous years

Source: Company annual reports available in public domain/ filed with the RoC, Crisil Intelligence

Key observations

- Pace Digitek Limited provides end-to-end solutions with highly integrated operations in the telecom tower sector, ranging from manufacturing and supply of power management systems, project execution through engineering, procurement and construction (EPC) or turnkey mode, product life cycle management services, and operations and maintenance (O&M)

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