CareEdge ANALYTICS & ADVISORY

A subsidiary of CARE Ratings Ltd.

Industry Research Report

on

EPC in Telecom, Gas and Water sector in India

June 2025

Disclaimer

This report is prepared by Care Analytics and Advisory Private Limited (CareEdge Research). CareEdge Research has taken utmost care to ensure accuracy and objectivity while developing this report based on information available in CareEdge Research's proprietary database, and other sources considered by CareEdge Research as accurate and reliable including the information in public domain. The views and opinions expressed herein do not constitute the opinion of CareEdge Research to buy or invest in this industry, sector or companies operating in this sector or industry and is also not a recommendation to enter into any transaction in this industry or sector in any manner whatsoever.

This report has to be seen in its entirety; the selective review of portions of the report may lead to inaccurate assessments. All forecasts in this report are based on assumptions considered to be reasonable by CareEdge Research; however, the actual outcome may be materially affected by changes in the industry and economic circumstances, which could be different from the projections.

Nothing contained in this report is capable or intended to create any legally binding obligations on the sender or CareEdge Research which accepts no responsibility, whatsoever, for loss or damage from the use of the said information. CareEdge Research is also not responsible for any errors in transmission and specifically states that it, or its Directors, employees, parent company – CARE Ratings Ltd., or its Directors, employees do not have any financial liabilities whatsoever to the subscribers/users of this report. The subscriber/user assumes the entire risk of any use made of this report or data herein. This report is for the information of the authorized recipient in India only and any reproduction of the report or part of it would require explicit written prior approval of CareEdge Research.

CareEdge Research shall reveal the report to the extent necessary and called for by appropriate regulatory agencies, viz., SEBI, RBI, Government authorities, etc., if it is required to do so. By accepting a copy of this Report, the recipient accepts the terms of this Disclaimer, which forms an integral part of this Report.

Table of Contents

List of Charts

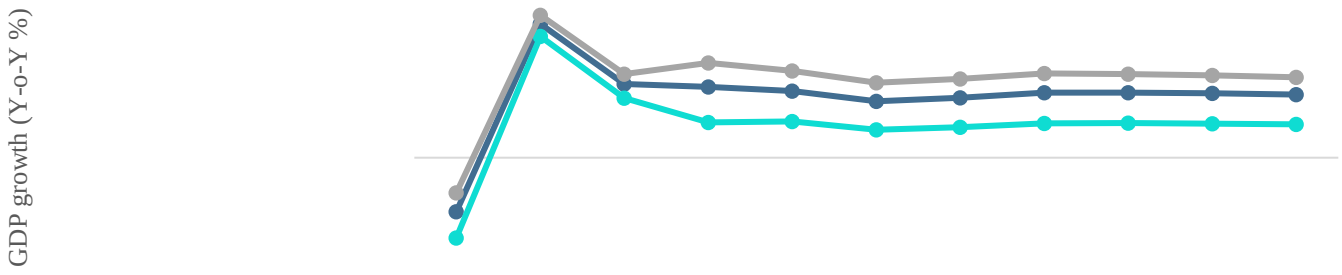
List of Tables

1 Economic Outlook

1.1 Global Economy

Global growth, which reached 3.5% in CY23, stabilized at 3.3% for CY24 and projected to decrease at 2.8% for CY25. Global trade is expected to be disrupted by new US tariffs and countermeasures from trading partners, leading to historically high tariff rates and negatively impacting economic growth projections. The global landscape is expected to change as countries rethink their priorities and policies in response to these new developments. Central banks priority will be to adjust policies, while smart fiscal planning and reforms are key to handling debt and reducing global inequalities.

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



	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
World	-2.7%	6.6%	3.6%	3.5%	3.3%	2.8%	3.0%	3.2%	3.2%	3.2%	3.1%
Advanced Economies	-4.0%	6.0%	2.9%	1.7%	1.8%	1.4%	1.5%	1.7%	1.7%	1.7%	1.7%
Emerging Market and Developing Economies	-1.7%	7.0%	4.1%	4.7%	4.3%	3.7%	3.9%	4.2%	4.1%	4.1%	4.0%

Source: IMF – World Economic Outlook, April 2025; Notes: P-Projection

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

	Real GDP (Y-o-Y change in %)										
	CY20	CY21	CY22	CY23	CY24	CY25P	CY26P	CY27P	CY28P	CY29P	CY30P
India	-5.8	9.7	7.6	9.2	6.5	6.2	6.3	6.5	6.5	6.5	6.5
China	2.3	8.6	3.1	5.4	5.0	4.0	4.0	4.2	4.1	3.7	3.4
Indonesia	-2.1	3.7	5.3	5.0	5.0	4.7	4.7	4.9	5.0	5.1	5.1
Saudi Arabia	-3.6	5.1	7.5	-0.8	1.3	3.0	3.7	3.6	3.2	3.2	3.3
Brazil	-3.3	4.8	3.0	3.2	3.4	2.0	2.0	2.2	2.3	2.4	2.5
Euro Area	-6.0	6.3	3.5	0.4	0.9	0.8	1.2	1.3	1.3	1.2	1.1
United States	-2.2	6.1	2.5	2.9	2.8	1.8	1.7	2.0	2.1	2.1	2.1

Source: IMF- World Economic Outlook Database (April 2025)

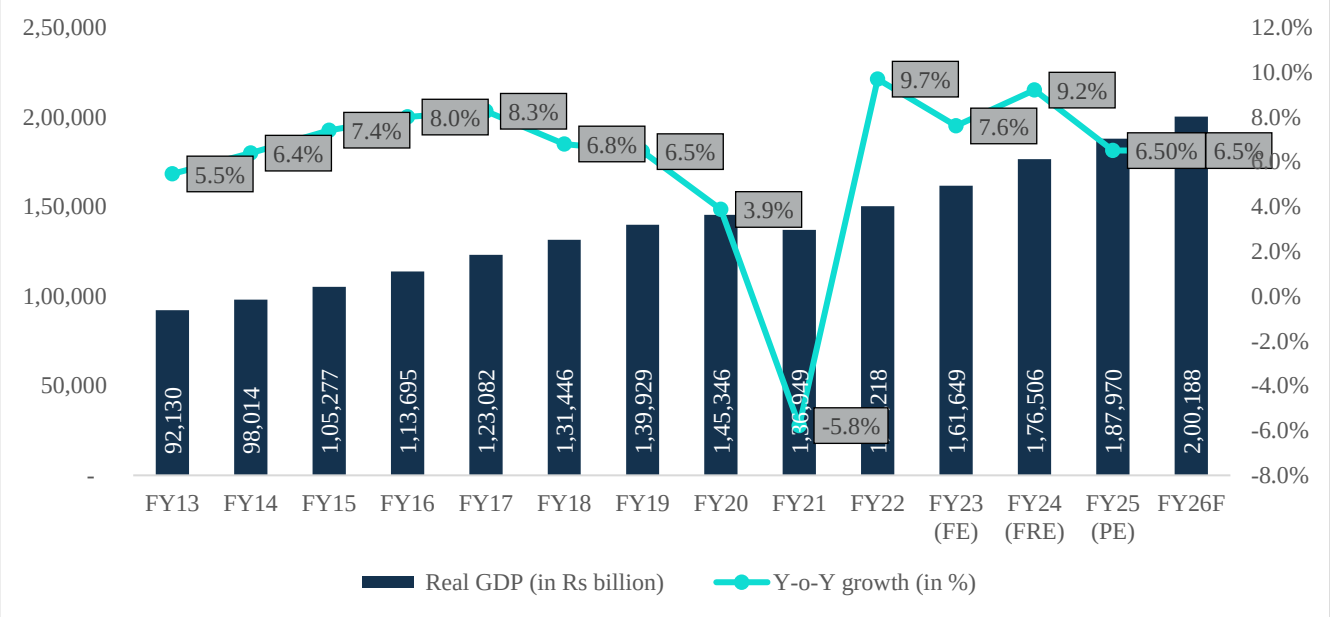
Note: P- Projections, E-Estimate; India's fiscal year (FY) aligns with the IMF's calendar year (CY). For instance, FY24 corresponds to CY23.

1.2 Indian Economic Outlook

1.2.1 GDP Growth and Outlook

Resilience to External Shocks remains Critical for Near-Term Outlook

Chart 2: Trend in Real Indian GDP growth rate



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

India's real GDP grew by 9.2% in FY24 (Rs. 176,505 billion) which is the highest in the previous 12 years (excluding FY22 being 9.7% on account of end of pandemic) and is estimated to grow by 6.5% in FY25 (Rs. 187,951 billion), driven by double digit growth particularly in the Manufacturing sector, Construction sector and Financial, Real Estate & Professional Services. This growth is also led by private consumption increasing by 7.6% and government spending increasing by 3.8% Y-o-Y. Real GDP growth is projected at 6.5% in FY26 as well, driven by strong rural demand, improving employment, and robust business activity.

GDP Growth Outlook (April 2025)

FY26 GDP Outlook: The RBI projects real GDP growth at 6.5% for 2025–26, driven by strong private consumption, steady investment, and resilient rural and urban demand. A favourable monsoon, robust services sector, and improving corporate balance sheets support this outlook.

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

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

FY26P (complete year)	Q1FY26P	Q2FY26P	Q3FY26P	Q4FY26P
6.5%	6.5%	6.7%	6.6%	6.3%

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

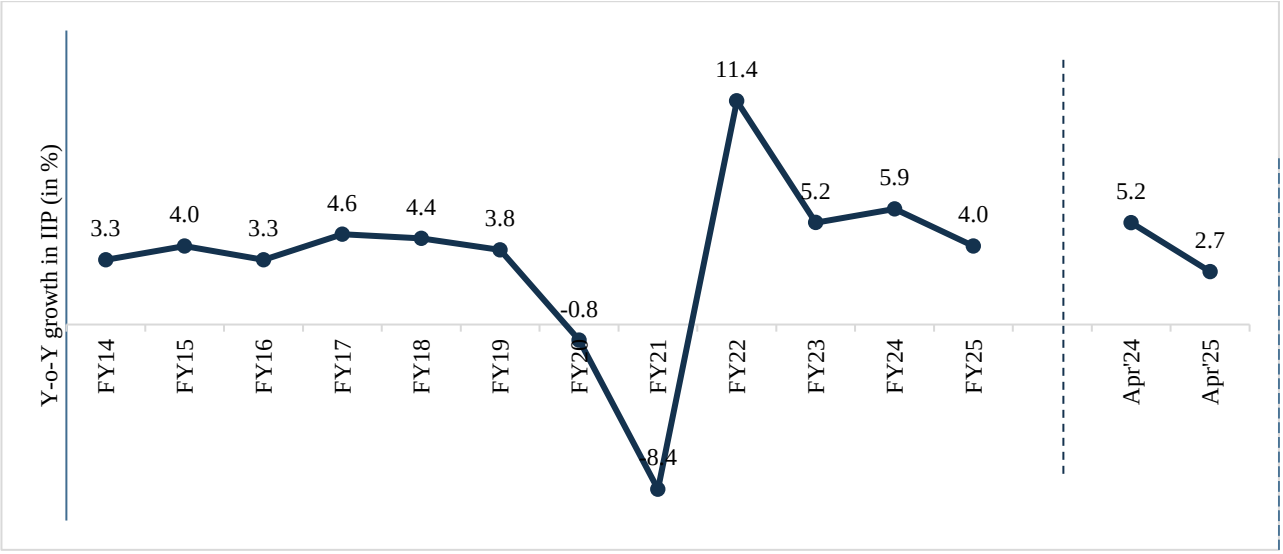
1.2.2 Industrial Growth

The Quick Estimates of the Index of Industrial Production (IIP) for April 2025 show a growth of 2.7%, compared to 5.2% in April 2024. The year-on-year growth moderation reflects subdued performance across key segments, largely due to a contraction in consumer non-durables, infrastructure industries, intermediate goods, capital goods, and primary goods.

In April 2025, industrial growth was supported by Manufacturing (3.4%) and Electricity (1.1%), while the Mining sector contracted by 0.2%. Within the manufacturing sector, industry groups such as pharmaceuticals, motor vehicles, and beverages recorded notable growth. Specifically, the electrical equipment and fabricated metal products segments contributed positively Use-based indices highlighted slower growth across Primary Goods, Capital Goods, and Intermediate Goods. Capital Goods, however, stood out with a strong 20.3% rise, suggesting continued investment momentum.

Manufacturing output grew by 3.4%, contributing significantly to overall industrial growth. This was primarily driven by strong performance in segments such as pharmaceuticals, motor vehicles, beverages, and electrical equipment.

Chart 3: Y-o-Y growth in IIP (in %)



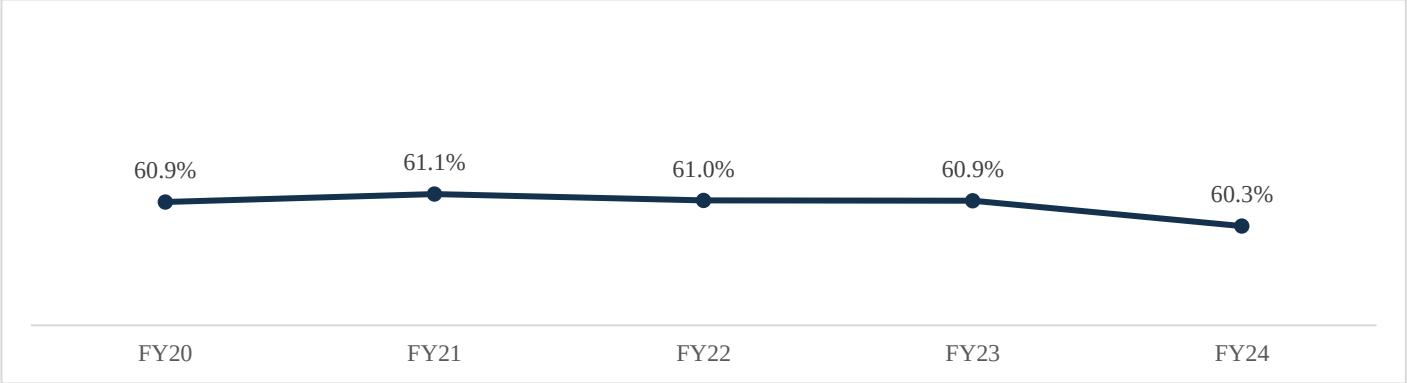
Source: MOSPI

1.2.3 Growth Trend in Consumption Demand

Private Final Consumption Expenditure is the largest component in Gross Domestic Product of the country. It has held a share of above 60% since the past five years. Within the last five years, it reached the highest share of 61.1% in FY21, post which it has been progressively declining albeit marginally.

This trend is attributed to a combination of factors impacting consumer spending. The pandemic, high global and domestic inflation, and tighter financial conditions have constrained private consumption. Poor agricultural output has particularly hurt rural demand, while the shift in household budgets towards higher health expenditures, at the expense of education, has further strained consumer finances. Increased health spending has added financial burdens, limiting spending on other essential items like food, clothing, and housing, which has been evident in the decreasing PFCE growth in these categories. Additionally, weak urban demand, driven by ongoing employment challenges, has exacerbated the situation. Although the anticipated revival of monsoon conditions may boost rural demand in the current fiscal year, the overall decline in PFCE highlights persistent issues in both rural and urban consumption patterns.

Chart 4: Private Consumption (as % of GDP) (at current prices)

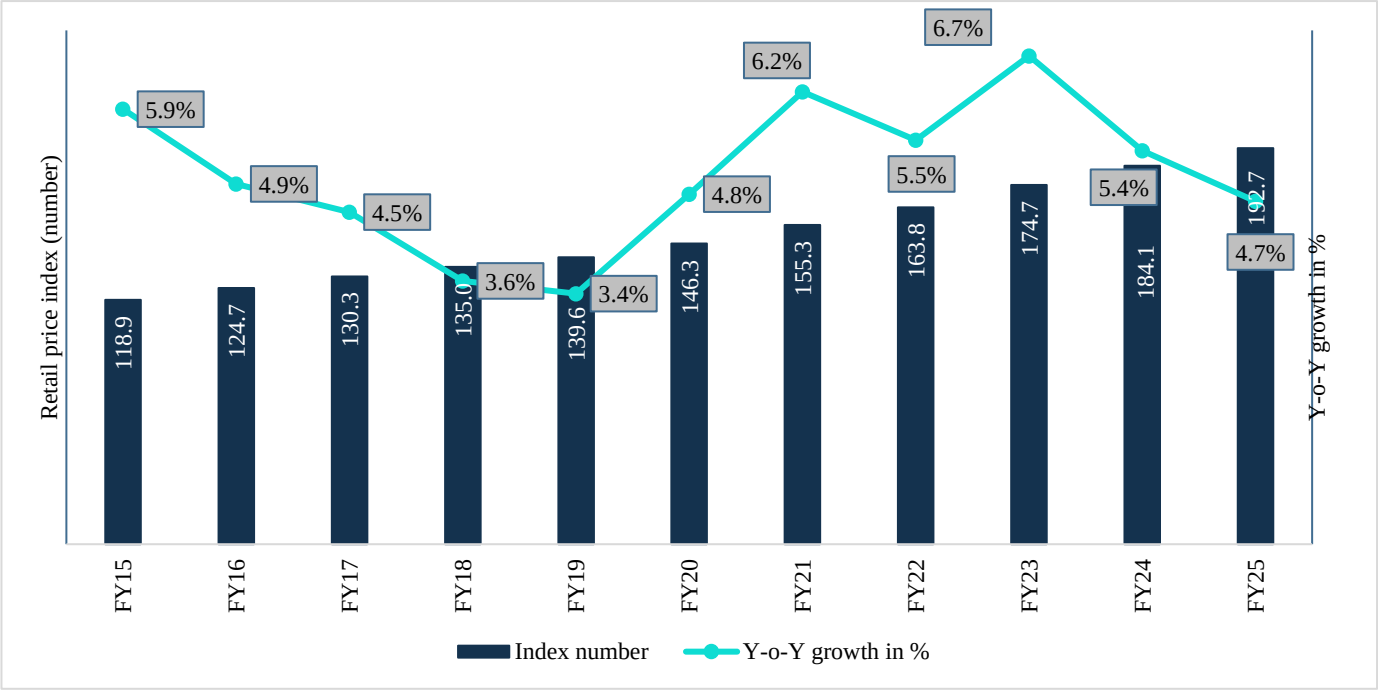


Source: MOSPI

1.2.4 Inflation scenario and Interest rate movement

The CPI (general) and food inflation in March, 2025 over March,2024 (3.34%, provisional) witnessed lowest Y-o-Y inflation since August 2019. The moderation was driven by decline of price inflation in Vegetables, Egg, Meat & fish, Cereals and Pulses and Milk.

Chart 5: Retail Price Inflation in terms of index and Y-o-Y Growth in % (Base: 2011-12=100)

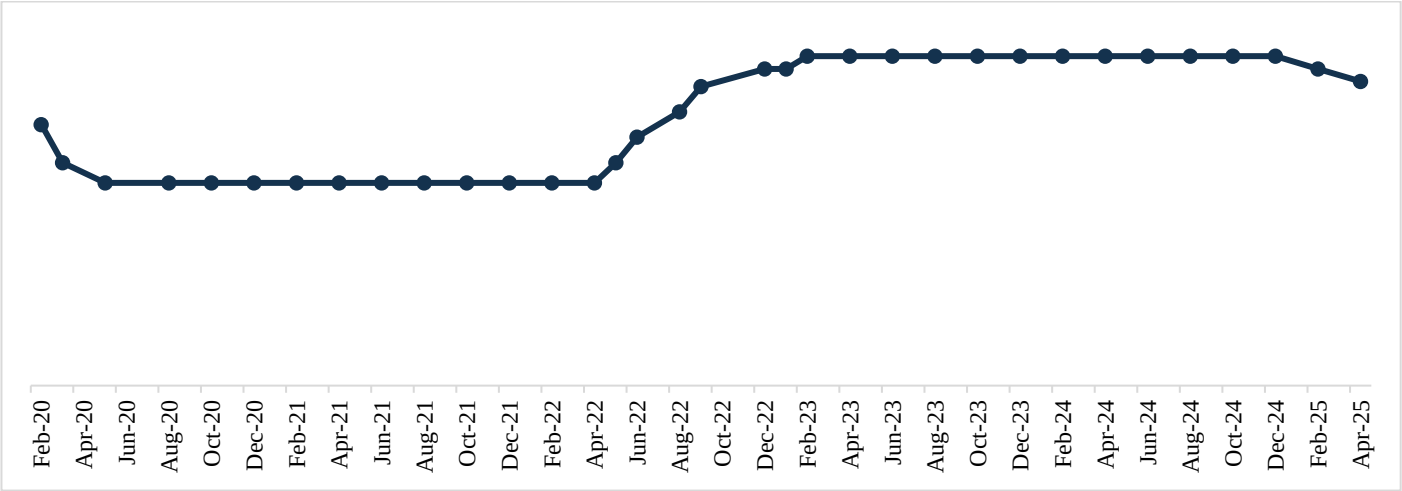


Source: MOSPI

The CPI is primarily factored in by RBI while preparing their bi-monthly monetory policy. At the bi-monthly meeting held in April 2025, RBI projected inflation at 4.0% for FY26 with inflation during Q1FY26 at 3.6%, Q2FY26 at 3.9% and Q3FY26 at 3.8% and Q4FY26 4.4%.

Considering the current inflation situation, RBI has cut the repo rate to 6.00% in the April 2025 meeting of the Monetary Policy Committee.

Chart 6: RBI historical Repo Rate



Source: RBI

Further, the central bank changed its stance to be accommodative. While headline inflation moderated during January-February 2025 with a decline in food inflation.

The economic growth outlook for India is expected to remain resilient, but it will require careful monitoring due to depreciation of the Indian rupee in recent months. Additionally, certain key sectors may face headwinds amid hiked tariffs from the US.

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

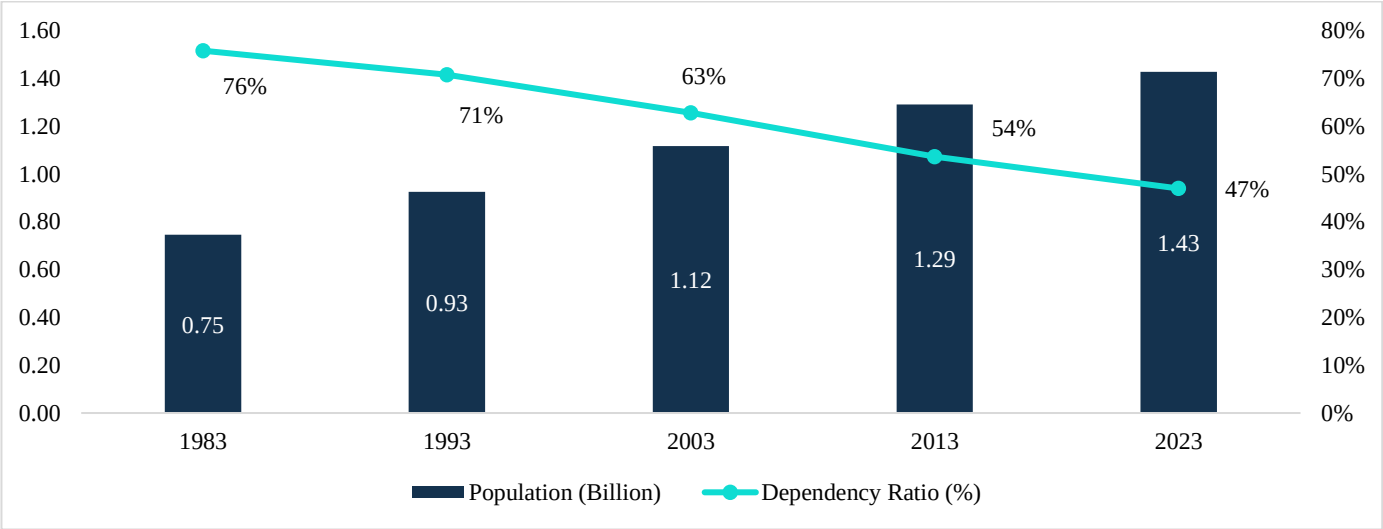
1.2.5 Overview on Key Demographic Parameters

- **Population growth and Urbanization**

The trajectory of economic growth of India and private consumption is driven by socio-economic factors such as demographics and urbanization. According to the world bank, India's population in 2022 surpassed 1.42 billion slightly higher than China's population 1.41 billion and became the most populous country in the world.

Age Dependency Ratio is the ratio of dependents to the working age population, i.e., 15 to 64 years, wherein dependents are population younger than 15 and older than 64. This ratio has been on a declining trend. It was as high as 76% in 1983, which has reduced to 47% in 2023. Declining dependency means the country has an improving share of working-age population generating income, which is a good sign for the economy.

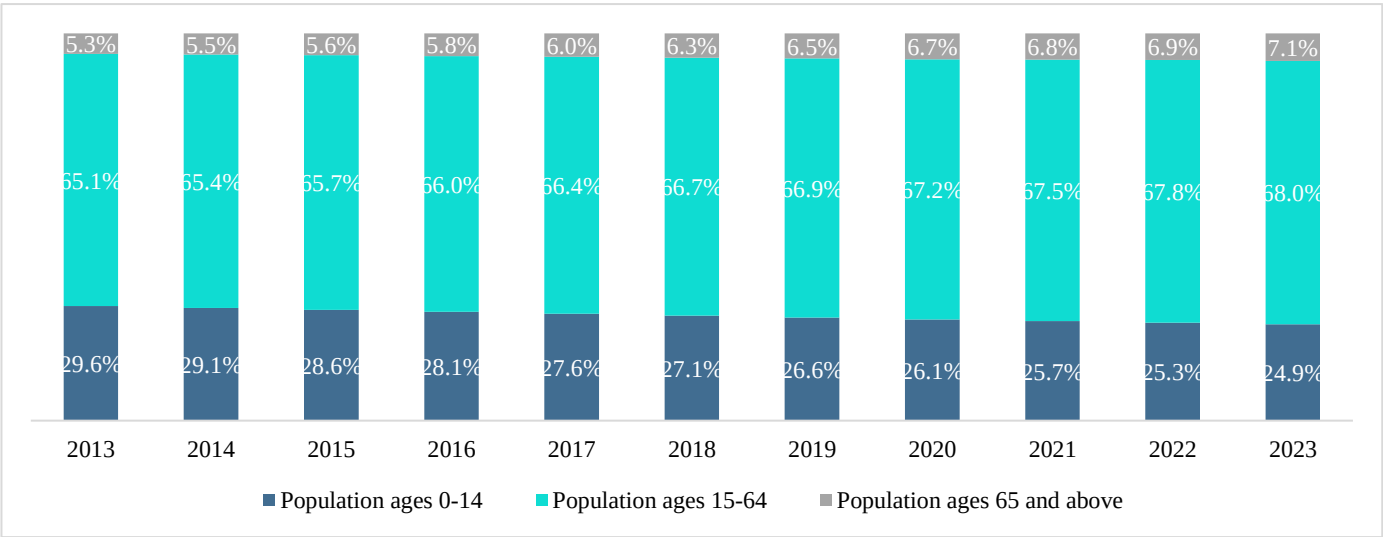
Chart 7: Trend in Population growth vis-à-vis dependency ratio in India



Source: World Bank Database

With an average age of 29, India has one of the youngest populations globally. With vast resources of young citizens entering the workforce every year, it is expected to create a 'demographic dividend'. India is home to a fifth of the world's youth demographic and this population advantage will play a critical role in economic growth.

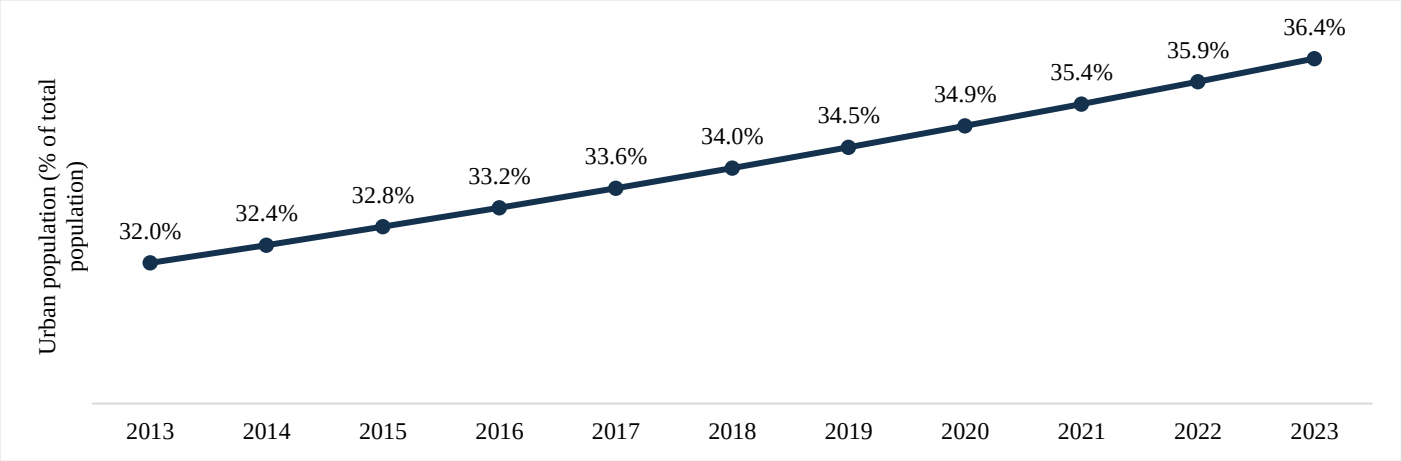
Chart 8: Age-Wise Break Up of Indian population



Source: World Bank Database

The urban population is significantly growing in India. The urban population in India is estimated to have increased from 413 million (32% of total population) in 2013 to 519.5 million (36.4% of total population) in the year 2023.

Chart 9: Urbanization Trend in India



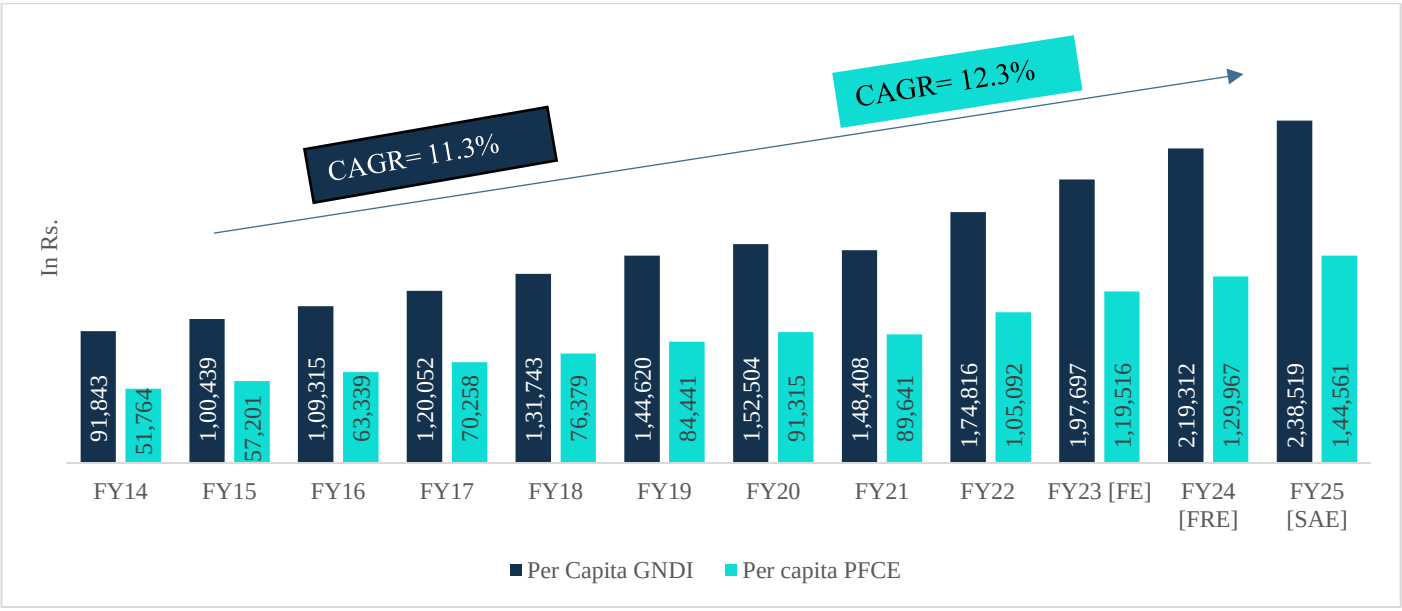
Source: World Bank Database

- **Increasing Disposable Income and Consumer Spending**

Gross National Disposable Income (GNDI) is a measure of the income available to the nation for final consumption and gross savings. Between the period FY14 to FY25, per capita GNDI at current prices registered a CAGR of 11.30%. More disposable income drives more consumption, thereby driving economic growth.

With increase in disposable income, there has been a gradual change in consumer spending behaviour as well. Per capita Private Final Consumption Expenditure (PFCE) which is measure of consumer spending has also showcased significant growth from FY14 to FY25 at a CAGR of 12.33%.

Chart 10: Trend of Per Capita GNDI and Per Capita PFCE (Current Price)



Source: MOSPI; Note: FRE – First Revised Estimates, FE – Final Estimate, SAE-Second Advance Estimate

1.2.6 GVA in the Industrial Sector

India's industrial sector is expected to grow by 10.8% in FY24, reaching Rs. 31.56 trillion, supported by positive business sentiment, falling commodity prices, and government initiatives like production-linked incentives. In FY25, growth is expected to slow down

to 5.9% y-o-y, down from 10.8% in FY24. The growth is driven primarily by manufacturing, construction, and utility services. The slow down can be attributed to the manufacturing segment likely to grow at 4.5%, lower than the previous year's 12.3%.

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

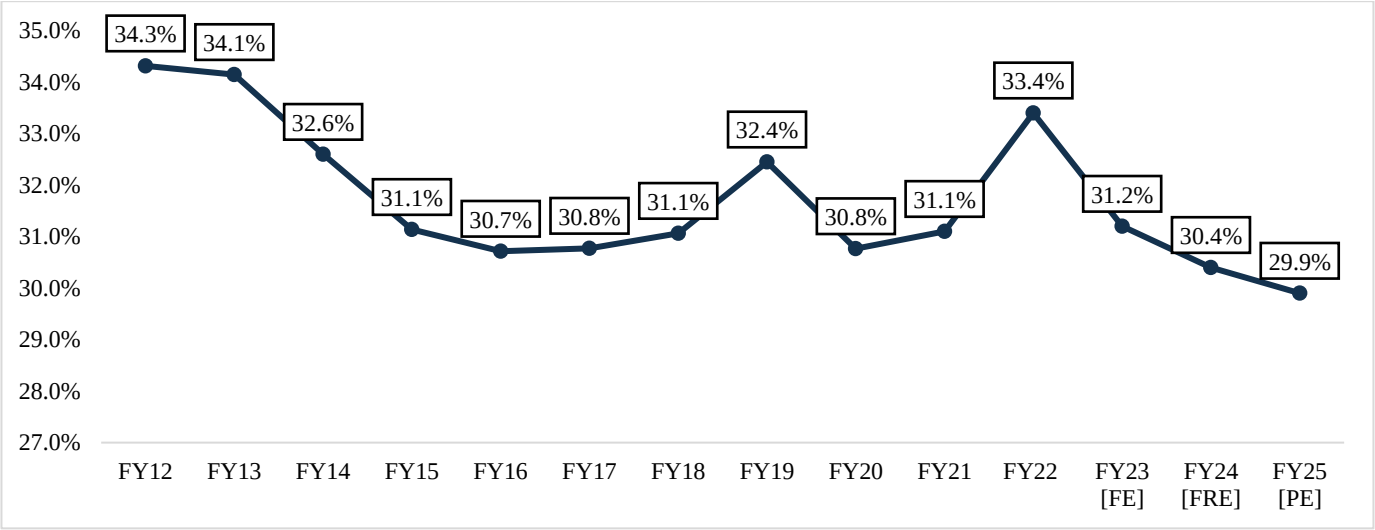
At constant Prices	FY19	FY20	FY21	FY22	FY23 (FE)	FY24 (FRE)	FY25 (PE)
Industry	**5.3**	**-1.4**	**-0.9**	**11.6**	**2.0**	**10.8**	**5.9**
Mining & Quarrying	-0.9	-3.0	-8.6	7.1	2.8	3.2	2.7
Manufacturing	5.4	-3.0	2.9	11.1	-3.0	12.3	4.5
Electricity, Gas, Water Supply & Other Utility Services	7.9	2.3	-4.3	9.9	11.5	8.6	5.9
Construction	6.5	1.6	-5.7	14.8	10.0	10.4	9.4
GVA at Basic Price	**5.8**	**3.9**	**-4.2**	**8.8**	**7.4**	**8.6**	**6.4**

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

1.2.7 Investment Trend in Infrastructure

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

Chart 11: Gross Fixed Capital Formation (GFCF) as % of GDP (At constant prices)



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

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

1.2.8 Concluding Remarks

Global economic growth faces headwinds from geopolitical tensions, volatile commodity prices, high interest rates, inflation, financial market volatility, climate change, and rising public debt. However, India's economy remains relatively strong, with an IMF

forecast of 6.2% GDP growth in CY25 (FY26 according to the fiscal year), compared to the global projection of 2.8%. Key drivers include strong domestic demand, government capital expenditure and moderating inflation.

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

The impact of U.S. tariffs on India's export trade is anticipated to be minimal. The engineering goods sector will have a potential U.S. tariff impact, whereas steel industry is affected by the 25% tariffs although the impact is expected to be minimal given the volume of goods exported is less.

On February 13, Prime Minister Narendra Modi and President Donald Trump discussed enhancing the U.S.-India trade relationship, with a target to increase bilateral trade from USD 200 billion to USD 500 billion by 2030. Negotiations for a multi-sector bilateral trade agreement (BTA) are expected to commence later this year, focusing on trade fairness, national security, and job creation.

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

2 EPC (Construction) Industry in India

2.1 Overview: EPC Services & Advantages

The Engineering, Procurement, and Construction (EPC) industry in India is a cornerstone of the nation's infrastructure development, playing a key role in sectors such as energy, transportation, water management, and industrial projects. The EPC model involves a single entity managing the design, procurement of materials, and construction of a project, delivering a functional facility to the client. This integrated approach ensures efficiency, quality, and accountability.

Key Market Areas in the EPC Construction Industry

Advantages of the EPC Model

Single Point of Responsiblity	•A single contractor manages all phases of the project—engineering, procurement, and construction—reducing complexities for clients. •Ensures clear accountability and facilitates better communication between the contractor and client.
Cost Efficency	•Fixed-Price Contracts: Clients are shielded from unexpected cost overruns, as the price is agreed upon upfront. Efficient resource planning, material procurement, and execution further optimize costs.
Time Efficency	•EPC firms focus on detailed planning and seamless execution, ensuring projects are completed on or ahead of schedule. Streamlined processes and the use of advanced technologies minimize delays.
Risk Mitigation	•Contractors assume risks related to design flaws, procurement delays, or on-site construction challenges, relieving clients of operational and financial burdens. Regulatory compliance and adherence to safety standards are handled by the EPC firm.
Quality Assurance	•EPC firms leverage standardized processes and advanced tools to deliver high-quality outputs. Adherence to global and national quality standards ensures durability and performance.
Scalablity & Expertise	•EPC contractors have the capacity to manage large-scale and technically complex projects. Their expertise spans multiple sectors, enabling the successful integration of engineering disciplines.
Advanced Technolgical Integration	•Tools like Building Information Modeling (BIM) allow detailed project visualization, reducing errors and improving coordination. Use of AI and IoT enhances monitoring and decision-making during execution.
Environmental & Sustainablity	•Modern EPC projects incorporate green construction practices, renewable energy technologies, and sustainable materials, aligning with environmental goals. Compliance with environmental regulations minimizes ecological impact.
Vendor & Supply Chain Management	•The EPC contractor handles sourcing, logistics, and vendor negotiations, ensuring high-quality materials are delivered on time. This reduces the client's involvement in operational details.
Global Competitiveness	•With the ability to handle international projects, Indian EPC firms are building expertise and credibility in global markets. Their cost-effective solutions and technical capabilities make them competitive on an international scale.

The EPC construction industry in India is the backbone of the nation's infrastructure development, catering to diverse sectors with a structured and efficient approach. Its advantages—such as single-point accountability, cost and time efficiency, risk mitigation, and scalability—position it as a critical model for large-scale projects. Growth drivers like government initiatives, renewable energy expansion, and smart city projects further bolster its prospects. By addressing challenges such as regulatory delays and skill gaps, the industry is well-placed to support India's infrastructure and economic transformation.

2.2 Overview of types of client in EPC Industry

- **Government Clients**

Government clients are pivotal to the EPC industry, spearheading large-scale infrastructure projects aimed at national development and public welfare. These projects are financed through public budgets, government bonds, or external loans from agencies like the World Bank or ADB. Key focus areas include highways, railways, airports, power plants, water supply systems, and urban infrastructure, driven by initiatives such as Bharatmala Pariyojana, the Gati Shakti Master Plan, and the Smart Cities Mission. Notable examples include national and state governments and PSUs like NTPC, NHAI, and Indian Railways. These projects demand adherence to strict regulations, fixed timelines, and budgets, emphasizing transparency and accountability throughout their execution.

- **Private Sector Clients**

Private sector clients in the EPC industry are businesses investing in infrastructure projects to enhance competitiveness, expand operations, or generate profits. These projects are typically financed through private funds, blending equity and loans, and focus on industrial facilities, renewable energy parks, commercial real estate, and data centers. Tailored to meet specific business needs, examples include manufacturers, mining companies, oil & gas operators, and private airport developers like Adani Airports and GMR Group. Such projects prioritize cost optimization, efficiency, innovation, and sustainability, with timelines that are more flexible compared to government-led initiatives.

- **Multinational Corporations (MNCs)**

Multinational corporations (MNCs) are global entities that invest in EPC projects in India to establish or expand their operations, leveraging international expertise and capital. Funded by global investments, these projects benefit from innovative technologies and advanced practices. MNCs primarily focus on specialized industrial facilities, logistics hubs, and energy projects, emphasizing automation and innovation. Compliance with international standards and certifications is a key requirement, ensuring quality and precision. Notable examples include energy giants like Shell and BP and industrial leaders like Siemens and General Electric. EPC contractors working with MNCs must demonstrate proven expertise, global reach, and the ability to meet stringent standards, often fostering long-term collaborations to deliver complex, high-quality projects.

- **Public-Private Partnership (PPP) Clients**

Public-Private Partnership (PPP) clients represent a collaborative model where public and private entities share funding, risks, and rewards for infrastructure projects. These partnerships focus on transportation infrastructure like roads, railways, and airports, as well as urban utilities such as metro systems and water supply networks. Examples include metro rail projects like the Delhi Metro and airport projects managed by private operators under government agreements. For EPC firms, working with PPP clients requires balancing regulatory compliance with commercial objectives, ensuring advanced coordination among stakeholders, and often integrating long-term operation and maintenance (O&M) contracts.

- **Industrial Clients**

Industrial clients in the EPC industry, such as manufacturers, refineries, and other operators, commission projects to build facilities for production and processing. These projects are typically funded internally or supported by loans and investments, focusing on factories, refineries, petrochemical plants, and warehouses. Emphasizing operational efficiency, safety, scalability, and productivity, these projects require highly specialized engineering expertise. Notable examples include steel plants commissioned by Tata Steel

and refineries executed for Reliance Industries or HPCL. EPC contractors working with industrial clients must have sector-specific experience and expertise to meet the unique demands of these complex projects.

The EPC industry serves a wide range of clients, each with unique requirements and expectations. Government and PPP clients drive large-scale infrastructure development, while private and industrial clients demand efficiency and customization. Renewable energy and international clients reflect the growing emphasis on sustainability and global collaboration. Understanding the nuances of each client type allows EPC firms to tailor their services, ensuring successful project delivery and client satisfaction.

2.3 Overview of key factors influencing EPC player selection

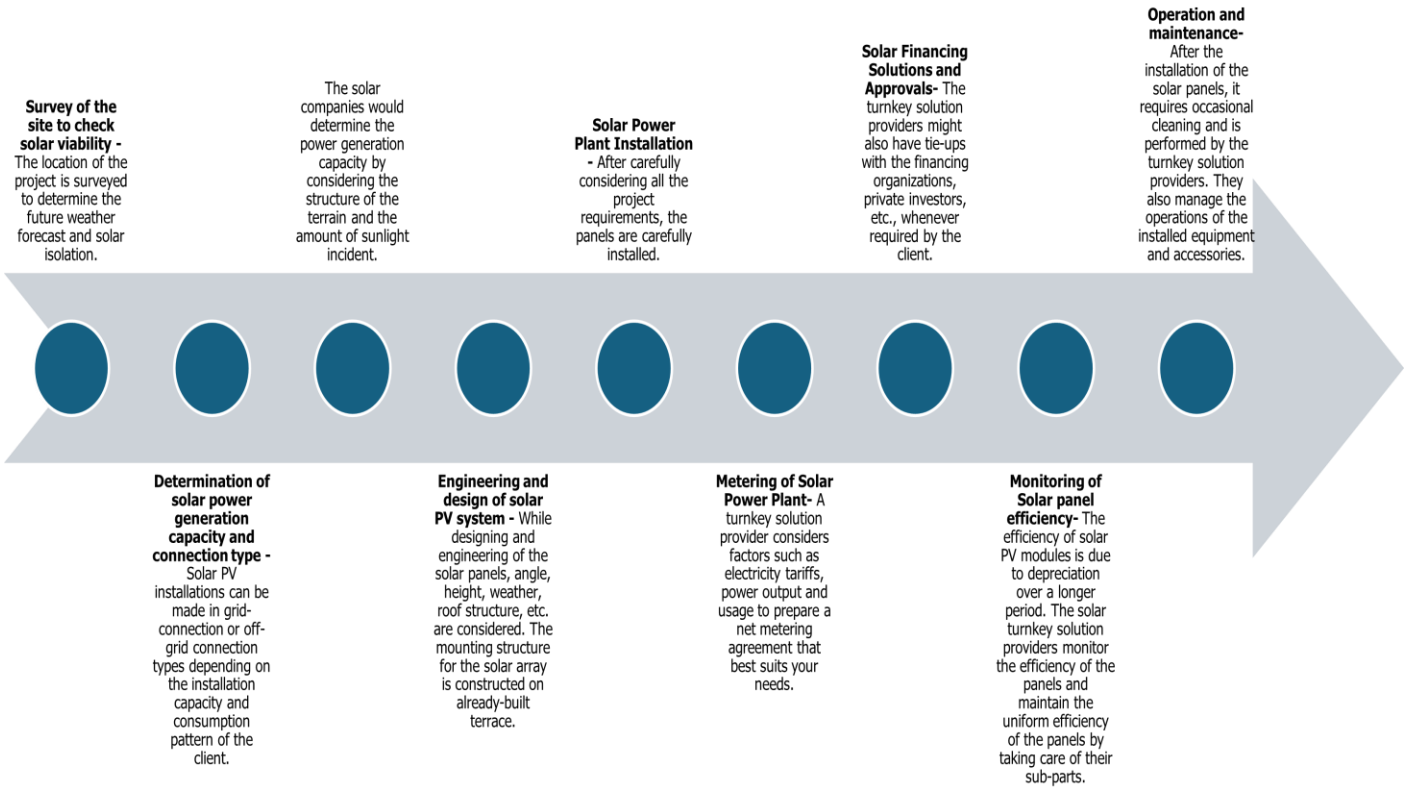
Experience & Expertise	• The experience of an EPC player in handling similar projects is one of the most important factors for selection. Clients often look for contractors with a proven track record in executing projects within the specific industry, whether in infrastructure, energy, industrial, or transportation sectors. • Expertise in handling complex projects, technical knowledge, and familiarity with regulatory requirements are essential for ensuring the successful completion of large-scale projects.
Financial Strength	• The financial stability of an EPC company is crucial in ensuring that the company can fund the project's various phases, including procurement of materials, manpower, and equipment. • The ability to raise capital, manage cash flow, and demonstrate a strong financial background assures clients that the contractor can complete the project without financial hurdles or delays.
Technological Capablity	• With the growing emphasis on automation, advanced construction techniques, and digital tools, technological capabilities are a key criterion for EPC player selection. Clients prefer contractors that integrate technologies like Building Information Modeling (BIM), Artificial Intelligence (AI), and robotics in the planning and execution phases, ensuring higher precision, efficiency, and cost-effectiveness in project delivery.
Reputation & Relaiblity	• A company's reputation in the market reflects its reliability in executing high-quality projects within agreed timelines. Clients tend to choose EPC players with positive past performance, on-time delivery, and a reputation for meeting or exceeding expectations. • Past project references, client testimonials, and independent reviews often play a role in selecting the right EPC contractor.
Compliance with Regulatory Requirement	• In India, compliance with local and national regulations, environmental laws, and safety standards is critical. EPC players must demonstrate the ability to navigate complex regulatory environments, ensure environmental protection, and follow safety protocols during project execution. • Non-compliance can lead to delays, fines, and even project shutdowns, making it an important factor in the selection process.
Cost Competitiveness	• Cost is a major deciding factor in EPC player selection, especially in price-sensitive markets like India. While the lowest bidder may be appealing, clients also look for an optimal balance between cost and quality. • The ability to offer competitive pricing without compromising on project quality, sustainability, or timelines is a key factor for clients.
Project Management Capablities	• The ability of an EPC contractor to manage projects efficiently is essential for meeting deadlines and adhering to budget constraints. Effective project management involves the ability to plan, coordinate resources, handle procurement processes, and deal with unforeseen challenges. • Strong leadership, project monitoring systems, and risk management strategies are also critical for success.
Resource Availablity	• Availability of resources such as skilled manpower, construction equipment, and raw materials is another important factor. EPC players must demonstrate their ability to mobilize resources quickly, ensuring no delays in project execution. • Companies with a wide network of suppliers, subcontractors, and in-house resources tend to be favored.
Sustainablity & Innovation	• Increasingly, clients are looking for EPC contractors who prioritize sustainability in their operations. This includes adopting green building practices, using renewable materials, and reducing carbon footprints. • Additionally, innovation in construction methods, energy efficiency, and waste reduction can influence the decision-making process, especially for projects involving sensitive environments or advanced technologies.
Post Completion Support	• Many clients prefer EPC players who can provide after-project support, such as maintenance, operations, and technical assistance. A reliable post-completion service ensures smooth project operation after the handover and minimizes risks related to operational failures or inefficiencies.

In India, the selection of an EPC player is a multifaceted decision that incorporates a combination of technical competence, financial robustness, reputation, adherence to regulations, and cost-effectiveness. Clients seek contractors who can deliver high-quality, timely, and cost-efficient projects, while also aligning with sustainability goals and providing ongoing support. The ability to adapt to modern technologies, manage risks effectively, and ensure compliance with regulations further strengthens an EPC player's selection prospects in the highly competitive Indian market.

2.4 EPC Project: Turnkey vs Balance of Plant

There are two types of modes for the EPC contract to be executed – the turnkey project structure and balance of plant structure.

Under the turnkey project structure, EPC company/contractor takes care of everything from design to execution of the work which includes EPC. The contractor delivers a ready to use facilities. The project is delivered at a pre-determined cost and time failing which can cause the contractor to pay monetary compensations. The turnkey solar project consists of the following process-



Under the balance of plant (BoP) or the balance of system (BoS) structure, the entire project is divided into many distinct parts. The modules, which form majority of the cost of the solar plant, are procured separately by the developer and the remaining segments including wiring, switches, mounting system, inverters, batteries etc. are procured under the EPC contract along with the project installation services.

2.5 Key covenants of EPC contract

The EPC agreement is the heart of the contract, detailing the scope of work, project schedule, quality standards, cost estimates, and the roles and responsibilities of all parties involved. The EPC contract is executed between a developer (owner) and the EPC contractor for a specific project/scope that needs to be delivered by the EPC Contractor.

Key Feature	Description
Performance Specification	Outlines the performance criteria the contractor must meet. These specifications ensure all parties clearly understand the scope of work being contracted.
Single Point of Responsibility	The contractor is solely responsible for delivering the entire scope of work. If the owner encounters issues, the contractor must resolve them and provide compensation. In consortium contracts, entities are jointly and severally liable.
Contract Price	Specifies the consideration for services and payment terms. Contracts may be fixed-price or include price variation clauses. In fixed-price contracts, the contractor bears any cost escalations.
Completion Date	Defines a guaranteed completion date, either fixed or based on the contract's commencement. Failure to meet this date makes the contractor liable for delay liquidated damages (DLDs).
Performance Guarantees	Ensures the facility meets required output, efficiency, and reliability. Includes performance guarantees backed by liquidated damages (PLDs) payable if performance parameters are not met.
Caps on Liability	Caps the contractor's liability at a percentage of the contract price, typically with sub-caps (e.g., 10–15% for DLDs and PLDs). The overall cap is generally 20–25% of the contract price.
Security	Requires the contractor to provide performance security (e.g., a bank guarantee) to protect the owner if obligations are not met.
Retention	Involves withholding a percentage of the payment until the project is completed and performs satisfactorily over a pre-agreed period, typically 6–12 months.
Variations	Permits the owner to modify the scope of work under specified terms. Also outlines the process for time extensions and contract price adjustments.
Force Majeure	Excuses both parties from fulfilling obligations in the event of force majeure.
Suspension	Grants the owner the right to suspend works. During suspension, the contractor must not remove any equipment from the project site.
Termination	Defines the contractual termination rights of both parties.

Construct of an EPC contract

An EPC contract (Engineering, Procurement, and Construction) is a type of agreement used for large-scale infrastructure, industrial, and energy projects. Under this type of contract, the EPC contractor is responsible for the design, procurement of materials, construction, and commissioning of the project. EPC contracts are commonly used in sectors such as energy (e.g., power plants), transportation (e.g., highways, railways), and industrial manufacturing. The key feature of an EPC contract is that it places the entire responsibility for the successful delivery of the project on the contractor, making it a "turnkey" project where the contractor provides a complete, ready-to-use facility. Here is a detailed explanation of how an EPC contract is structured:

- **Contract Structure and Framework**

An EPC contract typically has a comprehensive structure, detailing all aspects of the project, including technical requirements, scope of work, timelines, costs, and performance expectations. The contract includes the following components:

Scope of Work (SOW): This section defines the specific tasks the EPC contractor is responsible for, including engineering design, procurement of materials, construction, and commissioning of the project. It outlines deliverables at each stage of the project and often includes specifications for equipment, materials, quality standards, and methodologies to be used.

Contract Price and Payment Terms: The price structure in an EPC contract can be fixed price or cost-plus, depending on the type of agreement. The payment terms define when and how the contractor will be paid for the work completed. In a fixed-price contract,

the contractor agrees to deliver the project for a specified amount. Cost-plus contracts may involve payments based on actual costs incurred, plus a fee for overhead and profit.

Project Schedule: The EPC contract defines project milestones, timelines, and completion dates. This includes the expected delivery and installation schedules for equipment, materials, and finished structures. Delays can lead to penalties, and early completion may be rewarded.

- **Key Responsibilities of the EPC Contractor**

The EPC contractor assumes full responsibility for the successful delivery of the project. This includes:

Engineering: The contractor must design the project, often with input from the client, ensuring it meets the required specifications and standards. Engineering responsibilities can include structural design, civil, mechanical, electrical, and environmental considerations.

Procurement: The contractor is responsible for sourcing and purchasing materials, equipment, and services needed for the project. This includes managing suppliers, ensuring quality, and handling transportation logistics. Procurement also involves dealing with subcontractors and ensuring compliance with the project's technical and quality standards.

Construction: The contractor manages the actual construction or installation of the project. This involves site preparation, labour management, and the physical construction of buildings, infrastructure, or systems.

Commissioning: The contractor ensures the final integration and testing of the project. After construction, they are responsible for testing the systems and equipment to ensure they operate as intended and meet performance specifications.

Handover: Once the project is completed, the EPC contractor formally hands over the project to the client, ensuring all equipment is functioning properly and that the client is trained in its operation.

- **Risk Allocation**

Design Risk: The contractor is responsible for the engineering design of the project and must ensure the project meets the client's specifications, safety standards, and regulatory requirements.

Construction Risk: The contractor assumes the risk of delays, cost overruns, and construction defects. The contractor is usually responsible for ensuring that the project is completed on time and within budget.

Procurement Risk: The contractor manages the procurement of materials and equipment. They are responsible for sourcing the necessary items and ensuring their timely delivery to the project site.

Performance Risk: EPC contracts often include performance guarantees, where the contractor is required to ensure that the facility meets agreed-upon operational standards and performance metrics after handover.

Operational and Financial Risk: In some cases, the contractor may also assume operational and financial risks, especially if the project is not generating revenue as expected.

- **Guarantees and Warranties**

Performance Guarantees: The contractor guarantees that the project will meet specific performance benchmarks, such as energy output in power plants or processing capacity in industrial facilities.

Warranty Period: After completion, the contractor may offer a warranty period during which they are responsible for fixing defects or issues that arise from construction or equipment installation.

Defects Liability: In many contracts, the contractor is required to fix any defects discovered after project completion, within a specified period, at no extra cost to the client.

- **Dispute Resolution**

Arbitration: Many EPC contracts specify arbitration as the preferred method of dispute resolution. This is faster and more confidential than traditional litigation.

Mediation: In some cases, the contract may specify mediation, where an impartial third party helps both sides come to a resolution without going to court.

- **Force Majeure**

EPC contracts often include a "force majeure" clause, which protects the contractor from liability if unforeseen events (e.g., natural disasters, political instability, pandemics) delay or prevent the completion of the project. The contractor may be excused from performance due to circumstances beyond their control.

- **Termination Clauses**

The contract will define the circumstances under which either the client or the contractor can terminate the agreement. Common reasons for termination include:

Non-performance: If the contractor fails to meet agreed-upon milestones or deliverables.

Breach of Contract: If either party violates any major terms of the agreement.

Force Majeure: If an unforeseen event prevents the project's completion.

An EPC contract is a detailed and complex agreement that defines the roles, responsibilities, risks, and expectations of both the client and the contractor. It places full responsibility for the successful delivery of the project on the contractor, ensuring that the project is delivered on time, within budget, and in compliance with all specifications and quality standards. By clearly outlining the scope, payment terms, risk allocation, and dispute resolution mechanisms, an EPC contract provides a comprehensive framework for large-scale infrastructure projects.

2.6 Construction scenario in India and role played by EPC industry

The construction sector in India is a significant part of the economy, contributing to the nation's GDP and employment. It encompasses a broad range of activities, including infrastructure development, residential and commercial buildings, industrial projects, and urbanization. In recent years, the sector has witnessed substantial growth, driven by increasing urbanization, infrastructure development, government initiatives, and private sector participation. The EPC (Engineering, Procurement, and Construction) industry plays a crucial role in this growth, particularly in large-scale infrastructure projects.

Current Construction Scenario in India

- **Infrastructure Development**

Government Initiatives: The government has launched major infrastructure projects to improve connectivity, urbanization, and industrial growth. Initiatives like Bharatmala Pariyojana, Smart Cities Mission, Gati Shakti Master Plan, and Atal Mission for Rejuvenation and Urban Transformation (AMRUT) are central to India's infrastructure push.

Highways and Roads: The construction of highways and expressways has been a focal point, improving road connectivity between cities and rural areas. The National Highways Authority of India (NHAI) and other government bodies are leading these efforts.

Railways and Metro Projects: Rail and metro networks are expanding in tier-1 cities, with projects like the Delhi Metro, Mumbai Metro, and Bangalore Suburban Railway taking shape. These projects are aimed at easing urban congestion and promoting sustainable transportation.

Urbanization and Real Estate Development: Rapid urbanization has led to a rise in demand for residential and commercial real estate. Affordable housing, commercial complexes, and mixed-use developments are growing rapidly. The real estate sector has seen both private investments and public initiatives, including the Pradhan Mantri Awas Yojana (PMAY), which aims to provide affordable housing for all by 2022.

Energy and Industrial Projects: India's growing demand for energy has prompted the construction of large-scale power plants, particularly in the renewable energy sector (solar and wind), along with thermal power plants and hydropower projects. Industrial projects related to manufacturing, petrochemicals, steel plants, and refineries continue to expand, contributing significantly to infrastructure and job creation.

Smart Cities and Sustainable Infrastructure: The Smart Cities Mission aims to develop urban centres with a focus on sustainability, energy efficiency, and advanced technology integration. This includes smart grids, green buildings, waste management systems, and improved transportation infrastructure.

Role of EPC Industry in India's Construction Sector

Section	Details
Execution of Large-Scale Infrastructure Projects	EPC contractors are responsible for delivering turnkey projects, including engineering design, procurement of materials, and construction. They manage every phase, from planning to execution, ensuring timely project completion. For instance, road projects under the Bharatmala Pariyojana and railway electrification are primarily executed by EPC contractors.
Expertise in Handling Complex Projects	The complexity of modern infrastructure projects demands significant technical expertise, and EPC contractors provide the specialised knowledge required to execute projects such as power plants, refineries, and water supply systems. They integrate innovative technologies into construction, particularly in smart cities, metro rail systems, and high-tech industrial facilities.
Collaboration with Government and Private Sector	The EPC industry fosters collaboration between government bodies and private investors. Government agencies, such as NHAI, DMRC (Delhi Metro Rail Corporation), and state electricity boards, frequently work with EPC contractors to implement large-scale public infrastructure. In Public-Private Partnership (PPP) projects, EPC contractors offer the necessary expertise to deliver infrastructure efficiently, safely, and with cost optimisation.

Quality and Compliance	EPC contractors ensure that projects comply with national standards and regulations, including environmental norms, safety regulations, and labour laws. This is particularly important in sectors such as power generation, chemical plants, and transportation infrastructure.
Cost and Time Management	A significant advantage of the EPC model is its ability to control costs and manage time effectively. The fixed-price contract format guarantees that projects are delivered within budget, with the contractor assuming responsibility for any cost overruns. This project delivery model establishes a clear timeline, essential for meeting deadlines, especially for government-driven projects such as metro rail systems and airport expansions.
Innovation and Sustainability	The EPC sector is increasingly focusing on sustainability and green construction. For example, in renewable energy projects like solar power parks, EPC contractors lead the way in designing and executing projects that reduce environmental impact and incorporate sustainable practices. The emphasis on smart technologies, particularly in smart city projects and automated industrial plants, has driven the EPC industry to innovate in design, construction, and maintenance.
Overall Impact of EPC Industry	The EPC industry is crucial to India's construction and infrastructure growth. By providing a comprehensive, integrated approach to project execution, the EPC model enables the country to address its infrastructure challenges and meet the demands of urbanisation, industrialisation, and sustainability. From highways and railways to energy plants and smart cities, EPC contractors play a pivotal role in delivering large-scale, complex projects essential for India's economic growth and development.

2.7 Key regulatory factors influencing the industry

In the EPC (Engineering, Procurement, and Construction) industry in India, several regulatory factors influence project execution, compliance, and operational efficiency. These regulatory frameworks are designed to ensure that projects meet national standards, are completed on time, and comply with environmental, safety, and financial regulations.

Environmental Regulations	**Environmental Clearances**: EPC projects, especially those related to infrastructure and energy (like power plants, highways, and industrial facilities), must adhere to environmental regulations. The Ministry of Environment, Forest, and Climate Change (MoEFCC) requires environmental clearance for large projects, which often involves environmental impact assessments (EIA). These clearances ensure that projects minimize their ecological footprint, such as controlling air and water pollution and maintaining biodiversity. Green Building Certifications: With growing emphasis on sustainability, the use of green building and energy-efficient designs has become crucial. Regulations like the Energy Conservation Building Code (ECBC) and certifications such as LEED (Leadership in Energy and Environmental Design) play a key role in shaping EPC project execution.
Labor & Safety Regulations	**Labor Laws:** EPC contractors must comply with various labour laws, including the Factories Act, 1948, Labour Welfare Fund Act, and Mines Act, to ensure that workers' rights are protected. These laws cover worker welfare, payment of wages, working hours, and conditions, and ensure health and safety standards are met. **Safety Standards:** The National Safety Council and the Directorate General of Factory Advice Service & Labour Institutes (DG-FASLI) set safety standards for construction sites. These regulations aim to ensure that workers are provided with a safe working environment, including measures to reduce workplace accidents and hazards.
Taxation & Financial Regulations	**Goods and Services Tax (GST):** The introduction of GST has unified the tax structure across India, affecting the procurement of materials, execution of contracts, and the overall cost structure for EPC contractors. Contractors must ensure compliance with GST provisions and maintain proper records to avoid penalties. **Customs and Import Regulations:** For large-scale EPC projects that require importing machinery or raw materials (such as steel for construction or turbines for power plants), compliance with customs duties and import regulations is essential. Government initiatives like Make in India are encouraging local procurement, but imports may still be necessary for specialized components.

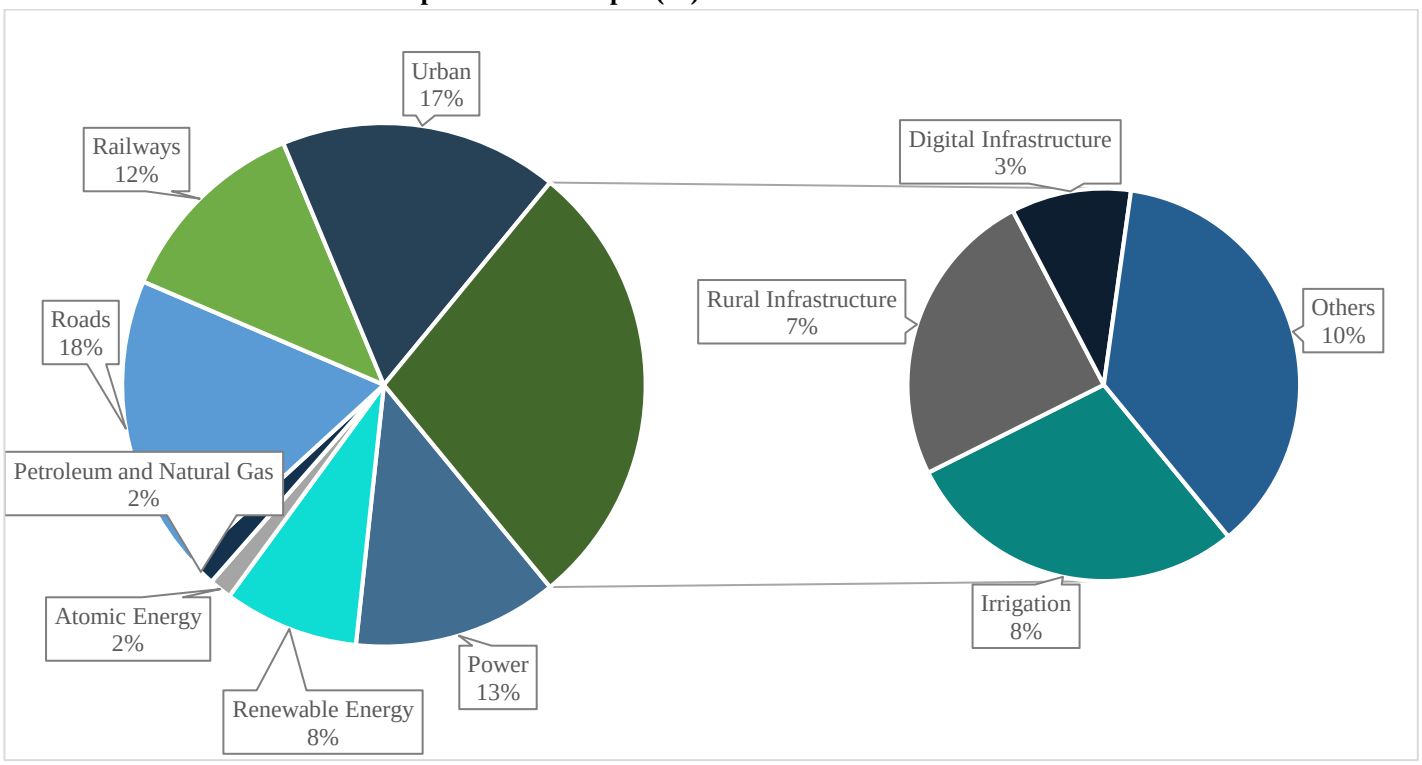
Building & Construction Codes	**Indian Standards (IS):** The Bureau of Indian Standards (BIS) sets various national standards for construction materials, methods, and practices. These include regulations for materials like cement, steel, and concrete, as well as guidelines for construction practices to ensure durability and safety. **Building Codes:** Specific codes such as the National Building Code of India (NBC) and local municipal regulations guide the construction and design of buildings, roads, and other infrastructure. Compliance with these codes is mandatory for ensuring the structural integrity and safety of projects.
Permits & Approvals	**Land Acquisition and Zoning Approvals:** The process of land acquisition and obtaining zoning permits is one of the most significant regulatory challenges for EPC contractors. Delays in obtaining land titles and environmental clearances can hold up projects. The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation, and Resettlement Act, 2013 governs land acquisition processes. **Local Authority Approvals:** For urban infrastructure projects, local municipalities and development authorities need to approve construction plans, roadworks, water supply systems, and drainage projects.
Sector Specific Regulations	**Energy Sector Regulations:** In the energy and power sector, EPC contractors must adhere to regulations set by bodies such as the Central Electricity Authority (CEA), the Ministry of Power, and the Central Electricity Regulatory Commission (CERC). These include guidelines for setting up power plants, transmission lines, and renewable energy projects. **Telecom Regulations:** For telecom infrastructure projects, EPC contractors must comply with Telecom Regulatory Authority of India (TRAI) guidelines and obtain approvals from the Department of Telecommunications (DoT).
FDI & PPP Framework	**FDI Regulations:** The Department for Promotion of Industry and Internal Trade (DPIIT) governs FDI policies in India, including foreign investments in EPC projects. The FDI framework ensures that foreign investors are compliant with Indian regulations, especially in sectors such as energy, defense, and infrastructure. **PPP Regulations:** Public-Private Partnership (PPP) projects follow a specific legal and financial framework established by the PPP policy. EPC contractors involved in PPP projects must adhere to both public and private sector requirements, including risk-sharing mechanisms, financing terms, and regulatory compliances.
Compliance with Sustainability Goals	The Indian government has committed to reducing its carbon emissions and increasing the share of renewable energy in its energy mix. EPC contractors are encouraged to follow sustainability guidelines and participate in green construction and clean energy initiatives, particularly in renewable energy projects and environmentally conscious urban development.

2.8 Overview of investments in various sectors in India

NIP was launched in December 2019 with a focus on infrastructure development to enable the country to achieve its target of USD 5 trillion economy by FY25 and USD 10 trillion by FY32. Infrastructure to play a significant role with 3% contribution to the GDP by FY25 (Rs 111 trillion) and is expected to remain same or increase its share by FY30 (Rs 25.00 trillion).

A taskforce was created to set up the pipeline. In the final report submitted by the task force in April 2020, the pipeline covers multiple sectors, such as urban infrastructure, renewable and conventional energy, roads, and railways that constitute nearly 71% of the projected total capex of Rs 111 trillion. It also includes investments in other sectors such as rural infrastructure, ports, airports, among others. The proposed investments will be implemented by both the government and the private sector.

Chart 12: National Infrastructure Pipeline Sectoral Split (%)



Source: NITI Aayog's report on National Infrastructure Pipeline

During FY20–25, sectors-wise breakup of NIP investment is with energy contributing the highest at Rs 26,900 billion around 24% of the total plan followed by roads Rs. 20,338 billion at 18%, urban Rs. 19,193 billion at 17%, and railways with an investment of Rs. 13,676 billion, which contributes 12% amount to ~71% of the projected infrastructure investments in India.

Sector Wise Breakup is provided in the Below Table:

Table 4: National Infrastructure Pipeline Sectoral Split (Rs. Billion)

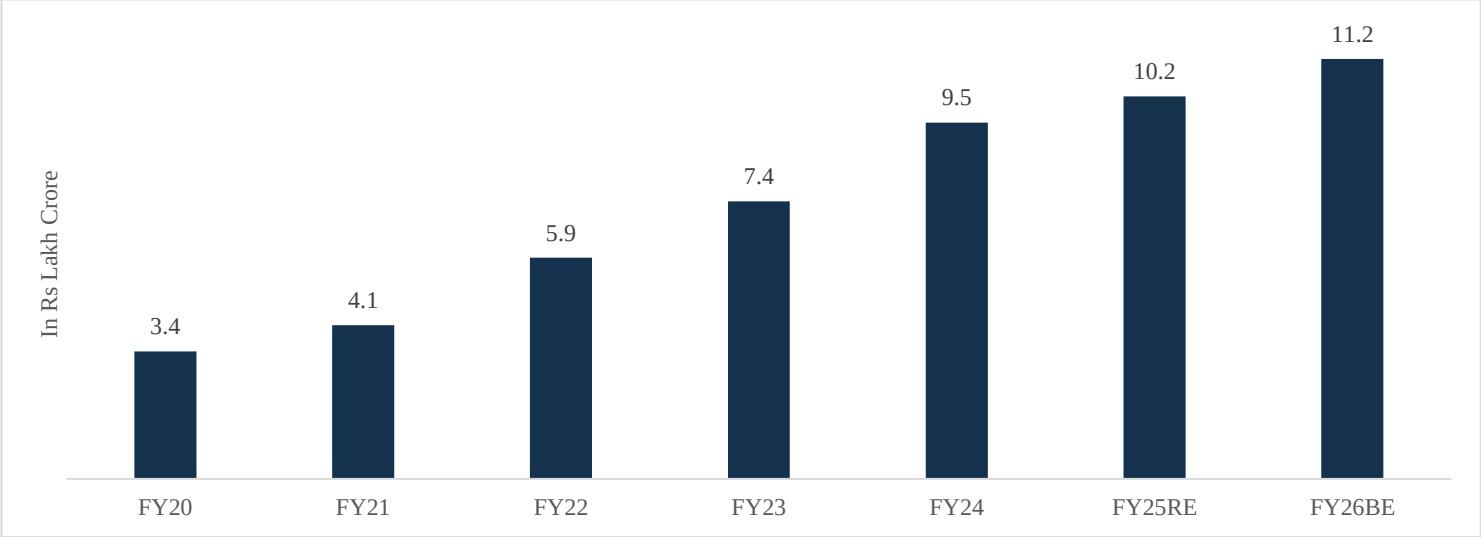
	FY20	FY21	FY22	FY23	FY24	FY25	No Phasing	Total
Power	1,641.4	2,255.5	2,217.3	2,234.9	2,252.4	2,110.0	1,392.8	14,104.3
Renewable Energy	305.0	1,510.0	1,440.0	1,700.0	2,170.0	2,170.0	-	9,295.0
Atomic Energy	116.4	214.6	283.2	331.2	326.7	282.8	-	1,555.0
Petroleum and Natural Gas	273.3	435.1	483.1	415.2	228.6	105.4	5.0	1,945.7
Total Energy	2,336.1	3,353.6	4,423.7	4,681.3	4,977.7	4,668.2	1,397.8	26,900.0
Roads	3,325.6	3,832.8	3,569.7	2,527.8	2,407.6	3,326.6	1,348.2	20,338.2
Railways	1,333.9	2,624.7	3,088.0	2,738.3	2,212.1	1,678.7	-	13,675.6
Ports	133.6	181.0	206.5	158.6	77.2	100.0	355.0	1,211.9
Airport	186.7	216.7	248.2	213.3	253.9	51.4	264.4	1,434.5
Urban	2,981.7	4,622.1	4,041.3	2,348.6	2,171.6	1,598.6	1,428.7	19,192.7
Irrigation	1,144.6	2,006.2	1,756.7	1,373.6	1,152.8	704.7	806.1	8,944.7
Rural Infrastructure	1,403.1	1,768.0	2,108.1	1,118.8	1,070.6	270.5	-	7,739.2
Digital Infrastructure	783.6	618.5	545.4	387.2	381.2	380.5	-	3,096.3
Agriculture and Food Processing Infrastructure	260.4	263.7	261.0	243.9	236.5	231.2	190.7	1,687.3
Social Infrastructure	594.7	806.9	935.0	651.0	565.8	243.9	334.3	4,131.6
Industrial Infrastructure	174.1	406.8	425.6	335.3	227.3	105.2	1,393.1	3,067.3
Total	**13,635.3**	**19,504.0**	**18,960.6**	**13,803.3**	**12,782.4**	**11,059.0**	**12,217.3**	**1,11,419.4**

Source: NITI Aayog's report on National Infrastructure Pipeline

2.9 Budgetary Outlay Towards Infrastructure

One of the key drivers for economic growth is the increased infrastructure investment thrust by the government. In the Union Budget FY26, the government continued its focus on infrastructure development with budget estimates of capital expenditure toward the infrastructure sector of Rs. 11.21 trillion. Furthermore, continuous efforts by the government to make the business environment convenient to operate and streamline the regulatory process will support the growth of investments in the infrastructure segment.

Chart 13: Trend in Capital Expenditure



Source: Union Budget Analysis

The Union Budget FY26 significantly boosts allocations for green energy initiatives, showcasing the government's focus on sustainability. The PM Surya Ghar Muft Bijli Yojana received Rs 20,000 crore to promote rooftop solar adoption. Similarly, Rs 2,600 crore was allocated to the PM-KUSUM Scheme to solarize agricultural pumps. The National Green Hydrogen Mission and Green Energy Corridors were each allocated Rs 600 crore to support the transition to clean energy. In FY26, the Ministry of New and Renewable Energy's budget rose by over 53% y-o-y basis, reflecting a strategic push towards climate-resilient infrastructure.

In FY25, PNGRB has authorized 307 Geographical Areas for development of CGD infrastructure with a potential coverage of about 100% of country's area and 100 % of the population. As on 30.09.2024, the total number of PNG (D) connections and CNG Stations in the country was 1.36 Cr and 7259, respectively.

2.10 Technological Advancements in EPC

The engineering and construction (EPC) industry is key to a country's growth, handling large-scale infrastructure projects and creating jobs. Traditionally, though, it has been slower to adopt digital tools compared to other industries. That started to change with the COVID-19 pandemic, which made remote work and safety a priority across sectors.

To keep operations running, many EPC firms began using cloud platforms, remote collaboration tools, and cybersecurity solutions. These technologies have now become part of the day-to-day, helping teams stay connected and productive. While these tools are helping in the short term, the industry is also looking to the future.

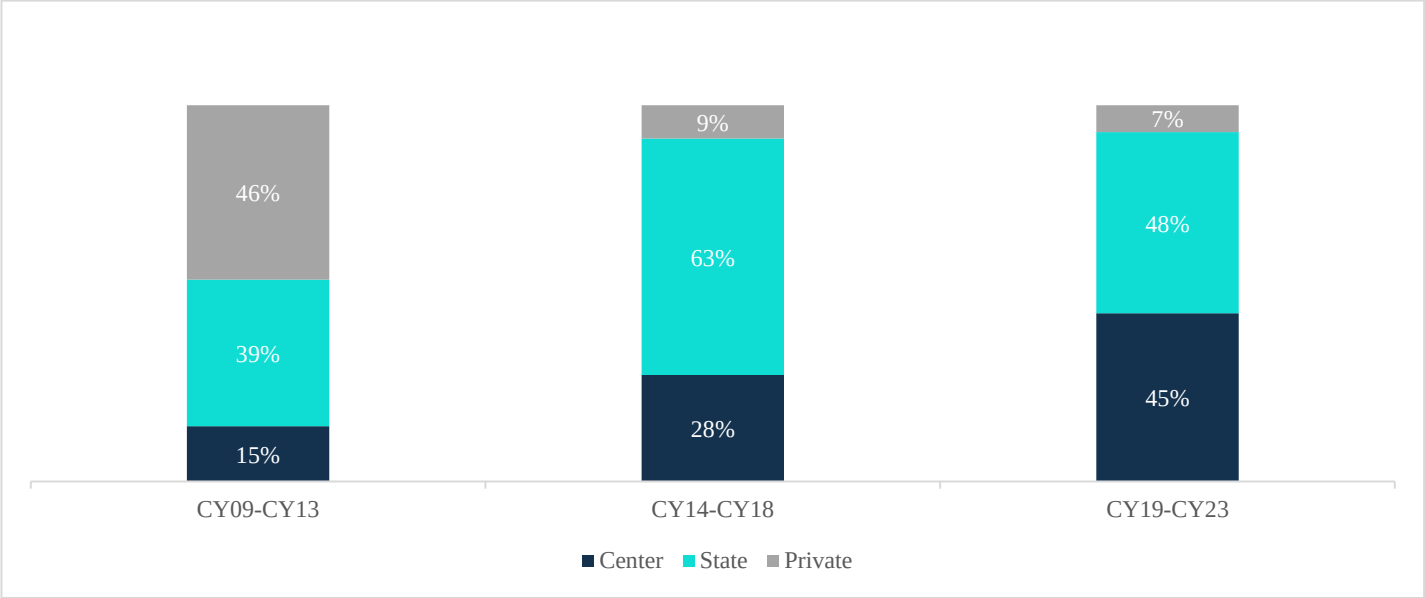
Advanced technologies like Artificial Intelligence (AI), Machine Learning (ML), Internet of Things (IoT), and 3D printing are gaining attention. These have the potential to improve everything from design to project delivery. A big focus now is making sure data is better managed. Tools like Building Information Modelling (BIM) and Common Data Environments (CDE) are helping teams store and access project data more efficiently. This shift is setting the stage for faster, smarter, and more sustainable construction in the years ahead.

2.11 Private Participation in National Infra projects

In recent years, the central government has significantly increased its spending on infrastructure to boost connectivity and lower logistics costs. This is aimed at supporting business growth and expanding the country's manufacturing

capacity, which could lead to higher economic output. Between CY19-CY23, state governments were responsible for 48% of total infrastructure investment, the central government contributed 45%, and the private sector made up only 7.2%. Major government programs like Bharatmala Pariyojana, the National Infrastructure Pipeline (NIP), and Sagarmala were launched during this time to encourage private sector involvement. While private participation in infrastructure projects has been slow to grow overall, there has been some improvement in areas like road development, especially after the Hybrid Annuity Model (HAM) was introduced in CY16 and contract terms for HAM and Build-Operate-Transfer (BOT) projects were updated in CY20.

Chart 14:Trends in infrastructure investments over five-year period



Source: Knight frank, CareEdge Research

Private equity (PE) participation in national infrastructure projects has emerged as a critical driver of funding and efficiency in recent years. With governments increasingly seeking alternative financing to bridge infrastructure gaps, PE firms bring much-needed capital, risk management expertise, and operational discipline. Their involvement enhances project execution timelines and long-term sustainability by fostering accountability and innovation. Additionally, PE investments help diversify the funding base and reduce the dependency on traditional public financing or debt-heavy models. In CY22 infrastructure investments were USD 3.7 billion which decreased to USD 0.8 billion in CY23 due to a combination of factors, including a global slowdown in PE-VC investment, weakening investor sentiment, and persistent macroeconomic headwinds like high interest rates and geopolitical tensions. However, it again bounced back to USD 4.3 billion in CY24 led by USD 2.2 billion funding in ATC and strong deal activity in roads infrastructure projects.

2.12 Key trends and growth drivers for the sector

The EPC (Engineering, Procurement, and Construction) sector in India is a vital contributor to infrastructure development, driven by robust demand, government initiatives, technological advancements, and private sector participation.

- **Government Initiatives and Policies**

India's infrastructure sector is being revolutionized through transformative programs like the National Infrastructure Pipeline (NIP), which envisages Rs 111 lakh crore (Rs 1.5 trillion) in investments by FY25 across sectors such as roads, railways, ports, airports, and energy. This plan provides a robust pipeline of projects, creating expansive opportunities for EPC players. Initiatives like

Bharatmala Pariyojana (highway development) and Sagarmala Projects (port-led industrial corridors) aim to improve logistics and connectivity, further boosting EPC demand. The Gati Shakti Master Plan integrates infrastructure projects across sectors, ensuring faster and more efficient execution. Additionally, the Smart Cities Mission focuses on urban transformation, including smart utilities, green buildings, and advanced urban infrastructure, driving specialized EPC requirements. These programs enhance connectivity, logistics, and urban infrastructure, ensuring a steady demand for EPC expertise in construction and engineering.

- **Infrastructure Growth**

Transportation investments in highways, metro rail systems, and airport modernization projects, such as the Navi Mumbai Airport and metro expansions, are driving significant EPC opportunities. Urbanization, fuelled by rapid population growth and city expansion, has increased demand for housing, water supply systems, waste management, and urban mobility infrastructure. Simultaneously, rural development initiatives like the Pradhan Mantri Gram Sadak Yojana (PMGSY) and electrification programs are enhancing rural connectivity and power access, further boosting the EPC sector. Investments in metro rail, airports, housing, utilities, and rural connectivity projects are creating expansive opportunities for EPC players across India.

- **Renewable Energy Push**

India's ambitious target of achieving 500 GW of non-fossil fuel capacity by 2030 has catalysed significant growth in the renewable energy sector, with a focus on solar parks, wind farms, and hybrid renewable projects. Large-scale EPC projects, such as the Rewa Ultra Mega Solar Park and advanced wind-solar hybrid systems, are becoming central to this transformation. Supporting policies, including the Green Energy Corridor for efficient renewable energy transmission and consistent project tenders by the Solar Energy Corporation of India (SECI), provide a steady demand pipeline for EPC services. These initiatives not only boost project activity but also foster technological advancements and scalability within the industry.

- **Digital and Technological Integration**

The EPC sector in India is leveraging innovative technologies and sustainable practices to enhance project efficiency and environmental compliance. Building Information Modelling (BIM) streamlines design and project management, minimizing errors and improving timelines. Artificial Intelligence (AI) and IoT optimize resource management, enable predictive maintenance, and facilitate real-time project monitoring. Drone technology is transforming site surveys, progress tracking, and safety inspections, ensuring precision and reducing costs. Additionally, a growing emphasis on green construction practices promotes sustainable, energy-efficient designs and eco-friendly materials, aligning with global environmental goals. These technologies enhance efficiency, ensure real-time insights, and support sustainable construction, driving the industry toward precision and environmental responsibility.

- **Financial Incentives and FDI**

Relaxed Foreign Direct Investment (FDI) norms, including 100% FDI in infrastructure development projects attract global players to India's construction and EPC markets, boosting competition and innovation. Incentives like tax holidays, reduced GST rates on affordable housing, and Viability Gap Funding (VGF) schemes further strengthen investment attractiveness. These measures ensure a consistent influx of capital and resources for critical infrastructure projects, driving long-term growth, expanding the EPC sector's role in India's development, and strengthening its competitiveness.

- **Industrial and Manufacturing Growth**

The Make in India initiative promotes domestic manufacturing of construction materials, equipment, and components, reducing reliance on imports and fostering self-reliance in the EPC industry. Simultaneously, the development of industrial corridors like the Delhi-Mumbai Industrial Corridor (DMIC) is creating significant demand for factories, logistics hubs, and supporting infrastructure, driving growth in industrial construction and boosting regional economies. These efforts collectively enhance the competitiveness of Indian EPC players and attract investments.

- **Export Opportunities**

Indian EPC firms are capitalizing on their cost-competitiveness and engineering expertise to expand into global markets, particularly in Africa, the Middle East, and Southeast Asia. These regions present opportunities in oil and gas facilities, power transmission, and

infrastructure projects, driven by growing development needs. By offering high-quality services at competitive prices, Indian companies are carving a niche in international markets, diversifying revenue streams, and strengthening their global footprint.

2.13 Threats and challenges

Despite its significant contributions to India's infrastructure growth, the EPC (Engineering, Procurement, and Construction) sector faces several challenges. These issues, if unaddressed, can affect project execution, profitability, and sector growth.

Challenges	Description
Regulatory and Approval Delays	Land acquisition and environmental clearances lead to prolonged negotiations and legal disputes. Bureaucratic hurdles add complexity, causing delays that increase costs and impact the financial viability and reputation of EPC contractors.
Financing Constraints	High initial investment needs, stringent lending norms, and reliance on delayed government payments create cash flow issues. Rising debt levels from delays and cost overruns hinder companies' ability to undertake large projects, affecting sector growth.
Price Volatility in Raw Materials	Fluctuations in steel, cement, and other materials, along with dependency on imports and exchange rate variations, increase project costs. Fixed-price contracts exacerbate the financial strain, reducing profit margins.
Skilled Workforce Shortages	A lack of skilled engineers, managers, and labourers for advanced projects affects project timelines and quality. Seasonal migration worsens labour availability, leading to delays and inefficiencies in infrastructure projects.
Intense Competition	Aggressive bidding and under-pricing erode profit margins, causing financial strain. Firms struggle to invest in technology and expand operations, limiting their growth and sustainability in the competitive EPC landscape.
Technological Gaps	Slow adoption of advanced technologies like BIM, AI, and IoT leads to inefficiencies and higher error risks. This technological lag reduces productivity, elevates costs, and diminishes competitiveness domestically and internationally.
Environmental and Social Challenges	Community resistance and strict environmental norms increase compliance costs and delay projects. Investments in eco-friendly technologies further impact profitability, while legal challenges related to environmental concerns exacerbate delays.
Global Risks	Geopolitical tensions and trade disruptions affect material availability and costs. The COVID-19 pandemic highlighted vulnerabilities in supply chains and logistics, compounding delays and increasing reliance on third-party suppliers, which introduces additional risks and inefficiencies.

Legal and Contractual Challenges	Disputes over contract terms and payment delays often result in costly legal battles. Fixed-price contracts expose firms to cost overruns, leading to financial and reputational risks that affect project management and client relationships.
Lack of R&D Investment	Limited investment in research and development restricts the adoption of modern techniques and materials. Reliance on traditional practices hampers efficiency and competitiveness, stunting innovation and growth in the sector.

3 Telecom Fibre Cable Infrastructure

3.1 Overview of the Indian Telecom Sector

The telecommunications sector plays an important role in the Indian economy as it contributes to the economic growth and GDP, and generates revenue for the government. There has been growth in the last few years in the telecom sector on the back of strong consumer demand and supportive policies by the government. For instance, the services of the telecom sector are available to consumers at an affordable rate due to fair competition and a proactive regulatory framework by the government.

As of March 2025 India, has the world's second largest subscriber base of 1.19 billion second to China. It jumped to 49th rank in 2024 from 67th in 2021 in the Network Readiness Index, an index published by Portulans Institute, an independent non-profit research and educational institute based in Washington DC which maps the network readiness landscape of 130+ economies based on their performance in four areas - Technology, People, Governance, and Impact.

Furthermore, there has been augmented growth in the last few years because of affordable tariffs, higher penetration, roll-out of Mobile Number Portability (MNP), expansion of 4G and 5G coverage, evolving consumption patterns of subscribers, Government's initiatives towards supporting India's domestic telecom infrastructure, and favourable regulatory environment.

India is divided into four circle categories where telecom services are provided that are-

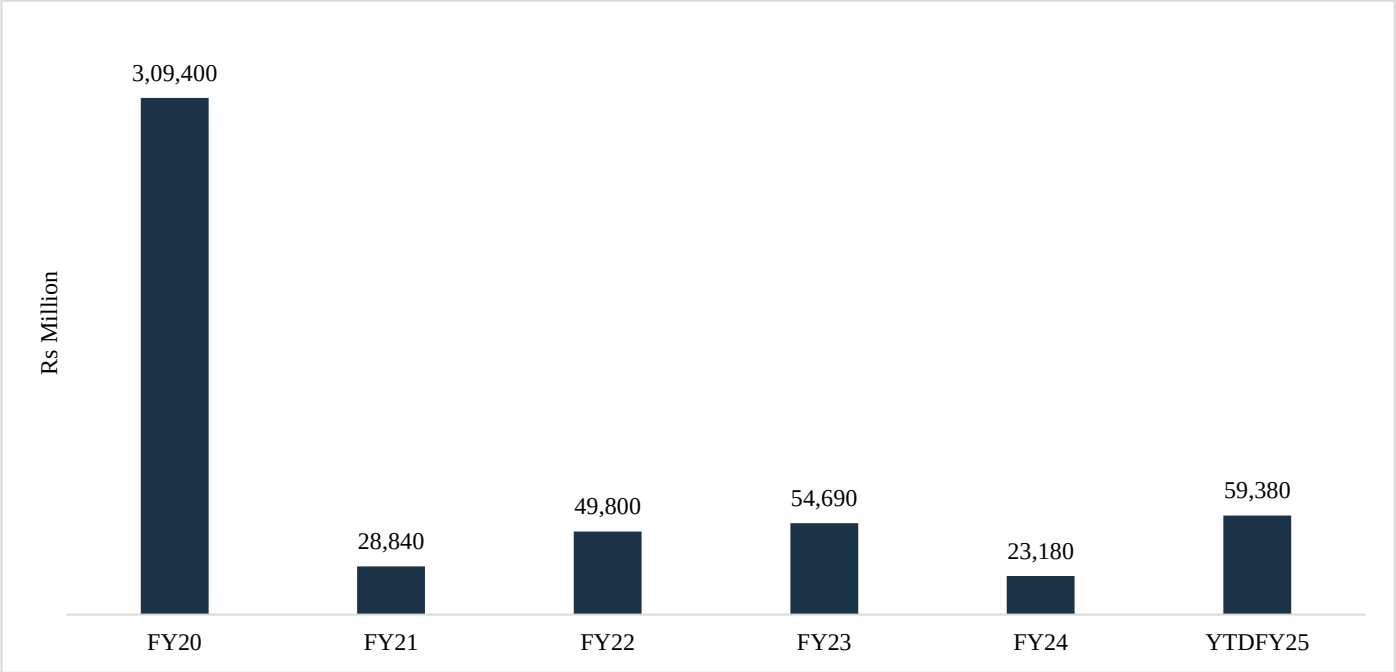
Metro	Circle A	Circle B	Circle C
•Delhi •Mumbai •Kolkata	•Andhra Pradesh •Gujarat •Karnataka •Maharashtra •Tamil Nadu (including Chennai) •Telangana	•Haryana •Kerela •Madhya Pradesh •Punjab •Rajasthan •West Bengal •Uttar Pradesh (East & West) •Uttrakhand •Andaman & Nicobar Island (Under West Bengal Circle)	•Assam •Bihar •Himachal Pradesh •Jammu & Kashmir •North East •Odisha

3.1.1 FDI Inflow

India has a liberalized FDI policy for the telecom sector, allowing foreign investors to hold up to 100% equity in telecom companies under the automatic route in most segments. This policy has encouraged foreign investment and participation in the Indian telecom industry. The Indian telecom sector has witnessed significant consolidation and mergers in recent years, leading to increased FDI inflows. Mergers and acquisitions involving major telecom operators have attracted substantial investments from foreign entities seeking to gain market share and scale in India. Foreign companies are partnering with Indian telecom operators to upgrade network infrastructure and roll out advanced telecommunications services.

The cumulative FDI in telecom sector has reached Rs 525.3 Billion from April 2019 to December 2025. This surge reflects the increasing confidence of global investors in the country's telecom market, driven by the expansion of mobile networks, digital infrastructure, and technological advancements. The sector is expected to see an increase in foreign direct investment over the next couple of years. This optimism stems from two recent developments: the opening of satellite communications to the private sector, and introduction of the Telecommunications Act, which are expected to make the sector attractive and stimulate investment.

Chart 15: Cumulative Foreign Direct Investment in Telecommunication Sector



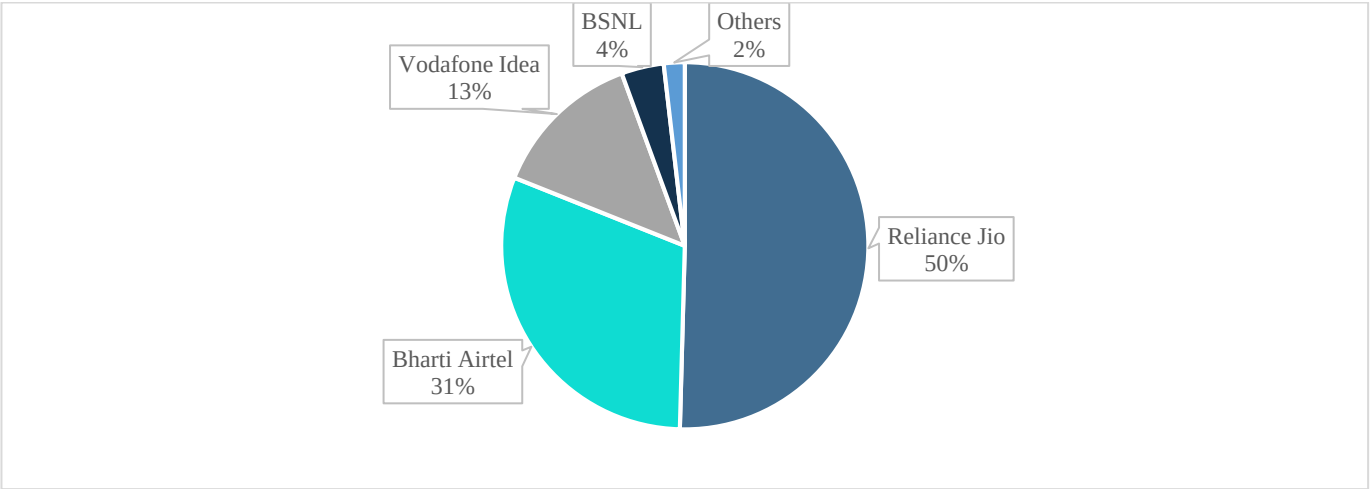
Source: Department for Promotion of Industry and Internal Trade
Note: YTD Data is for the period Mar-24 to Dec-24

3.1.2 Broadband Subscriber

The telecom industry is oligopolistic with three large private sector players dominating the market i.e. Reliance Jio Infocomm Ltd, followed by Bharti Airtel and Vodafone-Idea with a collective market share of around 94% in broadband, 70% in wireline, and 92% in wireless telephone subscribers. The broadband subscribers base increased from 904.5 million in December 2023 to 944.9 million in December 2024, i.e., an increase of 4.5% y-o-y basis. The increase in subscriber base is due to the increased affordability of 4G and 5G services over the past year and the surging demand for wireline broadband services used in smart televisions and work-from-home trends.

As of December 2024, the total broadband subscribers for Reliance Jio stands at 476.6 million, Bharati Airtel has 289.3 million, Vodafone Idea has 126.4 million, and BSNL has 35.3 million subscriber base. As compared to December 2023 BSNL has seen the highest growth of 40.6% followed by Bharti Airtel 9.3% and Reliance Jio at 1.4%. There has been decline in subscribers of Vodafone Idea of 0.7%.

Chart 16: Broadband (Wired + Wireless) Subscribers (As of December 2024)



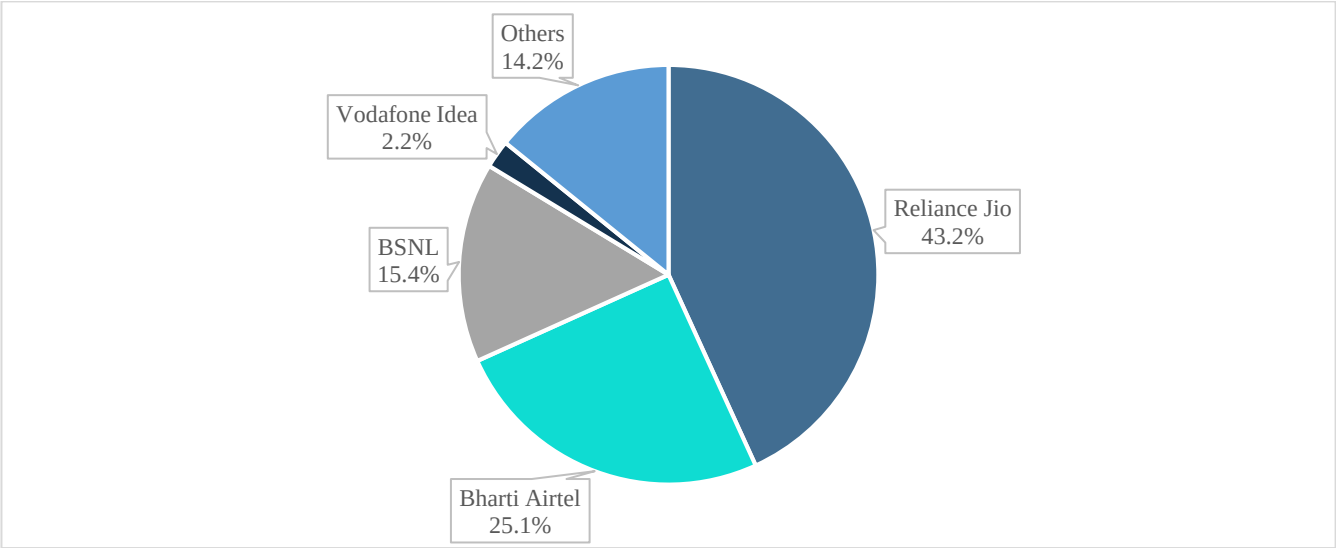
Source: TRAI, CareEdge Research

3.1.3 Wireline Telephone Subscriber

Wireline subscribers increased from 31.8 million at the end of December-23 to 39.2 million at the end of December-24. Net increase in the wireline subscriber base was 7.4 million with a y-o-y growth of 23.3%. The share of urban and rural subscribers in total wireline subscribers were 92.4% and 7.6% respectively at the end of December, 2024. The Overall Wireline Tele-density in India increased from 2.3% at the end of December-23 to 2.8% at the end of December-24. Urban and Rural Wireline Tele-density were 7.1% and 0.3% respectively during the same period.

The wireline subscriber market is dominated by Reliance Jio with a market share of 43.2% followed by Bharati Airtel and BSNL. The net wireline subscriber's addition for the month of December 2024 was 7,66,877 lead by Reliance Jio (6,56,823) followed by Bharti Airtel (1,62,945) and then by Tata Tele (9,278).

Chart 17: Wireline Telephone Subscribers (as of December 2024)



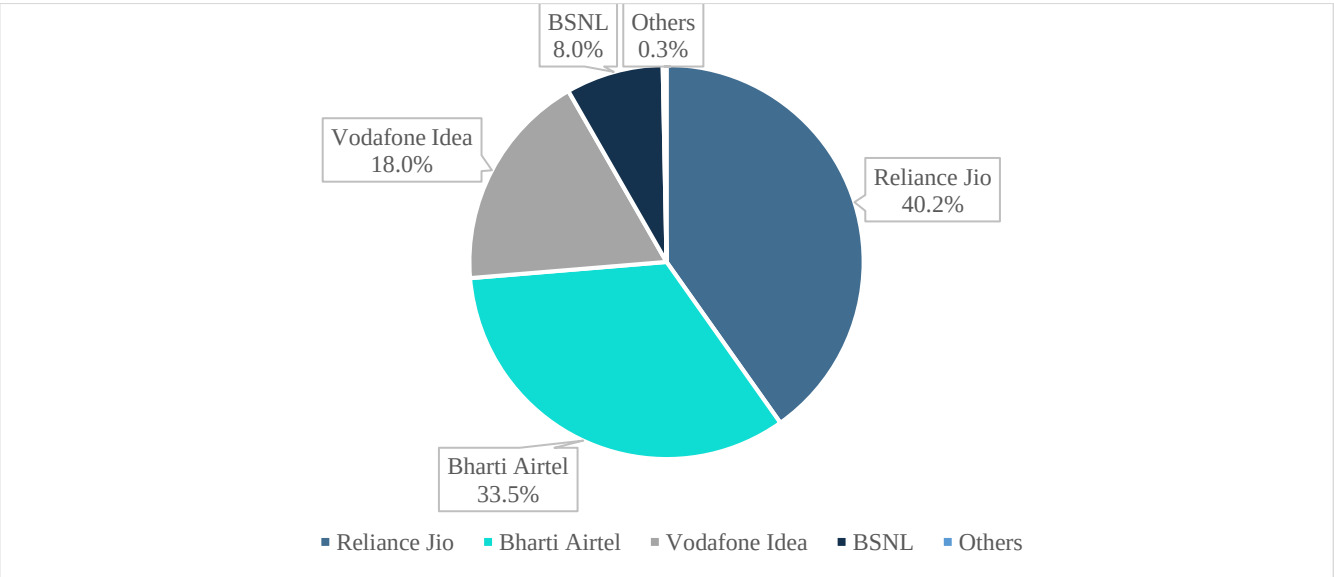
Source: TRAI, CareEdge Research

3.1.4 Wireless Telephone Subscription

There was a decrease in total wireless subscribers from 1,158.5 million at the end of December-23, to 1,150.7 million at the end of December-24. Both urban and rural areas saw reductions. Urban wireless subscribers fell from 633.4 million to 627.1 million, and rural subscribers decreased from 525.0 million to 523.6 million. This resulted in a drop in India's overall wireless tele-density from 83.0% to 81.7%

As of December 2024, the private access service providers hold 91.9% of the total market with Reliance Jio consisting of the major market share followed by Bharati Airtel and Vodafone Idea. The PSU service access providers consist only 8.1% of the total market.

Chart 18: Wireless Telephone Subscription (As of December 2024)



Source: TRAI, CareEdge Research

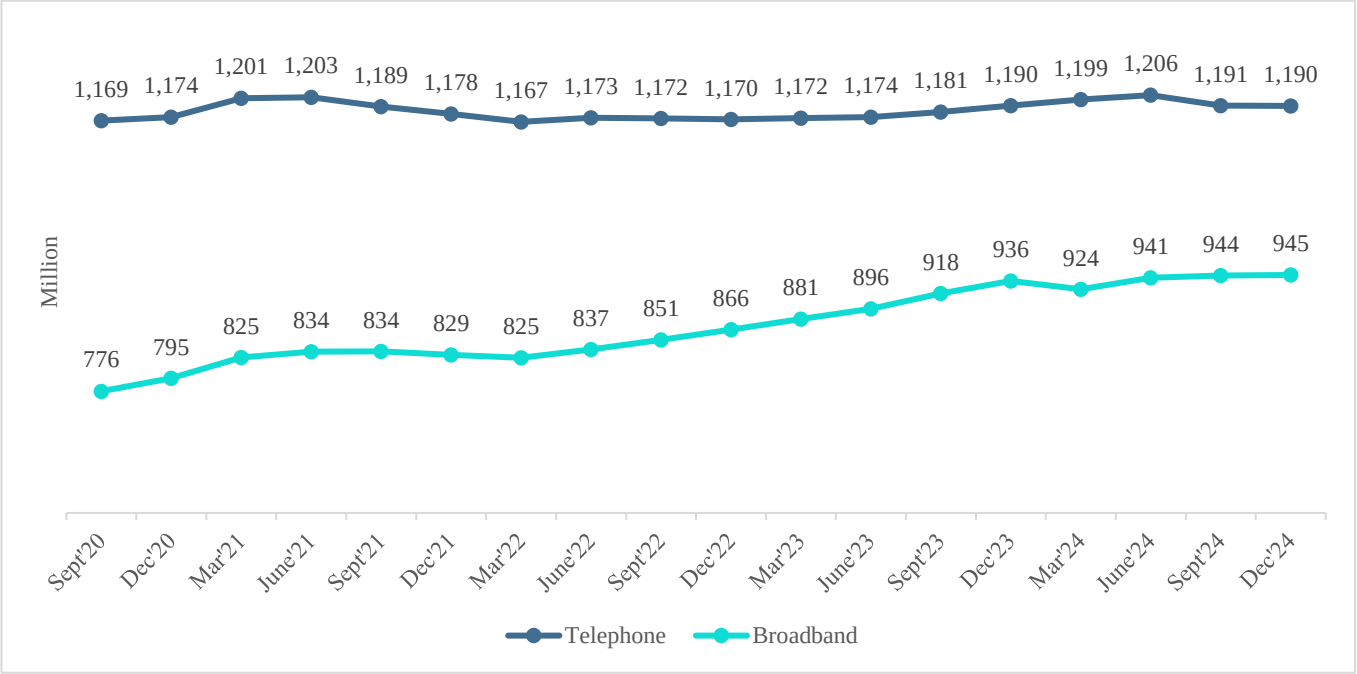
3.2 Performance Indicators in the Telecom Sector

3.2.1 Telephone and broadband Subscriber Base

The broadband subscriber base grew at a CAGR of 5.6% from 743.2 million in March 2020 to 944.9 million in December 2024, whereas the telephone subscriber base increased marginally to 1,189.9 million in December 2024 from 1,177.97 million in March 2020. There was a decline in March 2022 primarily because of the minimum recharge requirement[1] which led to the passive users surrendering connections. The number of telephone users was also affected by the consolidation of market and pricing interventions but after March 2022 there was increase in broadband subscriber base which can be attributed to the increasing inclusion of India's rural areas under the Bharat Net Scheme.

[1] Minimum recharge requirement every month to keep the phone number active.

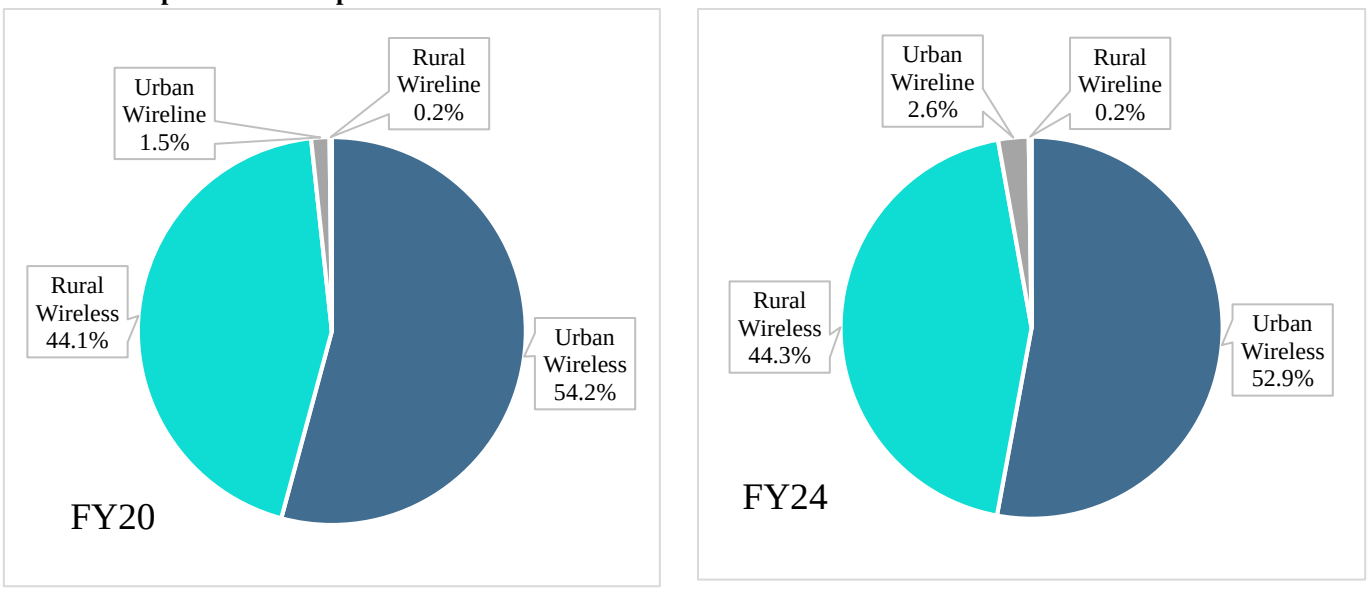
Chart 19: Telephone Industry - Subscriber Base



Source: TRAI, CareEdge Research

Out of the total telephone subscriptions, the share of rural telephone subscriptions increased from 44% in FY20 to 45% in FY24. However, the share of urban telephone subscriptions in total telephone subscriptions decreased from 56% in FY20 to 55% in FY24.

Chart 20: Composition of Telephone Subscribers for FY20 and FY24



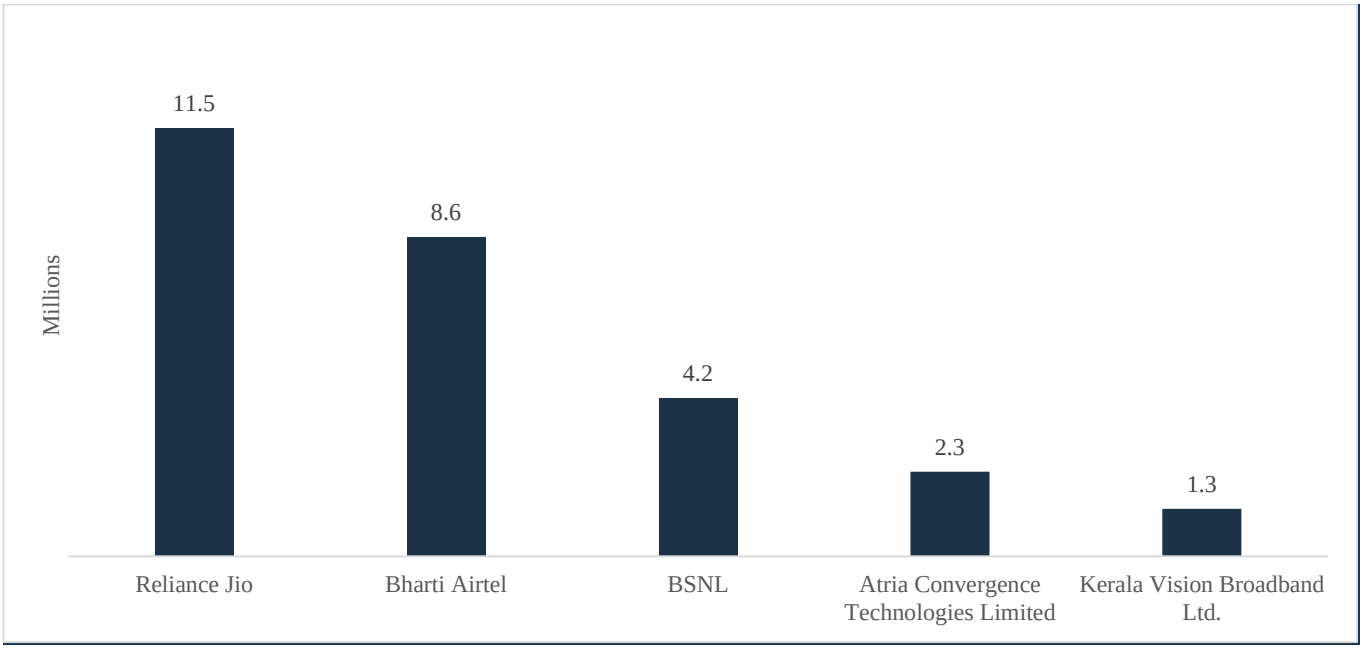
Source: TRAI, CareEdge Research

3.2.2 Subscribers Base for Top 5 Broadband Service Providers

The telecom sector is majorly driven by 5 service providers who constitute about 98% of the total subscriber base. As of December 2024, Reliance Jio was the largest wired broadband service provider with 11.5 million subscribers followed by Bharti Airtel with 8.6 million subscribers and BSNL with 4.2 million subscribers.

The subscribers were attributed to additions in Reliance Jio and Bharati Airtel subscriber base. The adoption of JioBharat phones and Jio AirFiber has led to increased numbers for Reliance Jio while enhancing rural coverage has led to growth in the Airtel subscriber base.

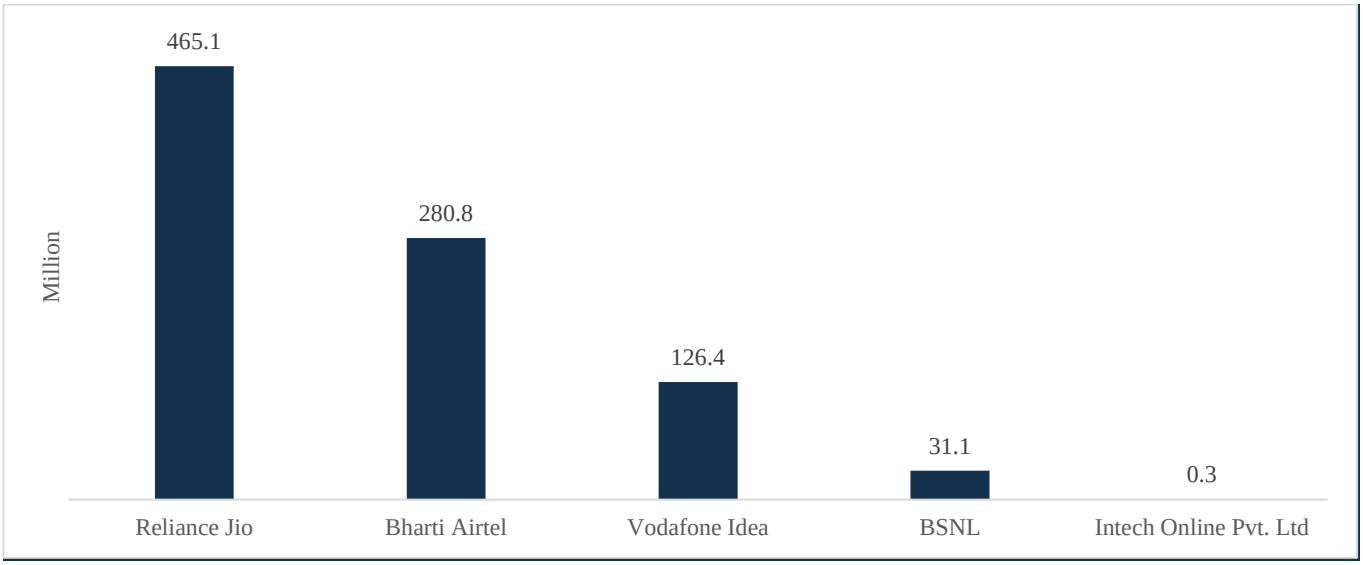
Chart 21: Subscribers base for Top 5 Wired Broadband Service Providers (as on December 2024)



Source: TRAI, CareEdge Research

As of December 2024, Reliance Jio was also the largest wireless broadband service provider with 465.1 million subscribers followed by Bharti Airtel with 280.8 million subscribers and Vodafone Idea with 126.4 million subscribers.

Chart 22: No. of subscribers for Top 5 Wireless Broadband Service Provider (as on December 2024)



Source: TRAI, CareEdge Research

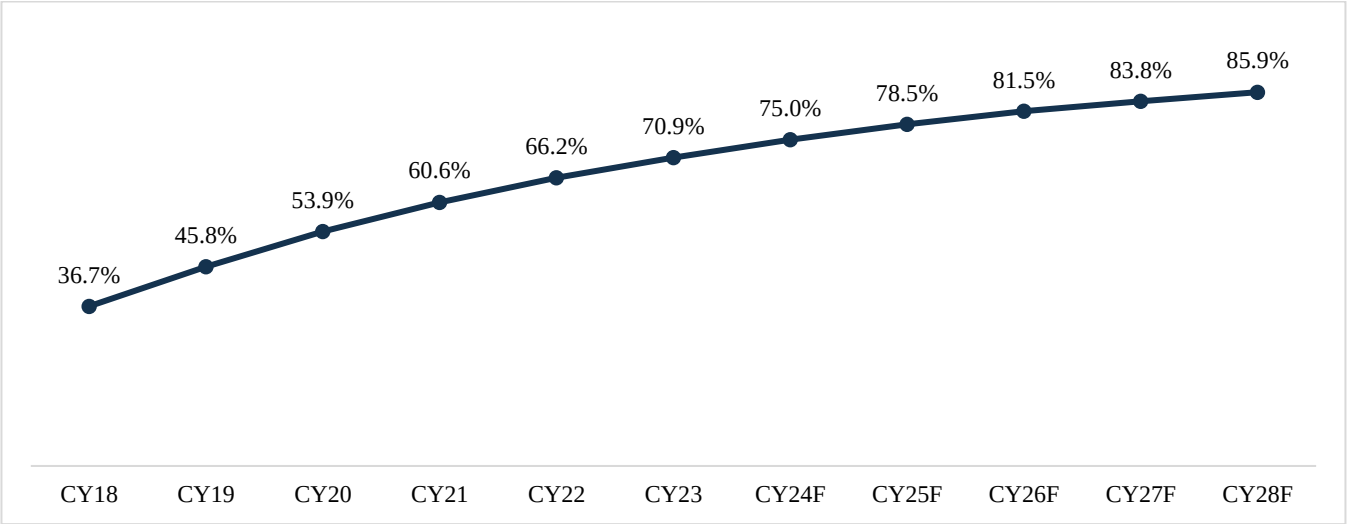
3.2.3 Internet Penetration

The Indian economy is rapidly inching toward a digital economy, supplemented by internet penetration. For instance, the internet penetration has risen from 36.7% in CY18 to 75% in CY24 and is expected to rise to 85.9% by CY28. India has witnessed significant growth in the number of internet users over the years. With a large population and rising smartphone penetration, millions of new users are coming online every month, contributing to the expansion of internet penetration. Whereas affordable smartphones and low-cost data plans have made internet access more accessible to a broader segment of the population, including those in rural areas.

Further, government-led initiatives such as Digital India have played a crucial role in promoting internet adoption and digital literacy across the country. For instance, initiatives such as BharatNet, which aims to connect rural areas with high-speed broadband, are helping to extend internet access to remote parts of the country. Similarly, projects focused on expanding broadband connectivity, setting up public Wi-Fi hotspots, and providing digital skills training have contributed to increased internet penetration. Besides, efforts to improve internet connectivity in rural areas have been ongoing, aiming to bridge the digital divide between urban and rural regions.

Accordingly, the growth of e-commerce platforms, digital payment services, online entertainment, and social media have contributed to increased internet usage in India. Consumers are increasingly turning to the internet for shopping, banking, entertainment, and social networking, driving up overall internet penetration.

Chart 23: Internet Penetration (In %)



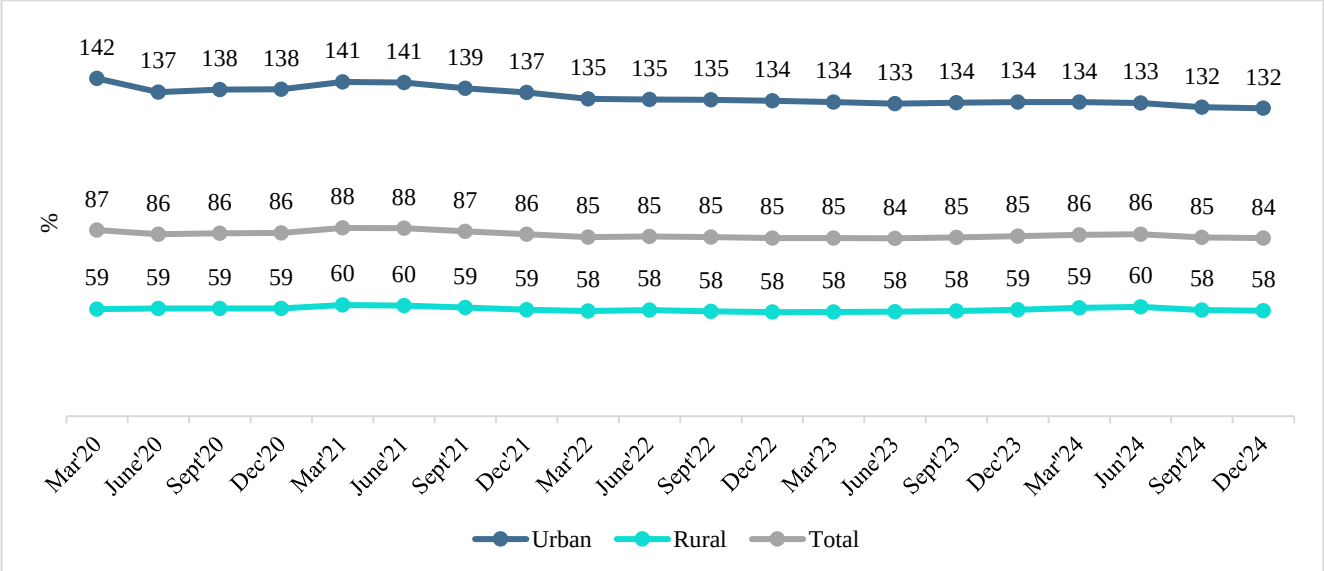
Source: Maia Research, CareEdge Research

3.2.4 Tele-Density

Tele-density denotes the number of telephones per 100 people. It is an important indicator of telecom penetration. India has witnessed significant growth in tele-density over the years, driven by population growth, urbanization, economic development, and government policies promoting telecommunications expansion. Mobile telephony has been the primary driver of tele-density growth in India.

Tele-density levels vary between urban and rural areas, with higher levels observed in urban centers compared to rural regions. Efforts to improve rural connectivity and expand telecom infrastructure in remote areas have helped narrow the rural-urban tele-density gap over time. The tele-density (wireless and wireline) stood at 58.2% in rural areas and 131.5% in urban areas in December 2024. There has been continuous decline in overall tele-density from March 2024.

Chart 24: Tele-Density of Telecom Subscribers (wireless and wireline)



Source: TRAI, CareEdge Research

The teledensity of top service areas and cities as of December 2024 are as follows:

Table 5: Teledensity of Top Services Areas

Sr. No.	Teledensity: Top 10 Service Areas	Dec'24
1.	Delhi	274.4
2.	Himachal Pradesh	119.8
3.	Kerala	118.9
4.	Punjab	110.9
5.	Karnataka	104.6
6.	Tamil Nadu	102.0
7.	Maharashtra (including Goa)	100.3
8.	Andhra Pradesh	94.3
9.	Gujarat	89.8
10.	J&K	89.7

Source: TRAI, CareEdge Research

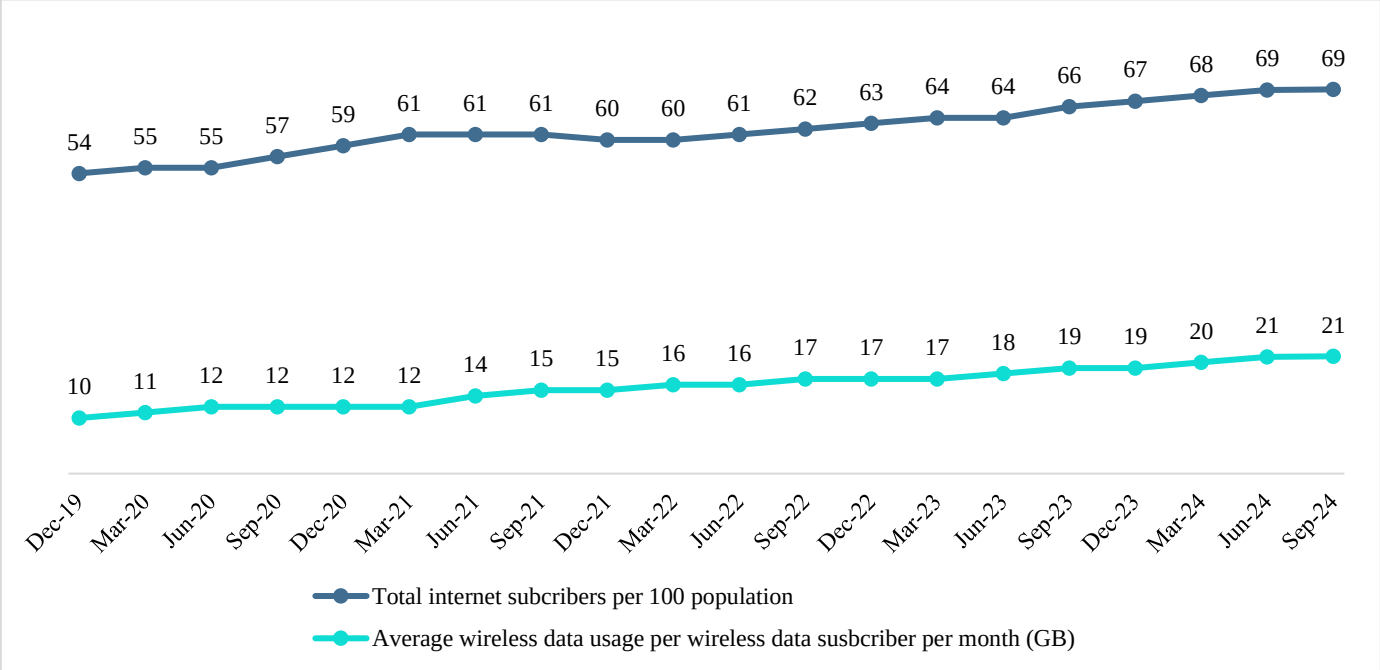
All the states in the above table has higher tele-density than the all India average of 84.4% at the end of December-24. Among states Himachal has the highest tele density at 119.8% followed by Kerala at 118.9% and then by Punjab at 110.9%. Among cities, Delhi has the highest tele density of 274.4%.

The outlook for tele density in India appears optimistic, driven by numerous factors such as increasing smartphone penetration, affordable data plans, government initiatives promoting digital connectivity, and the expansion of telecom infrastructure in rural areas. Tele density is expected to continue its upward trajectory as telecommunications services become more accessible and affordable across the country. Additionally, advancements in technology and the rollout of 5G and upcoming 6G networks are likely to further enhance tele density by facilitating faster and more reliable connectivity. However, challenges such as the digital divide between urban and rural areas, regulatory hurdles, and infrastructure constraints may need to be addressed to ensure equitable access to telecommunications services and sustained growth in tele density. Overall, the outlook for tele density in India remains positive, with continued efforts towards digital inclusion and infrastructure development expected to drive further expansion in the telecommunications sector.

3.2.5 Wireless Data Usage and Smartphone Penetration

Indian telecom industry's performance improved in FY24 led by tariff hikes and increased data usage. On y-o-y basis the average data consumption per subscriber improved by 11.1% during Sept-24, supported by the affordable pricing and continued pandemic-led trends such as work-from-home, higher usage of e-commerce, and virtual education among others which remain a major trend even after the pandemic. Furthermore, higher usage of video streaming applications and online games led to more subscribers adopting indoor entertainment options.

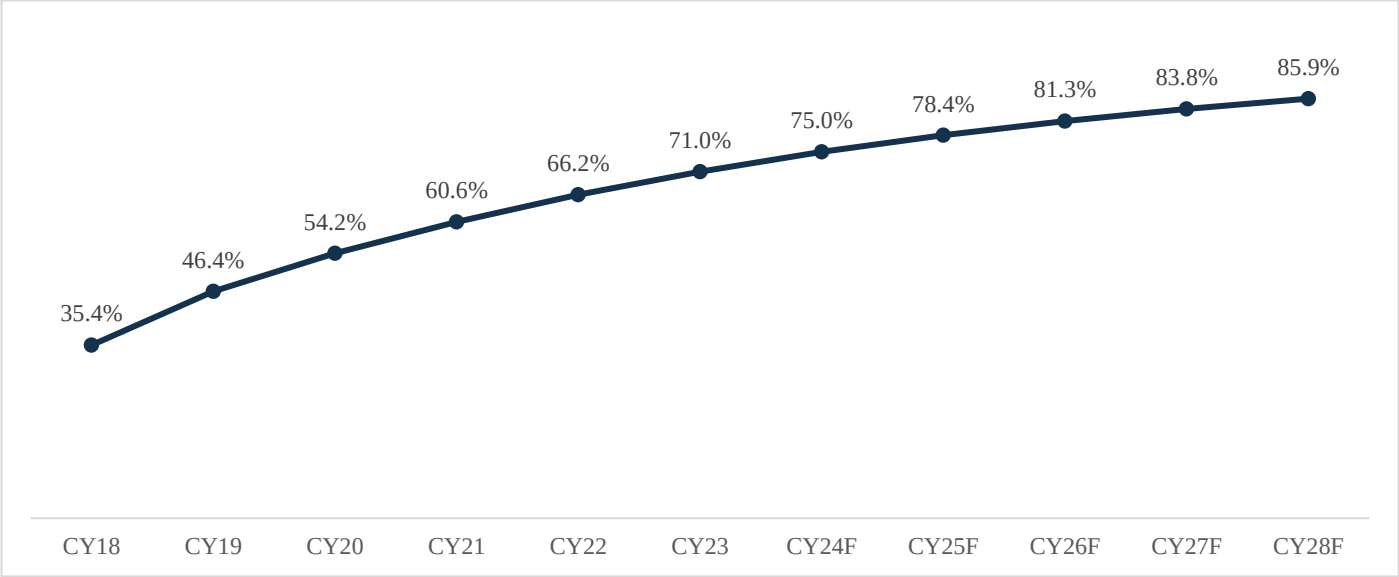
Chart 25: Performance Indicators of Wireless Data Usage



Source: TRAI, CareEdge Research

Ramp up in smartphone and internet penetration is one of the key growth drivers and play a significant role in development of Telecom industry. Smartphone and internet penetration have expanded the reach of towers to remote places, where traditional players were facing challenges.

Chart 26: Smartphone Penetration Rate



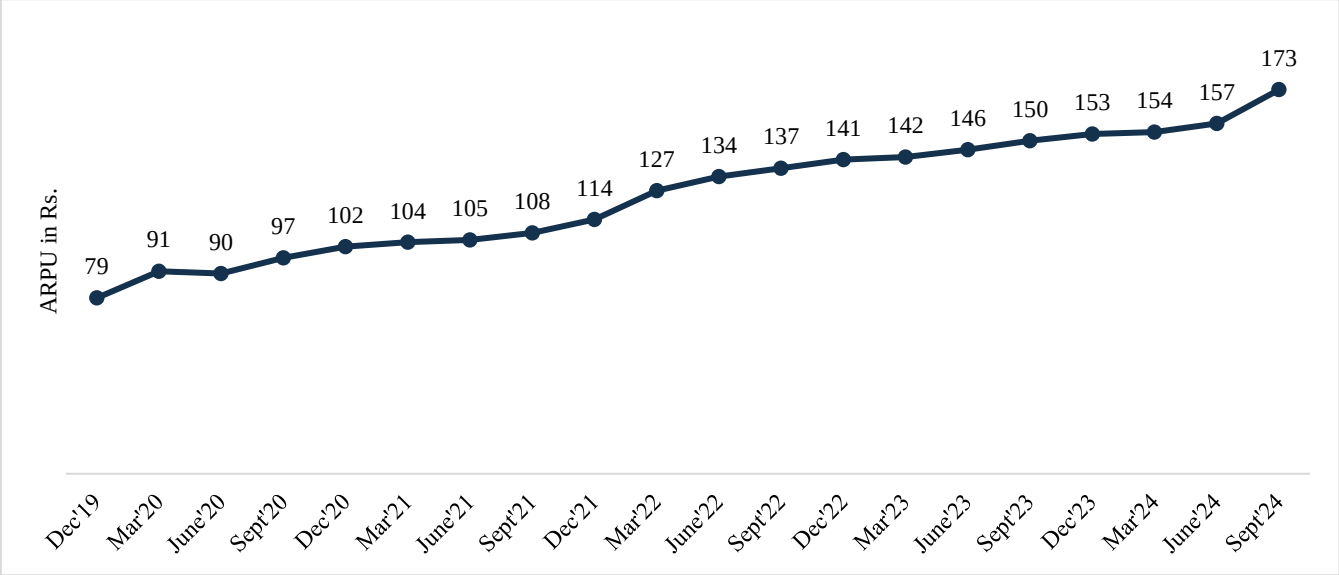
Source: Maia Research, CareEdge Research

3.2.6 Trend in Average Revenue Per User (ARPU)

The Average Revenue Per User (ARPU) per month for wireless services increased from Rs. 149.7 in quarter ended (Q.E.) Sept-23 to Rs. 173.5 in Q.E. Sept-24, reflecting a y-o-y growth of 15.9%. This growth was primarily driven by an increase in ARPU for both post-paid and prepaid services. The ARPU for post-paid services rose from Rs. 167.9 in Q.E. Sept-23 to Rs. 189.2 in Q.E. Sept-24, while the ARPU for prepaid services grew from Rs. 143.8 to Rs. 154.8 during the same period.

Volume of total wireless data usage decreased from 47,629 PB during Q.E. Sept-23 to 56,174 PB during Q.E. Sept-24 with y-o-y growth of 17.9%. Out of total data wireless usage in Q.E. Sept-24, 2G data usage was 66 PB, 3G data usage was 263 PB, 4G data usage was 43,083 PB and 5G data usage was 12,762 PB.

Chart 27: Trend in Average Revenue Per User



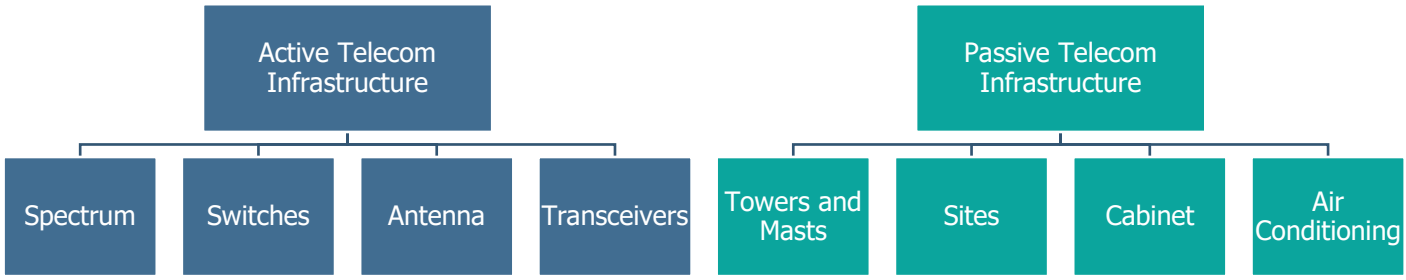
Source: Telecom Regulatory Authority of India (TRAI), CareEdge Research

3.3 Overview of Telecom Infrastructure: Active vs Passive

Active infrastructure refers to a telecommunications network's physical and tangible components that actively transmit, route, and process data signals. It includes a range of equipment, such as switches, routers, servers, and other network devices essential for functioning and managing a robust telecom network.

Passive infrastructure includes all the non-electronic elements required of a cell site. These can be tower itself, buildings or shelter, air conditioning plant, security, electricity generation capability for back-up, an electrical supply, technical premises, and pylons. However, the electronic elements required by a cell site such as base stations, microwave radio equipment, switches, antennae, and transceivers don’t fall under the scope of passive infrastructure.

Figure 1: Active and Passive Telecom Infrastructure Sharing



In India, infrastructure sharing refers to the practice of telecom operators and service providers sharing physical infrastructure to reduce costs, improve network coverage, and optimize resource utilization. The two main types of infrastructure sharing are active and passive infrastructure sharing. Both play crucial roles in the development of the telecom and broadband sectors in India, but they differ in terms of the infrastructure shared, the level of control, and the benefits they provide.

Table 6: Comparison of Active vs Passive Infrastructure Sharing in India

Aspect	Active Sharing	Passive Sharing
Components Shared	Active infrastructure sharing goes beyond the physical components and includes the active equipment responsible for processing and transmitting the network signal (base stations, RAN, core, etc.)	In passive sharing, the focus is on physical infrastructure. Telecom operators share the non-electronic elements that are necessary for the network's basic functioning e.g. (towers, masts, shelters, power, etc.)
Cost Savings	Active infrastructure sharing offers deeper cost reductions, particularly in Capex and Opex. Since telecom operators share expensive equipment like base stations, radio access networks, and the core network elements, the costs related to these assets are spread across the participating operators. Moreover, sharing spectrum (if allowed) also provides additional savings	The primary savings in passive sharing come from capital expenditure (Capex). By sharing the physical infrastructure, telecom companies reduce the cost of building and maintaining towers, land acquisition, power supply systems, and other facilities. Since each operator only needs to invest in their active equipment (e.g., base stations, radios), the cost burden of physical infrastructure is shared
Implementation Complexity	Active sharing is much more complex due to the need for integration between the networks of different operators. Sharing active infrastructure requires careful planning and coordination between operators, especially when dealing with shared base stations, spectrum, and core networks	Passive sharing is relatively simple to implement because it involves sharing of non-electronic assets. Operators are merely co-locating their equipment on shared towers or structures. They still maintain control over their own active equipment

Speed of Deployment	While active sharing may also accelerate deployment in terms of reducing costs, the complexity of network integration and coordination means it can take longer to establish shared infrastructure. This is particularly true when operators need to align their active equipment and integrate systems	Since passive infrastructure sharing involves the physical components only, it tends to result in faster deployment of network coverage. Multiple operators can quickly share existing infrastructure (such as towers and shelters) and reduce the time needed to establish a presence in new areas
Regulatory Encouragement	Active sharing is also encouraged, but it involves more regulatory scrutiny. Sharing active components, particularly spectrum and core networks, raises more concerns about competition, network neutrality, and service quality	Regulatory bodies like the Telecom Regulatory Authority of India (TRAI) have strongly encouraged passive sharing. The Indian government and TRAI recognize that sharing towers and other physical infrastructure can accelerate network rollout and enhance competition. This is especially important in India, where telecom networks need to expand rapidly to meet the demands of a growing population
Security and Privacy	Active sharing raises greater concerns about security and privacy, particularly when multiple operators share the same network infrastructure	Since passive infrastructure sharing only involves the physical components, there are fewer concerns about security and privacy. Each operator still maintains full control over its active equipment and data. The risks are primarily related to the physical security of the shared infrastructure (e.g., towers and shelters)
Impact on Network Performance	Active sharing, if well implemented, can lead to improved network performance due to resource pooling	Since passive sharing only involves physical infrastructure, it doesn't directly impact network performance. Operators maintain separate active networks and manage their own capacity, quality, and service levels
Examples	Active infrastructure sharing in India has been limited but is increasing, particularly in areas with high demand for 4G/5G services. For example, Jio and Airtel have begun sharing active equipment such as their Radio Access Network (RAN) in certain regions to improve efficiency and reduce costs	In India, companies like Indus Towers and Bharti Infratel operate as independent tower companies, offering passive infrastructure sharing services. These companies build and maintain towers, shelters, power systems, etc., which are then shared by multiple telecom operators like Airtel, Vodafone Idea, and Reliance Jio.

Passive Infrastructure Sharing is the simpler and more widely implemented model in India, offering cost savings and faster deployment. It allows operators to share physical assets like towers and buildings, which helps them expand their reach without the need for large capital investments while Active Infrastructure Sharing is a more advanced and complex model, providing deeper integration of networks and potentially greater cost savings. However, it also raises concerns regarding data privacy, network management, and operational challenges, making it less common than passive sharing, though it's gaining traction as networks evolve to 4G and 5G.

3.4 Optic Fibre Sector in India

3.4.1 Overview

The Indian optic fibre sector is a critical part of India's telecommunication and data transmission infrastructure. With the increasing digitization across industries and the proliferation of high-speed internet, there is a growing demand for reliable and high-capacity fibre optic cables in the country. The optic fibre ensures seamless data transfer and supports advanced communication networks.

Fibre is a fast-growing infrastructure asset class. Fibre demand in India is increasing at a rapid pace. Deployment of a large amount of high-frequency 4G and 5G spectrum needs a fibre backhaul. Whereas government initiatives such as BharatNet's and Digital India's focus on telecom infrastructure, especially fibre, is also contributing to increased fibre deployment.

Additionally, telcos' ambition of increasing FTTH/B penetration for residences, buildings, and enterprise customers is expected to boost the demand for fibre layouts. Towercos are well-positioned to address the fibre opportunity, with their existing experience of managing distributed infrastructure assets. Certain use cases that have tower at the central piece of network architecture, are already gaining traction. On the forefront is site fiberization, as it enhances backhaul and increases the valuation of the core tower assets, giving towercos increased control.

As per the report by GSMA and ABI, while optical fibre will play an important role, microwave backhaul will account for the majority of global backhaul links from 2021 to 2027, with around 65% market share.

Table 7: Comparison of Various Means of Backhaul Technologies

Segment	Microwave (7–40 GHz)	V-Band (60 GHz)	E-Band (70/ 80 GHz)	Fibre-Optic	Copper (Bonded)	Satellite
Future-Proof Available Bandwidth	Medium	High	High	High	Very Low	Low
Deployment Cost	Low	Low	Low	Medium	Medium/ High	High
Suitability for Heterogeneous Networks	Outdoor Cell-Site/Access Network	Outdoor Cell-Site/Access Network	Outdoor Cell-Site/Access Network	Outdoor Cell-Site/ Access Network	Indoor Access Network	Rural only
Interference Immunity	Medium	High	High	Very High	Very High	Medium
Range (Km)	5~30, ++	1~	~3	<80	<15	Unlimited
Time to Deploy	Weeks	Days	Days	Months	Months	Months

Source: TRAI

3.4.2 Type of EPC Services provided to Telecom Sector (Optic Fibre Cable)

EPC (Engineering, Procurement, and Construction) services for telecom optic fiber cable projects involve the end-to-end process of planning, designing, supplying, installing, and commissioning the fiber optic infrastructure. These services ensure the efficient and effective deployment of optical fiber networks, which are used for high-speed communication systems. Below are the key types of EPC services typically provided for optical fiber cable projects:

Design and Engineering Services

- **Site Surveys and Assessments**: Conducting feasibility studies and site surveys to assess the optimal routes, environmental factors, and any technical challenges for installing the fiber optic cables.

- **Network Design**: Detailed planning of the optical fiber network, including the topology, routing, fiber cable specifications, and integration with existing infrastructure. This can include both underground and aerial installations.
- **System Design**: Designing the overall network architecture, including the placement of fiber cables, splicing points, junctions, distribution systems, and equipment.
- **Network Optimization**: Ensuring the design minimizes signal loss and interference and provides the necessary bandwidth capacity for future growth.

Procurement Services

- **Sourcing Materials**: Procuring fiber optic cables, connectors, splice trays, fiber distribution frames, and other required equipment.
- **Equipment Procurement**: Sourcing active components such as optical switches, amplifiers, routers, and other hardware needed for the fiber optic network.
- **Vendor Management**: Selecting and managing suppliers for quality materials and equipment while maintaining cost efficiency.

Installation and Construction Services

- **Cable Laying and Installation**: Physical laying of fiber optic cables, either through underground trenches, ducts, aerial poles, or within buildings. This involves handling and securing the cables to ensure minimal signal degradation and protection from environmental factors.
- **Civil Works**: Conducting necessary civil works like digging trenches, constructing cable ducts, or mounting poles for aerial installations.
- **Splicing and Termination**: Fiber optic cable splicing (fusion splicing) and termination, where individual fibers are connected and made ready for data transmission.
- **Testing and Commissioning**: Performing initial tests to ensure the fiber optic cables meet the required standards (e.g., OTDR testing) and then commissioning the system for operational use.

Integration and Commissioning Services

- **System Integration**: Integrating fiber optic cables with existing communication networks, including network switches, routers, and transmission equipment.
- **Commissioning of Equipment**: Ensuring the active and passive equipment works seamlessly together, including power systems, signal amplifiers, and management systems.
- **Performance Testing**: Running tests like Bit Error Rate (BER), signal attenuation, and throughput to ensure the fiber optic system works at peak performance.

Project Management and Documentation

- **Project Planning and Scheduling**: Creating timelines, managing resources, and ensuring that the project stays on schedule and within budget.
- **Documentation**: Providing as-built drawings, installation manuals, test results, and operational documentation for future reference and maintenance.
- **Compliance and Approvals**: Ensuring all installations comply with industry standards, regulations, and client specifications, and obtaining necessary permits.

Post-Construction and Maintenance Services

- **Testing and Quality Assurance**: Post-installation testing to verify the quality of the network, including signal strength, attenuation, and data throughput.
- **Maintenance and Support**: Providing long-term support services such as routine inspection, troubleshooting, network upgrades, and fiber replacements.
- **Network Monitoring**: Offering monitoring services to detect faults, optimize performance, and maintain the integrity of the fiber optic network over time.

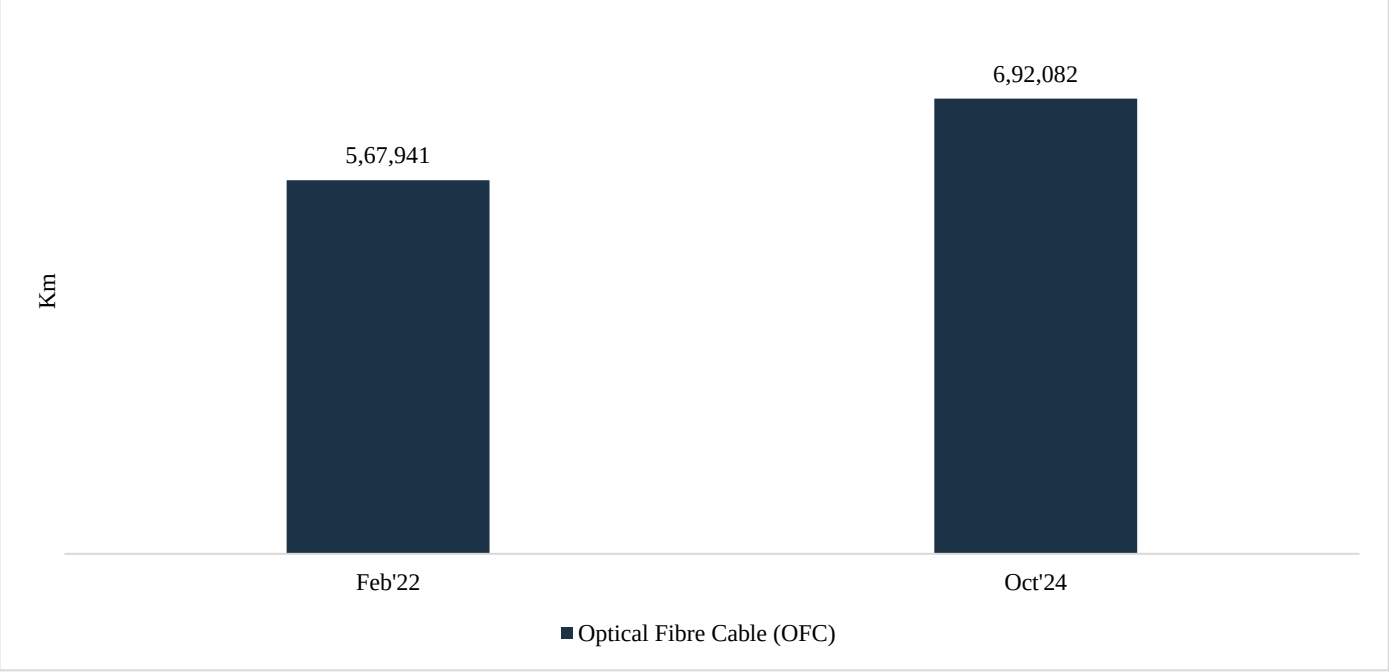
In summary, EPC services for optical fiber cable projects cover everything from the initial design, procurement of materials, installation, to testing and long-term maintenance. The goal is to deliver a fully functional, high-performance fiber optic network tailored to the client's needs.

3.4.3 Historical Growth and Current Scenario

BharatNet, one of the biggest rural telecom projects in the world, implemented in a phased manner to all Gram Panchayats (approximately 2.5 lakh) in the country for providing non-discriminatory access to broadband connectivity to all the telecom service providers with an objective to enable access providers like mobile operators, Internet Service Providers (ISPs), Cable TV operators, content providers to launch various services such as applications like e-health, e-education and e-governance in rural and remote India. The project has been approved by Union Cabinet on 25.10.2011. A Special Purpose Vehicle (SPV) is executing the project namely Bharat Broadband Network Limited (BBNL), which has been incorporated on 25.02.2012 under Indian Companies Act 1956. On 30.04.2016, the Telecom Commission approved to implement the project in three phases

As of January 15, 2025, over 2,10,552 Gram Panchayats (GPs) have been made service-ready under the BharatNet project and as of October 2024 6,92,082 Km of OFC has been laid. Additionally, 11,69,571 Fibre-To-The-Home (FTTH) connections are commissioned and 1,04,574 Wi-Fi hotspots are installed to ensure last-mile connectivity

Chart 28: Optical Fibre Network Connectivity



Source: Ministry of Communications

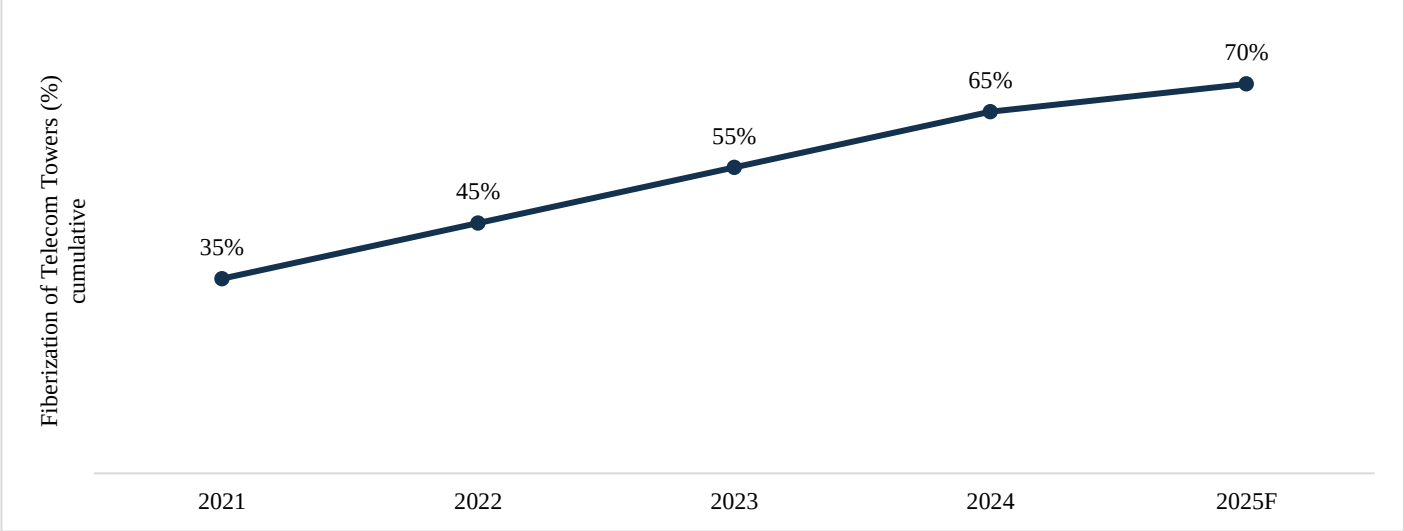
3.4.4 Expected Growth in India's OFC Network

Optical fibre has evolved as the most practical wired solution for backhaul, considering its extraordinary capacity. Owing to its almost limitless capacity and scalability, it is the right choice for high-capacity routes where logistics are manageable, the capacity need is high, and the potential revenue gain offsets the expense. In the coming years, its share in the mobile backhaul network is likely to go up owing to the expected growth in the data traffic and the increasing requirement of backhaul for new technologies such as LTE, LTE Advanced, IMT-2020, etc.

The National Broadband Mission released by DoT in December 2019, envisaged to increase by around two and half times the number of fiberized telecom towers in the country.

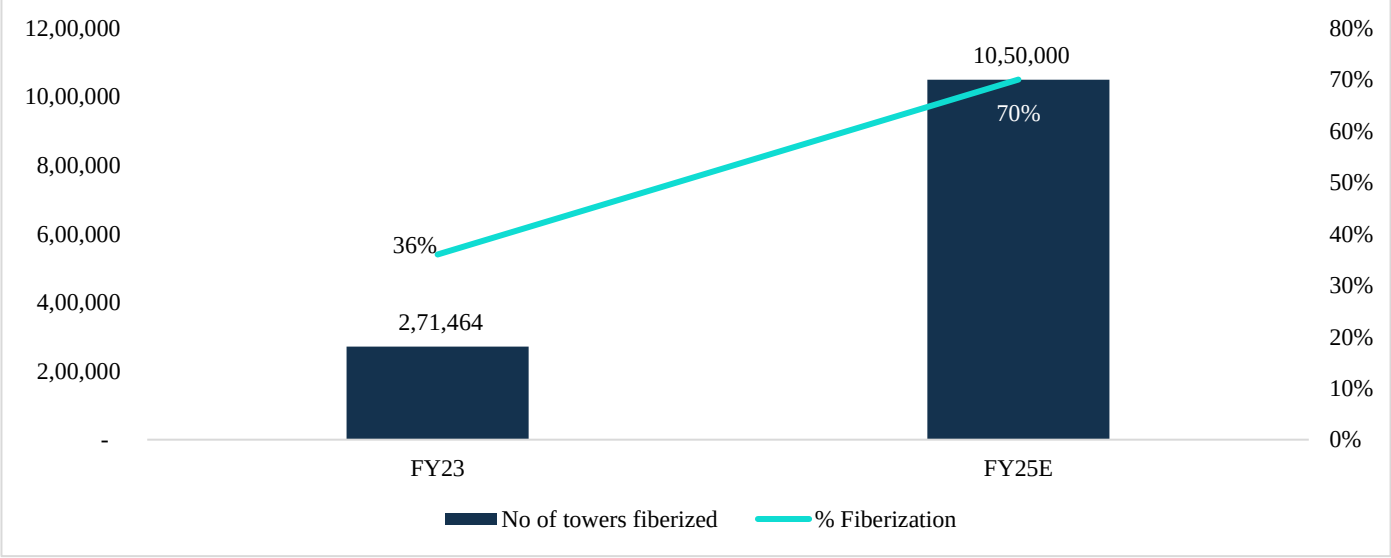
The National Broadband Mission, 2019 has set the 5-year target as below:

Chart 29: Fiberization of Telecom Towers



Source: Consultant Report, TRAI

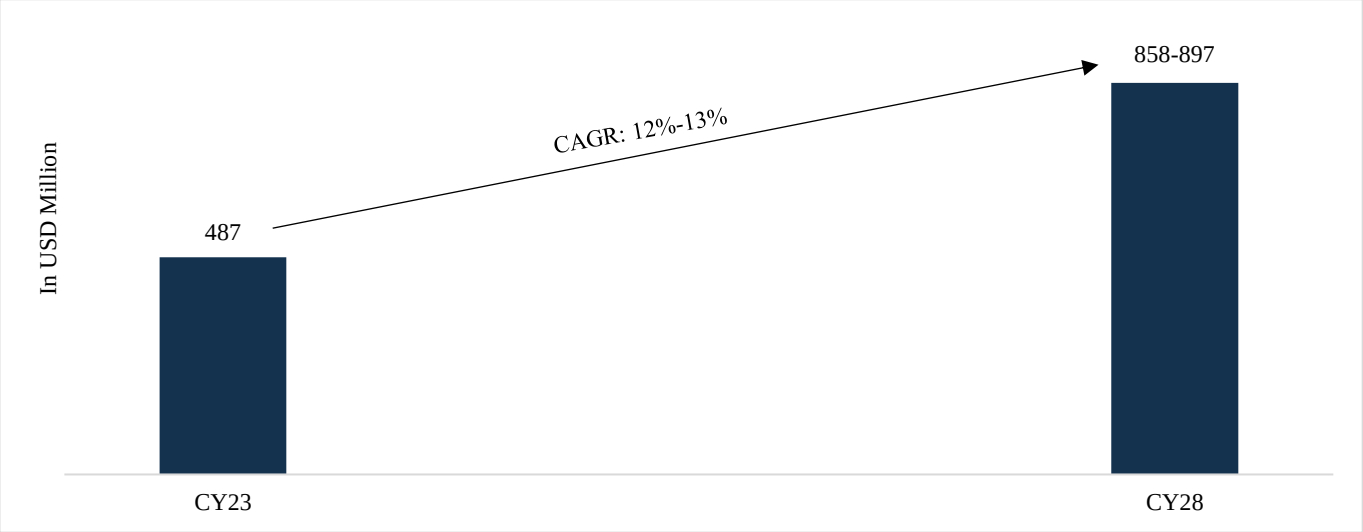
Chart 30: Number of Fiberized towers in India



Source: CareEdge Research

About 3,50,000 towers have been fiberized i.e. 44% of the total tower installed and an estimated 7,95,000 at the end of FY25 i.e. 70% of the total tower installed.

Chart 31: Market Size of Optic Fibre



Source: Technavio; CareEdge Research

India's Optical Fiber Cable (OFC) and accessories market is poised for substantial growth, driven by strategic government initiatives and rising demand for advanced broadband connectivity

3.4.5 End-Users in Fibre Optic Network

Telecommunications:

Telecommunications is one of the primary end-user sectors for optical fibre. Telecom companies use optical fibre networks to transmit vast amounts of data over long distances with high speed and low latency. Optical fibre forms the backbone of modern telecommunications infrastructure, facilitating services such as internet connectivity, voice communication, and video streaming. The telecommunication sector is expected to grow at a CAGR of 8% to 9% in the next three years.

Key uses of optical fibre in the telecommunications industry:

- Long-Distance Communication: Optical fibre is primarily used for long-distance communication due to its low signal attenuation and high bandwidth capabilities. It enables telecommunications providers to transmit voice, data, and video signals over vast distances with minimal signal loss.

- Backbone Networks: Optical fibre forms the backbone of telecommunications networks, including national and international communication networks. It serves as the infrastructure for high-capacity data transmission between central offices, data centres, and network aggregation points.

- High-Speed Internet: Optical fibre is the preferred medium for delivering high-speed internet services to residential, commercial, and industrial customers. Fiber-to-the-Home (FTTH) and Fiber-to-the-Premises (FTTP) deployments enable telecom operators to offer ultra-fast broadband connections with symmetric upload and download speeds.

- Mobile Backhaul: Optical fibre is used for mobile backhaul, connecting cell towers and base stations to the core network. Fibre optic links provide the high bandwidth and low latency required to support the increasing data traffic generated by mobile devices and smartphones.

- Data Center Interconnectivity: Optical fibre connects data centres and facilitates the interconnection of servers, storage systems, and networking equipment. High-speed fibre links enable data replication, backup, and disaster recovery, ensuring seamless operations and data availability.

- Cloud Computing: Optical fibre supports cloud computing services by providing fast and reliable connectivity between cloud data centres and end-users. Fibre-optic links enable the transfer of large volumes of data to and from cloud-based applications, platforms, and services.

- Video Conferencing and Streaming: Optical fibre enables high-quality video conferencing and streaming services by delivering real-time video and audio signals with low latency and high fidelity. Fibre-optic networks support the transmission of high-definition (HD) and ultra-high-definition (UHD) video content for telecommunication applications.

- Voice over IP (VoIP): Optical fibre supports Voice over IP (VoIP) services, allowing telecom operators to deliver voice communications over IP networks. Fibre-optic links provide the reliability and quality of service required for VoIP calls, including voice clarity, call stability, and low latency.

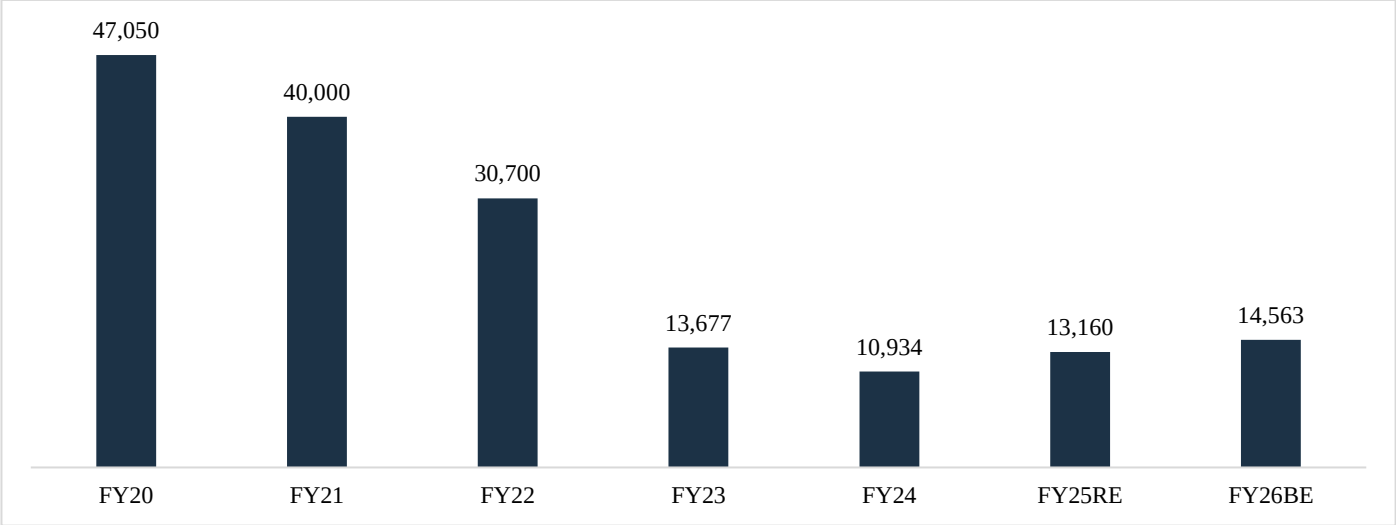
- Network Resilience and Reliability: Optical fibre enhances network resilience and reliability by offering robust performance in challenging environments, including harsh weather conditions and electromagnetic interference. Fibre-optic links are less susceptible to signal degradation and outages compared to traditional copper-based connections.

Government and Defence:

Governments and defence organizations utilize optical fibre for secure & reliable communication networks. Fibre-optic cables are deployed in military installations, government agencies, and critical infrastructure to transmit sensitive data, surveillance feeds, and command signals securely. Optical fibre provides a secure communication infrastructure for government agencies and defence organizations, enabling the transmission of sensitive data, classified information, and mission-critical communications. Additionally, fibre-optic networks offer high levels of security, immunity to electromagnetic interference (EMI), and resistance to eavesdropping. They are deployed for surveillance and intelligence gathering purposes, enabling the transmission of video feeds, sensor data, and reconnaissance information from unmanned aerial vehicles (UAVs), satellites, surveillance cameras, and other monitoring devices to command centres and intelligence agencies.

The has been y-o-y growth in Budget allocation of optic fibre cable used for defence services of about 20.4% in FY25 as compared to FY24 and it is expected to raise the same by 10.7% in FY26.

Chart 32: Optical Fibre Cable-Based Network for Defence Services



Source: Union Budget

Industrial Automation and Manufacturing:

Industrial sectors leverage optical fibre for automation, control, and monitoring applications in manufacturing plants and industrial facilities. Fibre-optic communication enables real-time data exchange between sensors, machinery, and control systems, enhancing efficiency, productivity, and safety in industrial operations.

Further, optical fibre serves as a high-speed communication medium for transmitting data between industrial equipment, sensors, controllers, and supervisory control and data acquisition (SCADA) systems. Fibre-optic networks provide reliable and high-bandwidth connectivity for real-time monitoring, control, and management of manufacturing processes. They form the backbone of industrial Ethernet networks, connecting devices such as programmable logic controllers (PLCs), human-machine interfaces (HMIs), robots, and sensors. Fibre-optic links enable fast and deterministic communication, supporting critical automation tasks and production workflows.

Transportation and Smart Infrastructure:

Transportation systems and smart city initiatives deploy optical fibre networks for traffic management, public safety, and infrastructure monitoring. Fibre-optic cables support intelligent transportation systems (ITS), surveillance cameras, traffic sensors, and smart grid solutions, enabling efficient and sustainable urban development.

Energy and Utilities:
Energy companies and utilities employ optical fibre for monitoring and managing power grids, pipelines, and utility networks. Fibre-optic communication enables remote monitoring of infrastructure, fault detection, and grid optimization, contributing to reliable and resilient energy distribution.

The following uses optic fibre as its main component-

Smart Grid
As per the National Smart Grid Mission (NSGM), Ministry of Power, a smart grid is an electrical grid with automation, communication, and IT systems that can monitor power flows from points of generation to points of consumption (down to appliances level) and control the power flow or curtail the load to match generation in real-time or near real-time. NSGM was established by the Government of India in 2015 to plan and monitor the implementation of policies and programmes related to smart grid activities in India. In addition, the NSGM envisages capacity-building initiatives for distribution sector personnel in the field of smart grids.

Smart grids can be achieved by implementing efficient transmission & distribution systems, system operations, consumer integration, and renewable integration. They help to monitor, measure, and control power flows in real-time, which can contribute to the identification of losses, and thereby, appropriate technical and managerial actions can be taken to arrest the losses.

Furthermore, smart grid solutions can contribute to the reduction of transmission & distribution losses, peak load management, improved quality of service, increased reliability, better asset management, renewable integration, better accessibility to electricity, etc., and enable self-healing grids.

Moreover, the primary aim of the smart grids is to improve the reliability of the electricity networks and make the grid amenable to renewable energy inputs through distributed generation. Further, increased efficiencies with smart grids and smart meters empower consumers to manage their electricity consumption in a better manner and help them reduce their bills.

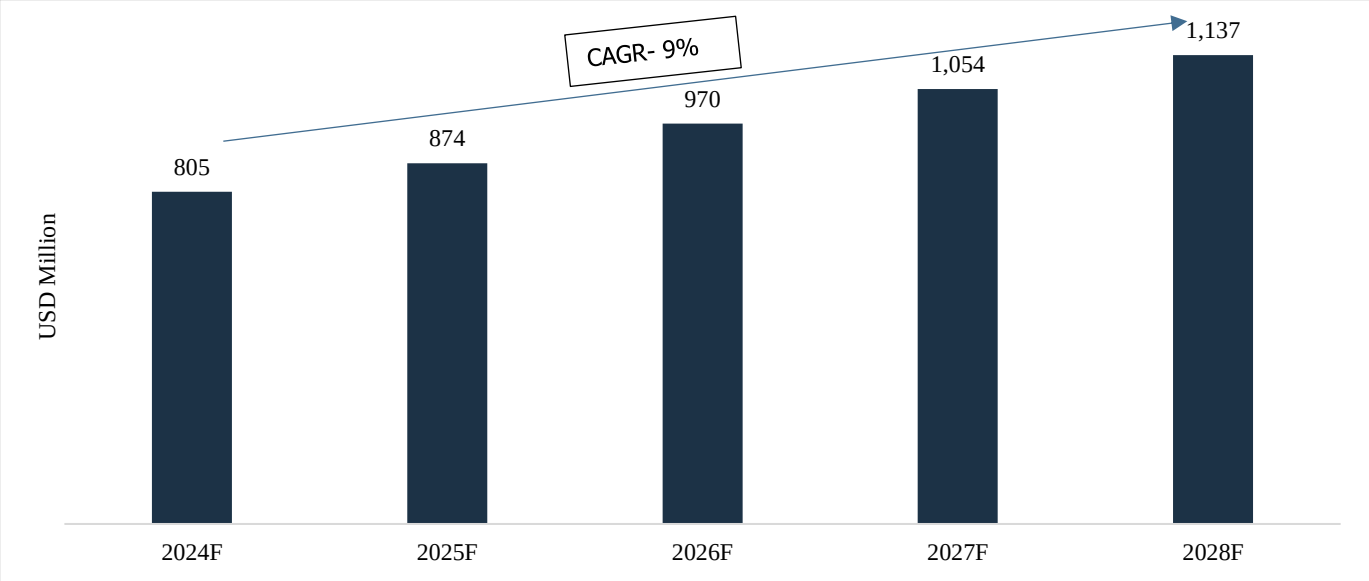
Smart Meters
Smart meters are digital meters like conventional meters. They record data on energy consumption. Also, they can transmit the energy consumption data to utilities at specific intervals, which permits more frequent monitoring of consumption alongside assisting in reducing T&D losses.

Further, smart meters are being installed under various government schemes including NSGM and Integrated Power Development Scheme (IPDS) wherein the government is providing funding to the states for implementing smart metering projects launched by DISCOMs.

For instance, Energy Efficiency Services Limited (EESL) is implementing projects launched by various DISCOMs in Uttar Pradesh, Haryana, Bihar, Rajasthan, Andaman & Nicobar Islands, Delhi, etc., wherein EESL is infusing the initial capital expenditure and DISCOMs are paying back to EESL on monthly rental basis.

High-Voltage Transmission Lines
Fibre optics are deployed along high-voltage transmission lines to provide communication capabilities for remote monitoring and diagnostics. Fibre-optic cables are installed on transmission towers or bundled with overhead conductors, allowing utilities to monitor line conditions, detect faults, and perform predictive maintenance activities. The High Voltage Transmission Line market size is expected to grow at a CAGR of 9% from the year 2024 to 2028.

Chart 33: Market Size of High Voltage Transmission Lines in India



Source: Maia Research, CareEdge Research

3.4.6 Key Factors governing the growth of telecom OFC network in India

Over the past few years, OFC has emerged as a core component for supporting India's fledgling digital ecosystem. OFC rollouts are increasing in India having an OFC footprint of around 6,92,082 Kms as of October 2024. These rollouts have been driven largely by the government's push to increase internet penetration across the country through its projects like Digital India, BharatNet, Smart Cities Mission, National Broadband Mission as well as through telcos growing focus on site fiberization and fiberizing the last mile. Some of the key growth factors for telecom OFC are:

BharatNet Phase III

BharatNet project is being implemented by BBNL (Bharat Broadband Network) for connecting approximately 2.6 lakh Gram Panchayats of the country for providing broadband access to rural India. Under BharatNet, the connectivity is being provided, primarily by laying of Optical Fibre Cable (OFC), in the middle mile between Block and the Gram Panchayats.

BharatNet Phase III is a critical extension of the BharatNet project, which aims to provide high-speed broadband connectivity to rural and remote areas across India. The primary goal is to enhance digital access, foster economic growth, and bridge the digital divide.

NHAI Demand for Optical Fiber Cables

NHAI is working towards development of around 10,000 km of Optic Fibre Cables (OFC) infrastructure across the country by FY24-25. National Highways Logistics Management Limited (NHLML), a fully owned SPV of NHAI, will implement the network of Digital Highways by developing integrated utility corridors along the National Highways to develop OFC infrastructure. Around 1,367 km on Delhi - Mumbai Expressway and 512 km on Hyderabad - Bangalore Corridor have been identified as pilot routes for the Digital Highway development.

Providing internet connectivity to remote locations across the country, the OFC network will help to expedite the roll out of new age telecom technologies like 5G & 6G. Recently inaugurated, 246 km long Delhi – Dausa – Lalsot section of the Delhi - Mumbai Expressway features a three-meter-wide dedicated utility corridor used to lay Optical Fibre Cables, which will serve as the backbone for the roll out of the 5G network in the region. OFC laying work along the National Highways has started and is targeted for completion in about a year.

Increasing Demand for High-Speed Internet

The increasing use of smartphones, OTT platforms, digital services, and cloud computing has caused a surge in data consumption, driving the need for faster, more reliable internet connectivity

The growth of 5G technology in India is significantly boosting the optic fiber market. As 5G networks expand, they require extensive fiber optic infrastructure to support the high-speed, high-capacity, and low-latency demands of 5G applications. Currently, only a few number telecom towers in India are connected with fiber, which needs to increase for full 5G capabilities. The deployment of 5G and fiber optics is also expected to improve connectivity in rural areas, providing essential services and boosting economic development. The synergy between 5G technology and the optic fiber market in India is creating a robust foundation for future technological advancements. This growth is driven by the need for high-speed internet and advanced applications like autonomous vehicles and remote healthcare. Overall, 5G is a key driver for the optic fiber market's expansion.

The rise of smart cities and the Internet of Things (IoT) technologies also fuel the demand for faster, stable, and high-capacity data transmission networks, which can be efficiently provided by optical fiber infrastructure

Private Sector Investment and Competition

Leading telecom companies in India, including Reliance Jio, Bharti Airtel, and Vodafone Idea, are heavily investing in optical fiber networks to meet the growing demand for high-speed data and stay competitive in the market. However, Telecom companies often collaborate on sharing optical fiber infrastructure, which reduces capital expenditure and accelerates the rollout of fiber networks across the country.

Furthermore, these operators are replacing outdated copper networks with optical fiber networks to improve speed, reliability, and service delivery. This modernization aligns with the global trend toward fiber-first approaches for broadband infrastructure

3.5 Recent EPC Projects

In FY24 Telecom Services sector saw the awarding of 11 new contracts with a cumulative value of Rs 19,899 crore. Bharat Sanchar Nigam (BSNL), a major player in the sector, awarded two significant contracts:

- Tata Consultancy Services (TCS) bagged a mega contract worth Rs 15,000 crore for the deployment of 4G networks across India. As a part of the contract terms, Tejas Networks will supply the radio access network (RAN) equipment.
- ITI bagged a contract worth Rs 3,889 crore for network expansion under the reservation quota (RQ) Order. The scope of work involves the supply, installation, commissioning, and AMC for a 4G mobile network, which would be deployed across 23,633 sites in the West Zone of the BSNL network

3.6 Government Policies and Initiatives

1. Statutory Body in the Telecom Sector

Telecom Regulatory Authority of India (TRAI) is the statutory body for the Indian telecom sector. Since the sector is highly regulated, TRAI as a sector regulator plays a pivotal role in development, broadcasting and cable services.

The Telecom Regulatory Authority of India (TRAI) Act, 1997 provides for the establishment of TRAI and the Telecom Disputes Settlement and Appellate Tribunal (TDSAT) to regulate telecommunication services, adjudicate disputes, dispose of appeals and protect the interest of service providers and consumers in the sector.

2. National Broadband Mission 2.0 (NBM)

The National Broadband Mission 2.0 (NBM 2.0) is a strategic initiative launched by the Government of India on January 17, 2025, to expand high-speed broadband connectivity across the country, particularly focusing on underserved rural areas. Building upon the foundation laid by NBM 1.0 (2019–2024), NBM 2.0 aims to propel India into a new era of digital transformation and global competitiveness

he primary objective of NBM 2.0 is to connect the remaining 1.7 lakh villages across the country and to achieve ambitious milestones. The goal is to ensure that at least 60 out of every 100 rural households have access to broadband connectivity. Additionally, its aim to achieve a minimum fixed broadband download speed of 100 Mbps, creating a robust digital infrastructure for rural India. Building on the success of NBM 1.0 (2019-2024), following will be the key benefits of NBM 2.0:

- Extending operational optical fiber cable (OFC) connectivity to 2.70 lakh villages by 2030 with 95% uptime from ~50,000 as of now.
- To provide broadband connectivity to 90% of anchor institutions like Schools, PHCs, Anganwadi Centre, and Panchayat offices by 2030.
- Improve the Fixed broadband download Speeds- National Average from 63.55 Mbps in November 2024 to a minimum 100 Mbps by 2030.
- To achieve 100% mapping of fiber networks owned by government PSUs by 2026on PM GatiShakti National Masterplan Platform (PMGS) and use PMGS for planning of Additional Bharatnet project.
- For Ease of Doing Business - reduce the Right of Way application average disposal time from 60 days (now)to 30 days by 2030. In 2019 it was 449 days.
- Increase the number of rural internet subscribers per 100 population from the current 45 to 60 by 2030.
- Achieve the target of powering 30% of mobile towers with sustainable energy by 2030.
- Work on enhancing the usage of the 'Call Before u Dig' (CBuD) mobile app to protect underground Telecom infrastructure and other utilities. Hon'ble PM had launched it in March 2023.
- Collaborate with all stakeholders viz. Central Ministries and departments, States, UTs and municipalities to ensure the effective implementation of the New RoW Rules 2024, issued under the Telecommunications Act, 2023.
- To facilitate rollout of the 5G network, in nook and corner of the country and for futuristic networks of 6G, work to create a robust, ready to use street furniture infrastructure across the country.
- To work with all stakeholders for Common/Shareable telecom ducts and utility corridors in all linear projects to improve the maintenance and cost efficiency of telecom networks and other utilities.

3. BharatNet

The BharatNet Project is a landmark initiative by the Indian government designed to bring high-speed broadband connectivity to rural India. Originally approved by the Union Cabinet on October 25, 2011, as the National Optical Fibre Network (NOFN), the project was rebranded as BharatNet in 2015. Its primary aim is to link all Gram Panchayats (GPs) by connecting block headquarters to these GPs using optical fiber, thus ensuring that broadband access is available to all on a non-discriminatory basis.

BharatNet is crucial in enabling the delivery of digital services such as e-health, e-education, and e-governance in rural and remote areas. To ensure widespread accessibility, the project provides last mile connectivity through public Wi-Fi or other suitable broadband technologies, including FTTH at government institutions like schools, hospitals, post offices, police stations etc.

Some of the key achievements under BharaNet initiative are as follow:

• Connectivity to Villages

The government has accorded approval to connect 354 villages in border areas of Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttar Pradesh, Bihar, Rajasthan, Gujarat, Uttarakhand, Karnataka and West Bengal.

As of May 2024, out of the 354 uncovered villages, 288 have been provided coverage by the installation of 266 mobile towers. An additional 55 villages have also been approved under the scheme out of which 26 have been covered.

• 4 G-Based Mobile Service in 502 Uncovered Villages under Aspirational District Scheme

States of Uttar Pradesh, Bihar, Madhya Pradesh and Rajasthan having 502 uncovered villages have been planned for provisioning of 4 G-based mobile services under this scheme. As of May 2024, 209 villages have been covered by installing 174 mobile towers.

• **Comprehensive Telecom Development Plan (CTDP) for North-Eastern Region**

Under this scheme, the government is implementing mobile connectivity on 2G for uncovered villages along National Highways of Assam, Manipur, Mizoram, Nagaland, Tripura, Sikkim and Arunachal Pradesh by setting up towers. The scope was to cover 1,481 uncovered villages by installing 1,094 towers.

As of May 2024, 566 towers have been installed covering 963 villages. Another project for provision of 4G mobile services in 2,374 uncovered villages in Arunachal Pradesh and 2 districts of Assam was approved. In Arunachal Pradesh, 344 towers have been commissioned covering 660 villages, while in Assam, 222 sites have been commissioned covering 303 villages.

• **Provisioning of 4G Mobile Services in 85 Uncovered Villages and Seamless Mobile Coverage along NH-4 in Andaman and Nicobar Islands**

Agreement for setting up 82 towers to provide mobile services on 4G technology in 85 uncovered villages and 42 towers for providing 4G mobile services to bridge the gaps in mobile connectivity along uncovered National Highways. As of April 2023, 105 tower sites have been approved as against 124 tower sites.

• **Access Points Deployed Under PM-WANI**

The framework of the Prime Minister's Wi-Fi Access Network Interface (PM-WANI) was approved in December 2020 to proliferate broadband through Public Wi-Fi Networks. As of May 2024, a total number of 1,99,912 hotspots have been installed.

BharatNet Project phases are below:

Phase	Government Plan	Status
I	Targeted the connection of 100,000 Gram Panchayats using the existing fibre of Central Public Sector Undertakings (CPSUs) such as BSNL, RailTel and Power Grid and laying incremental fibre to bridge the connectivity gap up to the GPs. The government owns the incremental Optical Fibre Cable and the ownership of the existing fibre vested with the current ownership of respective CPSU's	Completed
II	Aimed to extend the network to an additional 150,000 Gram Panchayats, further expanding its reach to more remote regions using multiple implementing models like State- led Model, Private Sector Model and CPSU Model, along with last mile connectivity in GPs through Wi-Fi or any other suitable broadband technology. Certain States like Chhattisgarh, Gujarat, Jharkhand, Andhra Pradesh, Maharashtra, Odisha and Telangana have opted for state led model under which centre provided them a fixed amount for implementation whereas states like Madhya Pradesh, Uttar Pradesh and Sikkim were CPSU led model, which is in the hands of BSNL	In Progress
III	BharatNet is expected to progress into its third phase, often referred to as BharatNet Phase III. This phase is anticipated to focus on expanding and strengthening the existing network infrastructure established in Phases I and II. In BharatNet Phase III, the GPs are to be connected on ring network of 8 to 10 GP's in IP- MPLS network. For this, the government on August 4. 2023 has approved Rs 1.39 lakh crore. The project implementation agency is required to connect all GPs in a ring topology with IP-MPLS aggregation/ access routers with each ring having 8 to 10 GPs. Wherever, the OFC in the existing made- over network is damaged, the PIA will be paid replacement charges at the predefined rates in the bid as per PO for which a separate work order will be issued by BSNL	In Progress

Introduction of BharatNet Phase III

There are three phases of BharatNet project. The third and the latest phase of the BharatNet project is BharatNet Phase III which has an outlay of Rs 65,000 crore. This phase prioritizes last-mile connectivity to rural areas through innovative solutions, leveraging public-private partnerships (PPP) and advanced technologies. It consists of 16 packages spread across all states and union territories.

BSNL invited tenders for designing, supplying, constructing, installing, upgrading, operating, and maintaining the middle-mile network of BharatNet Phase-3 under a Design Build Operate and Maintain (DBOM) model.

Key Features of BharatNet Phase III

- **Focus on Last-Mile Connectivity**: Phase III targets 6.25 lakh villages with solutions like Wi-Fi hotspots (2-5 per gram panchayat) and fiber-to-the-home (FTTH) services, delivering high-speed internet of 100 Mbps or more.
- **Innovative Network Structure**: A ring topology is being implemented to prevent network disruptions caused by single points of failure, addressing issues faced in previous phases.
- **Three-Tier Project Structure:**
  - **BSNL** will provide internet-leased line bandwidth.
  - **Private Players** will manage middle-mile connectivity with operation and maintenance responsibilities for 10 years.
  - **Udyami Model**: Local village entrepreneurs (Udyamis) will handle last-mile delivery to end users in collaboration with BSNL.
- **Job Creation:** The project is expected to create approximately 25,000 direct and indirect jobs over the next 2-3 years, contributing to local employment and skill development.

Recent projects under BharatNet Phase III

In November 2024, ITI Limited emerged as the lowest bidder for three packages of the BharatNet Phase 3 Project, with a cumulative order value of Rs 4,559 crore. The packages include states such as Arunachal Pradesh, Nagaland, Manipur, Himachal Pradesh, West Bengal, and the Andaman and Nicobar Islands.

Additionally, HFCL Limited and its consortium partners in November 2024 secured contracts worth over Rs 6,925 crore for middle-mile network infrastructure in Uttar Pradesh. It HFCL also secured another BSNL contract for the BharatNet Phase-3 project in Punjab, with a bid of Rs 1,244 crore and a subsequent 10-year O&M contract worth approximately Rs 746 crore.

4. Bharat 6G Alliance

Under this scheme, the Government of India is to facilitate next-generation 6G research and innovation in India to be able to contribute front-line in 6G technology and manufacturing by 2030. The Department of Telecommunications constituted a Technology Innovation Group on 6G (TIG-6G) in November 2021 with members from Ministries, research and development institutions, academia, standardization bodies, Telecom Service Providers and industry to develop Vision, Mission and Goals for the 6G and also develop a roadmap and action plans for 6G in India.

The TIG-6G in turn constituted six Task Forces with industry, academia, R&D institutions and Government as members of Multi-Disciplinary Innovative Solutions, Multiplatform Next Generation Networks, Spectrum for Next Generation Requirements, Devices, International Standards Contribution and Funding Research and Development.

An Apex Council is constituted to lay down the Phase-wise objectives of the Bharat 6G Mission and consult the Bharat 6G Alliance.

The Mission will be completed in two phases:

- Phase 1 from 2023-2025 (2 years)
- Phase 2 from 2025-2030 (5 years)

5. Digital Communications Commission

The policy was set up by the government of India on 11th April 1989 to deal with various aspects of telecommunications. The policy was redesigned as the 'Digital Communications Commission' from the 'Telecom Commission' on 22nd Oct 2018.

The Digital Communications Commission is responsible for:

- Formulating the policy of the Department of Telecommunications for approval of the Government;
- Preparing the budget for the Department of Telecommunications for each financial year and getting it approved by the Government; &
- Implementation of Government's policy in all matters concerning telecommunication.

3.6.1 Reforms

There are various telephone reforms that shaped the current telecom sector. Details of the same are as follows:

1. Indian Telegraph Right of Way (Amendment) Rules, 2022

To enable the speedy rollout of 5G, the Indian Telegraph Right of Way (Amendment) Rules, 2022 were introduced which facilitate faster and easier deployment of telegraph infrastructure. The amended rules contain provisions for the usage of street furniture for the installation of small cells and telegraph lines. The fees and charges are also rationalized for seeking Right of Way (RoW) permissions by Telecom Service Providers (TSPs) and Infrastructure Providers (IP) to bring uniformity across the country.

2. Wireless Planning and Coordination (WPC) Rules

The government has brought procedural reforms to wireless licensing. These include the delicensing of various frequency bands to promote innovation, manufacturing and export, as under:

- Spectrum in 865-868 MHz band delicensed for facilitating IoT and M2M, RFID etc. applications.
- 9 KHz to 30 MHz band delicensed for contactless Inductive Charging etc.
- 433-434.79 MHz band delicensed for various Short-Range Devices (SRD) applications.

The government has also released National Frequency Allocation Plan 2022 giving guidance to the users of the spectrum to plan their network in accordance with relevant frequency and parameters.

3. PM GatiShakti National Master Plan Platform for 5G rollout

The telecom assets are being mapped on PM GatiShakti National Master Plan Platform. Around 10 lakh Rkm of optical fibre cable (OFC) laid by PSUs i.e. BSNL, BBNL, RailTel, GAIL, PowerGrid has been mapped and around 23 lakh Base Transceiver Stations (BTS) of all Telecom Service Providers (TSPs) have been mapped with details like fiberized and non-fiberized etc.

The tool developed by Bhaskaracharya National Institute for Space Applications and Geoinformatics (BISAG) on PM GatiShakti National Master Plan calculates the required length and route of the nearest OFC to a particular fiberized tower. Street furniture like the electricity poles, bus shelters, traffic lights, etc. laid by the state government are being progressively mapped. The DoT NMP platform is being integrated with the State NMP platforms so that various assets of the state are visible on the NMP DoT platform.

4. Design-Led Manufacturing Under Telecom PLI Scheme-

The scheme is based on the Production Linked Incentive Scheme under Atma Nirbhar Bharat Abhiyan with an aim of boosting domestic manufacturing and exports in the target segments of telecom and networking products to encourage Make in India. The Production Linked Incentive Scheme for Telecom and Networking Products was approved in February 2021 with an outlay of Rs. 12,195 crores for a period of 5 years. There is a 4-7% incentive on the sale of specified products under the scheme. The support under the Scheme is to be provided for a period of five (5) years, i.e. from FY 2021-22 to FY 2025-26.

Union Budget 2022-23 announced design-led manufacturing for 5G products to facilitate design-led manufacturing of 5G products under the PLI scheme for telecom and network products. It provides additional incentives of 1% over the existing incentives for products that are designed and manufactured in India. A total of 42 companies including 28 MSMEs have been approved by the Department of Telecommunications, out of which 17 companies are approved for the additional incentive of 1% under design-led manufacturing criteria.

The various other initiatives are as follows:

1. Telecom Technology Development Fund (TTDF) Scheme-

TTDF Scheme aims to fund R&D in rural-specific communication technology applications and form synergies among academia, startups, research institutes, and the industry for building and developing the telecom ecosystem. IT will also help in creating the ecosystem for research, design, prototyping, use cases, pilots, proof of concept testing, etc. The scheme entails grants to Indian entities to encourage and induct indigenous technologies tailor-made to meet domestic needs.

2. Revival Plan of MTNL and BSNL-

In its meeting held on 27.07.2022, the Union Cabinet approved the revival plan of MTNL and BSNL. The highlights of the same are as follows:

- Raising Rs. 17,571 crores through sovereign guarantee bonds by MTNL for a term of 10 years or more with a waiver of guarantee fee for repaying the high-cost debt and restructuring it with a new substantial loan. The principal/interest will be repaid by MTNL through the proceeds of the rental/sale of land assets.
- All telecom services in Delhi and Mumbai will be provided by BSNL through the leasing of operational assets or any other appropriate model. After BSNL takes over the operation of MTNL in Delhi and Mumbai, the remaining assets with MTNL would continue to monetize to discharge its loan liabilities.
- The government will provide budgetary support of Rs. 1,600 crores for restructuring and operational integration of Telecom PSUs as a one-time grand for the unsustainable debt of MTNL.
- Sanction of capex of RS. 22,471 crores as equity infusion in BSNL in FY23 and FY24. It includes the project requirement of MTNL of RS. 1,851 crores in Delhi/Mumbai.

3. Champion Service Sector Scheme (CSSS)-

The Champion Service Sector Scheme is a central sector scheme of the Department of Commerce. It is an umbrella scheme with 2 sub-schemes of DoT.

Table 8: Details of sub-schemes in CSSS

Sub-Scheme under CSSS	Proposal Approver (2022-23)	Amount Approved
Brand Building of India as Telecom Manufacturing and Services Destination	Proposal for participation in 6 events/ exhibitions	Rs. 11.92 Cr
Digital Communication Innovation Square (DCIS)	Proposal for funding of 43 startups/ MSMEs/ consortiums	Rs. 51.56 Cr

Source: PIB

4. Transition to the Next Generation of Internet Protocol-

The DoT has been working with ISPs, equipment manufacturers, data centre providers, states, UTs, central ministries, and departments for a smooth transition to Internet Protocol version 6 (IPv6). As a result, most of the stakeholders are ready to handle IPv6 traffic and offer IPv6 services. With an IPv6 capability ratio of 79.23%, India ranks 2nd out of 240 countries as per the latest information of the Asia Pacific Network Information Centre (APNIC).

5. Establishment of Digital Intelligence Unit (DIU)-

The DIU was created with an objective of strengthening the trust in digital ecosystem and mitigating frauds involving telecom resources. DIU has been conceptualized for the implementation of Big Data Analytics and Artificial Intelligence-based solutions to generate intelligence for uncovering telecom-related frauds in India.

6. Development of Online License Management System of DoT-

For issuing various types of licenses and registration certificates, a web-based portal 'SARAL SANCHAR' (Simplified Application for Registration and Licenses) has been developed by the Department of Telecommunications. SaralSanchar portal has also integrated with the National Single Window System (NSWS), BharatKosh, MCA-21 and NIC e-office to enable smooth filing, payment and processing of applications.

7. Launch of Bharat Digicom Innovation Portal-

Bharat Digicom Portal has been launched to promote the ecosystem of digital communication technologies and applications in India which is being developed by DoT along with TCoE (Telecom Centre of Excellence). It is a single-point engagement platform for all stakeholders.

3.7 Key Threats and Challenges in Telecom optical Fibre cable (OFC) infrastructure

Telecom optical fiber cable (OFC) infrastructure in India plays a crucial role in ensuring high-speed internet connectivity, supporting mobile networks, and enabling other critical digital services. However, the development, maintenance, and expansion of this infrastructure face several threats and challenges. Below are some of the key issues:

Infrastructure Development Challenges

- **Geographical and Environmental Factors:**
  - **Rural and Remote Areas:** Optical fiber cable deployment in rural and remote areas is often hindered by difficult terrain, inadequate road networks, and high costs of infrastructure setup. These areas require significant investment and planning to ensure connectivity.
  - **Weather Conditions:** Adverse weather conditions, such as heavy rains, flooding, or extreme temperatures, can damage underground or overhead fiber cables, leading to frequent maintenance requirements and service interruptions.
- **Right of Way (RoW) Issues:**
  - Acquiring permission to lay fiber cables across public or private land can be time-consuming, bureaucratically complex, and expensive due to RoW permissions, especially in urban areas where infrastructure is congested.
  - Disputes with landowners or local authorities can delay projects, leading to increased costs and extended deployment timelines.

Security Threats

- **Vandalism and Theft:**
  - Fiber optic cables are often subject to theft, particularly in regions with less security or during the process of cable laying. The cables can be cut or stolen for resale of the copper inside or other materials.
  - **Vandalism:** In some areas, cables are damaged intentionally due to social or political unrest, affecting telecom services.
- **Cybersecurity Threats:**
  - **Hacking and Data Interception:** Fiber optic networks can be targets for cybercriminals who may attempt to intercept data transmission or compromise network security.
  - **Sabotage:** With telecom networks critical for government, military, and business operations, there is a growing concern about the deliberate sabotage of fiber optic infrastructure for strategic or malicious purposes.

Financial and Economic Challenges

- **High Initial Investment:**
  - The capital expenditure required for laying fiber optic cables is considerable. This includes costs for materials, equipment, manpower, and digging trenches, especially for underground cables. Small and medium-sized telecom operators may struggle to fund such large projects.
- **Cost of Maintenance:**
  - Ongoing maintenance of optical fiber infrastructure (e.g., repairing broken cables, upgrading old infrastructure) incurs significant costs, which are often not accounted for in initial budgets.
- **Regulatory and Policy Issues:**
  - The regulatory framework around telecom infrastructure, including price caps and service agreements, may sometimes limit the ability of operators to charge adequately for services, affecting profitability and investment in infrastructure expansion.
  - Delays in policy approvals and changes in regulations can impact the pace of network rollout.

Competition and Market Fragmentation

- **Fragmented Market:**
  - India's telecom market is highly competitive, with numerous operators and service providers, many of which are involved in building or renting fiber infrastructure. This fragmentation can lead to inefficiencies in planning, deployment, and resource allocation.
- **Infrastructure Sharing:**
  - While there are initiatives for infrastructure sharing among telecom providers, there are still some bottlenecks due to reluctance to share fiber infrastructure or competition-driven resistance to collaborative efforts.

Technological and Capacity Issues

- **Scalability and Upgrades:**
  - As demand for higher bandwidth continues to increase, operators must constantly upgrade their fiber networks to accommodate faster data speeds. This can lead to significant investment needs for infrastructure upgrades, including the laying of additional fiber or implementing newer, more efficient technologies.
- **Technology Obsolescence:**
  - As new fiber technologies emerge (e.g., advanced DWDM - Dense Wavelength Division Multiplexing), there is a need for continuous technological upgrades. Some telecom companies may face challenges in keeping up with new technology due to budget constraints or the complexity of the upgrade process.

Social and Political Challenges

- **Political Instability and Strikes:**
  - Political instability or local strikes can impede the progress of laying fiber infrastructure. These disruptions may delay timelines, affect labor availability, or result in damage to the installed network.
- **Local Opposition to Infrastructure Projects:**
  - Communities may resist the construction of telecom infrastructure due to concerns about environmental impact, safety, or loss of land access. Local political resistance can lead to project delays or cancellations.

Environmental and Sustainability Concerns

- **Environmental Impact:**
  - The environmental impact of laying cables, especially in ecologically sensitive areas, can raise concerns from environmental groups or government bodies. This includes damage to forests, water bodies, and wildlife habitats during construction.

- **Sustainability of Materials:**
  - The use of environmentally harmful materials in the production of fiber optic cables or their disposal at the end of their life cycle can lead to sustainability challenges, as the country pushes towards eco-friendlier telecom infrastructure.

Skilled Labor Shortage

- **Lack of Skilled Workforce:**
  - Fiber optic cable installation and maintenance require specialized skills. In India, there is a shortage of adequately trained personnel for these technical jobs, which leads to delays and increases in labor costs.
- **Training and Knowledge Gaps:**
  - In many cases, workers are not sufficiently trained in the latest technologies and best practices, which impacts the efficiency of deployment and repair work.

Environmental and Disaster Resilience

- **Disaster Vulnerability:**

India faces natural disasters such as floods, earthquakes, and cyclones, which can severely damage fiber optic infrastructure. The need for more resilient and disaster-proof fiber infrastructure is pressing, but it requires additional investment and planning.

4 Sewage Infrastructure

4.1 Overview of the sewage treatment infrastructure in India

India is the world's most populous country with 1.43 billion people. Out of this, 63.6% of the population lives in rural areas and 36.4% are connected to the urban centres according to United Nations. According to Census 2011, as many as 53 cities in India had a population above a million. At this current growth rate, the urban population is estimated to reach 607 million by 2030; and it is estimated that by 2050, 50% of the country's population will be in urban cities. This unsustainable increase in urban population exerts enormous pressure on city planners, especially for provisioning utility services, particularly water supply, sewerage, storm water drainage and solid waste management.

Sewage infrastructure in urban India faces significant challenges due to rapid urbanization, population growth, and outdated systems. The untreated sewage is a major contributor to the pollution of rivers, lakes, and groundwater. While some metropolitan cities have well-developed underground sewer systems and sewage treatment plants (STPs), many smaller cities and towns lack adequate infrastructure. Open drains and unplanned sewage disposal systems are common in these areas, leading to environmental degradation and public health risks. Despite the government initiatives like AMRUT and the Smart Cities Mission, many STPs underperform or remain non-operational due to power shortages, poor maintenance, or inefficiencies in design. Decentralized systems, such as small-scale sewage treatment plants, are being promoted to manage wastewater locally in areas where centralized networks are unfeasible. Whereas in rural India, sewage infrastructure primarily relies on decentralized and on-site sanitation systems, as centralized sewage networks are non-existent. Most rural households use septic tanks, pit latrines, or soak pits, which are often poorly maintained, leading to overflow and environmental pollution. Greywater and faecal sludge are frequently discharged untreated into open drains, fields, or water bodies, contributing to groundwater contamination and waterborne diseases.

According to the Central Pollution Control Board (CPCB), the estimated sewage generation was almost 39,600 Million liters per day (MLD) in rural regions, while in urban regions it was estimated to be 72,368 MLD for the year 2020-21. The estimated volume in the urban cities is almost double that of the rural regions because of the availability of more water for sanitation which has improved the standard of living.

Current technologies and practices in Urban waste management (UWM)

In India, UWM is performed in two ways (1) On-site systems and (2) Off-site systems.

- **On-site systems**

An onsite system retains wastewater in the vicinity of the toilet in a pit or tank, and the produced sludge is removed periodically to the faecal sludge/septage treatment system. In India, approximately 60% of the population relies on on-site sewage management systems, also known as non-sewered sanitation, which treat sewage at the point of generation. The most widely used system in the country is the conventional septic tank combined with soaking methods such as soak pits and dispersion trenches. A septic tank is an underground chamber that collects and partially treats domestic sewage through anaerobic processes. Within the tank, solids settle and undergo anaerobic digestion, reducing sludge volume and allowing the overflow effluent to infiltrate into the ground via the soak pit without clogging the leaching system. However, in practice, many premises lack proper soaking arrangements due to space limitations and limited awareness. Consequently, pathogenic effluents are often discharged directly into open drains, creating significant public health risks.

On-site sewage treatment systems consistently produce faecal sludge or septage, which must be safely collected, transported, treated, and either reused or disposed of. Faecal Sludge and Septage Management (FSSM) is particularly important in India, where approximately 60% of households rely on on-site sanitation systems. In urban areas, these systems include double leach pits and septic tanks.

Off-site system

An off-site system removes wastewater from the vicinity of the toilet for disposal elsewhere. An off-site system comprises of a sewerage network to transport sewage to a sewage treatment plant (STP), the treated wastewater's solid content is disposed to drying beds, and liquid is disposed to waterbodies.

Sewage collection system: Wastewater collection can be done using two systems (1) Separate system, which collects sewage and stormwater in separate drains, and (2) Combined system, which collects sewage and stormwater together in the same drain. In India, almost all the sewer networks are designed for separate systems, which satisfies the technical and economic advantages. However, old sewerage systems which were developed during British rule have a combined system like in Kolkata.

Sewage treatment facilities: In India, under an off-site treatment system, domestic sewage is transported to STPs. The STPs are designed based on the influent characteristics like Total suspended solids (TSS), Biochemical oxygen demand (BOD), and Faecal coliform (FC). At present, 1,469 STPs (as of 2020 – 21) have been installed in the urban centres of 28 states and union territories in India, with a total installed capacity of 31,841 MLD.

Table 9: Comparative STP status for years 2014 and 2020

STP Status	2014		2020	
	Number of STPs	Capacity (MLD)	Number of STPs	Capacity (MLD)
Operational	522	18,883	1,093	26,869
Non-operational	79	1,237	102	1,406
Under-construction	145	2,528	274	3,566
Total Installed	746	22,648	1,469	31,841
Proposed	70	628	162	4,827
Total treatment	816	23,276	1,631	36,668

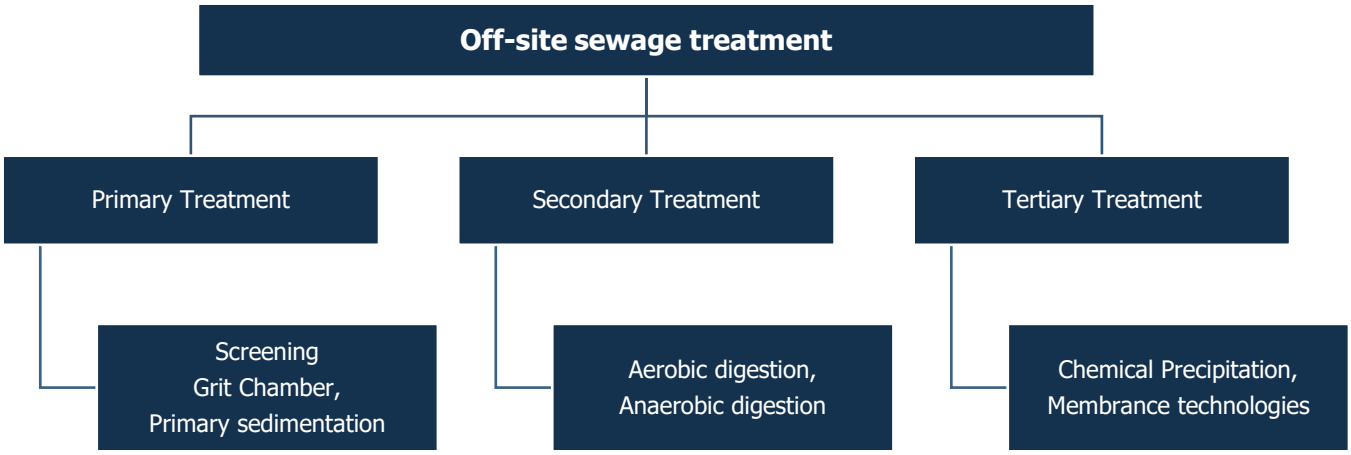
Source: Central Pollution Control Board, CareEdge Research

In an off-site system, sewage treatment is composed of three stages (1) Primary treatment, (2) Secondary treatment, and (3) Tertiary or advanced treatment.

- **Primary treatment** is a preliminary filtration process designed to eliminate physical and chemical pollutants, such as suspended solids, along with partial removal of organic nitrogen, phosphorus, and heavy metals. However, its effectiveness in removing microbial pathogens is limited. This stage comprises three main steps: (1) Screening, (2) Grit Chamber, and (3) Primary Sedimentation.
- **Secondary treatment** involves biological processes to break down organic matter, achieving up to 85% reduction in Biological Oxygen Demand (BOD). This stage can be either aerobic or anaerobic. Aerobic treatment utilizes dissolved oxygen in wastewater, allowing aerobic or facultative bacteria to reduce or eliminate BOD, Chemical Oxygen Demand (COD), dissolved and suspended organics, volatile organics, nitrates, phosphates, and other substances. Anaerobic treatment, on the other hand, occurs in the absence of dissolved oxygen or air and is conducted by anaerobic and facultative bacteria.
- **Tertiary treatment** focuses on removing contaminants that secondary treatment cannot address. This stage includes methods like chemical precipitation and membrane technologies. Chemical precipitation is used to remove phosphorus, helping to prevent eutrophication, as well as salts for industrial reuse of treated wastewater and heavy metals. Membrane technologies offer an alternative for removing hardness but generate a reject solution containing salts, which requires disposal through ocean discharge or thermal evaporation.

Following tertiary treatment, disinfection is performed to address coliform bacteria that could impact the quality of receiving water. Chlorination is the commonly used disinfection method in sewage treatment. Since the treated sewage comes directly from secondary aerobic biological treatment, chlorinating these effluents does not pose significant risks.

Chart 34: Three stages of sewage treatment in an Off-site system



Source: Niti Aayog, CareEdge Research

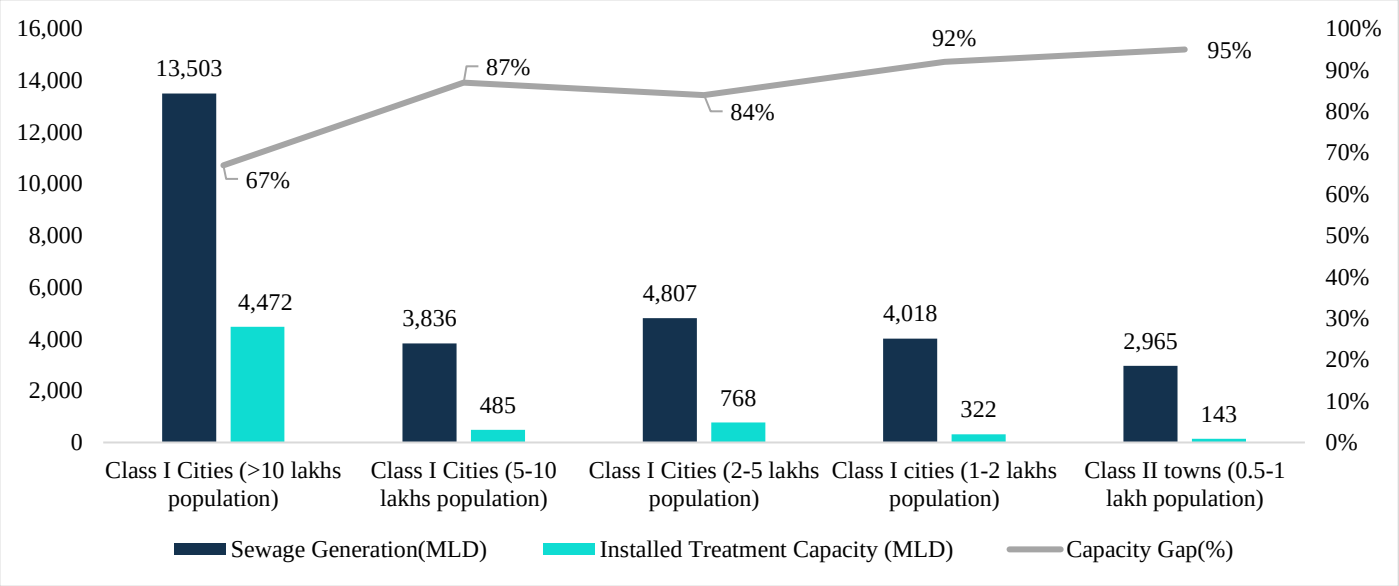
4.2 Overview of Urban Waste Generation and Treatment

In India, the sewage generation in the urban region was 72,368 million litres per day (MLD) for the year 2020-21, while the installed sewage treatment capacity is 31,841 MLD. The operational capacity is 26,869 MLD, which is exceptionally low than the load generation.

As per a Niti Aayog report, as of August 2022, of the total sewage generation only 28% i.e. 20,236 MLD was treated which implies that 72% of the waste water is left untreated and is disposed in the various water bodies like river, lakes or underground water. Some capacity additions like 4,827 MLD sewage treatment have been proposed but a gap between the waste water generation and treatment of 35,700 MLD i.e. 49% still remains.

Additionally, as per the CPCB (2021) in the city-scale assessments, the wastewater generation from Class I cities and Class II towns is estimated as 29,129 MLD, and under the assumption of a 30% decadal increase in urban population, it is expected to be 33,212 MLD at the current time. Against this, the existing capacity of sewage treatment is only 6,190 MLD. There is still a 79% (22,939 MLD) capacity gap between sewage generation and existing sewage treatment capacity. Another 1,742.6 MLD wastewater treatment capacity is being planned or built. Even with this added to the current capacity, there is still a sewage treatment capacity shortfall of 21,196 MLD.

Chart 35: Sewage generation and treatment capacities (MLD)



Source: Central Pollution Control Board

As per the data provided by State Pollution Control Boards (SPCBs)/ Pollution Control Committee (PCCs) in the year 2020-21, there are 1,631 STPs (including proposed STPs) with a total capacity of 36,668 MLD covering 35 States/UTs. Out of 1,631 STPs, 1,093 STPs are operational, 102 are Non-operational, 274 are under construction and 162 STPs are proposed for construction. Out of 1,093 operational STPs, compliance status of 900 STPs is available and only 578 STPs having a combined capacity of 12,200 MLD are found complying with the consented norms prescribed by the SPCBs / PCCs.

Table 10: State-wise Sewage generation and treatment capacity

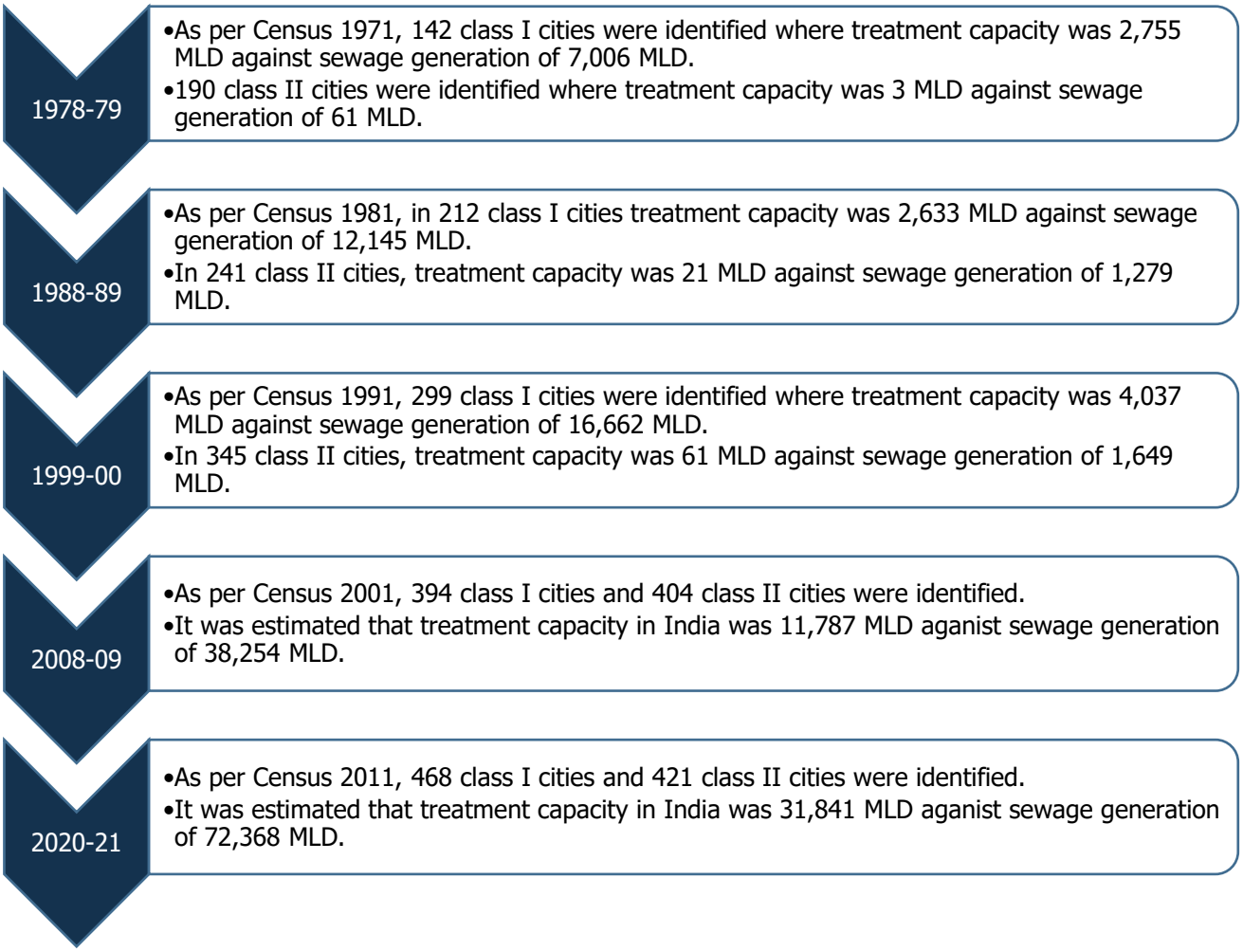
States / UTs	Sewage Generation (in MLD)	Installed Capacity (in MLD)	Proposed Capacity (in MLD)	Total treatment capacity (in MLD) including planned/proposed	Operational treatment capacity (in MLD)
Andaman & Nicobar Islands	23	-	-	-	-
Andhra Pradesh	2,882	833	20	853	443
Arunachal Pradesh	62	-	-	-	-
Assam	809	-	-	-	-
Bihar	2,276	10	621	631	-
Chandigarh	188	293	-	293	271
Chhattisgarh	1,203	73	-	73	73
Dadra & Nagar Haveli	67	24	-	24	24
Goa	176	66	38	104	44
Gujarat	5,013	3,378	-	3,378	3,358
Haryana	1,816	1,880	-	1,880	1,880
Himachal Pradesh	116	136	19	155	99
Jammu & Kashmir	665	218	4	222	93
Jharkhand	1,510	22	617	639	22
Karnataka	4,458	2,712	-	2,712	1,922
Kerala	4,256	120	-	120	114
Lakshadweep	13	-	-	-	-
Madhya Pradesh	3,646	1,839	85	1,924	684
Maharashtra	9,107	6,890	2,929	9,819	6,366

States / UTs	Sewage Generation (in MLD)	Installed Capacity (in MLD)	Proposed Capacity (in MLD)	Total treatment capacity (in MLD) including planned/proposed	Operational treatment capacity (in MLD)
Manipur	168	-	-	-	-
Meghalaya	112	-	-	-	-
Mizoram	103	10	-	10	-
Nagaland	135	-	-	-	-
NCT of Delhi	3,330	2,896	-	2,896	2,715
Orissa	1,282	378	-	378	55
Pondicherry	161	56	3	59	56
Punjab	1,889	1,781	-	1,781	1,601
Rajasthan	3,185	1,086	109	1,195	783
Sikkim	52	20	10	30	18
Tamil Nadu	6,421	1,492	-	1,492	1,492
Telangana	2,660	901	-	901	842
Tripura	237	8	-	8	8
Uttar Pradesh	8,263	3,374	-	3,374	3,224
Uttarakhand	627	448	67	515	345
West Bengal	5,457	897	305	1,202	337
Total	**72,368**	**31,841**	**4,827**	**36,668**	**26,869**

Source: National Inventory of STPs, CPCB

4.3 Insight on historical growth in STP capacity in India

Chart 36: STP capacity over the years



Source- National Inventory of STPs, CPCB

Since 1971, India's urban population has tripled, leading to a significant increase in sewage generation as urban areas expanded and water usage intensified. Although treatment capacity has grown in absolute terms, the percentage of sewage treated has fluctuated, often lagging the rapid increase in sewage generation. Despite the increase in treatment capacity from 2,758 MLD (1978-79) to 31,841 MLD (2020-21), the gap between sewage generation and treatment remains vast, resulting in untreated sewage being discharged into water bodies. The disparity between sewage generation and treatment highlights the need for comprehensive urban planning, increased investment in wastewater infrastructure, and the adoption of innovative technologies to close the treatment gap.

4.4 Expected growth in the sector

About 37% of the Indian population lives in urban centers according to census 2011 and the number is expected to go up rapidly leading to the increase in demand for fresh water. The generation of wastewater is double in cities as compared to rural India because of availability of more water in urban cities due to increased living standards and the urbanization pace.

Rapid urbanisation has also intensified the demand for food and fresh water, leading to higher water consumption and the discharge of wastewater back into natural sources. With the increased use of water for household, industrial, and agricultural purposes, effective wastewater management and treatment have become crucial.

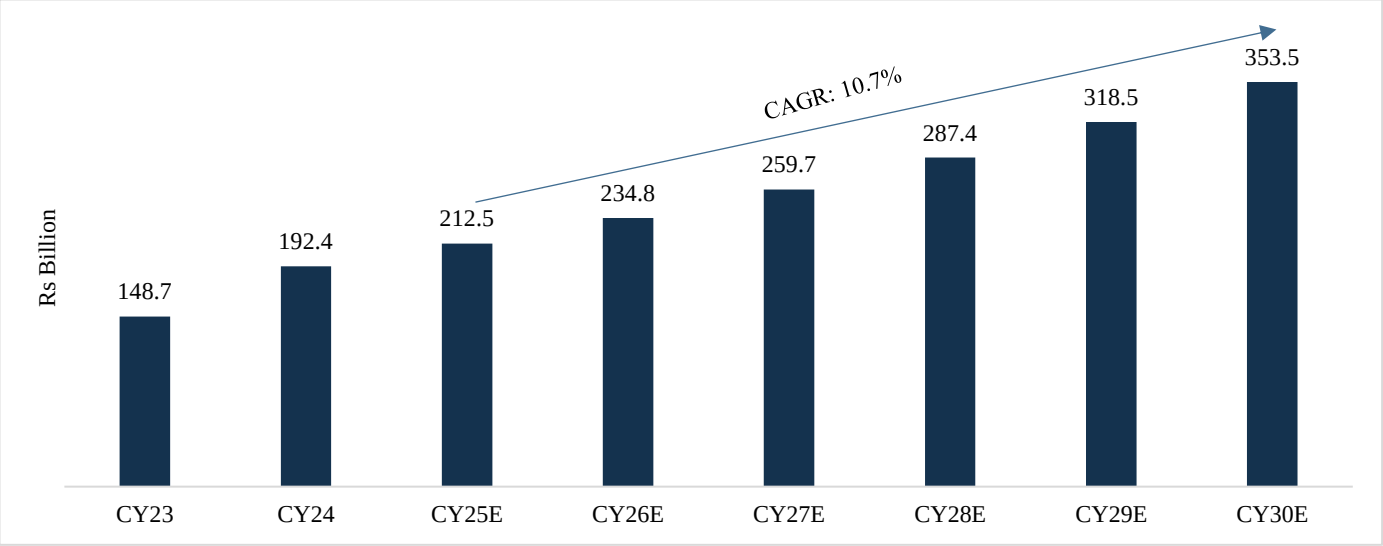
In FY21, only 28% of the total sewage generated—amounting to 20,236 million litres per day (MLD)—was treated, leaving 72% of wastewater untreated. This untreated wastewater is frequently discharged into rivers, lakes, or underground water sources, causing significant environmental challenges. However, this presents a substantial opportunity for growth and development in the wastewater management sector.

4.5 Market size of Water waste management market in India

- India, the world's most populous country, is facing significant water challenges, with 18% of the global population relying on just 4% of the world's freshwater resources. Less than one-tenth of its annual rainfall is stored, and the country is increasingly classified as water-stressed. The situation is aggravated by excessive water use for agriculture, excessive groundwater extraction, and erratic monsoon rainfall, leading to approximately 50% of the population experiencing high-to-extreme water shortages, as per NITI Aayog.
- The per capita water availability in India is rapidly decreasing due to the growing population. Currently, it is below 1,700 cubic meters per person annually and is expected to fall to 1,367 cubic meters by 2031. A 2022 report highlighted that 1,006 out of 7,089 water assessment units in the country are 'over-exploited', indicating the unsustainable use of groundwater resources.
- With the rising pace of urbanisation, the demand for drinking water is shifting from rural to urban areas, and by 2050, it is estimated that India will require around 1,450 km^3 of water, with 75% of this demand coming from agriculture. Many urban areas, situated along rivers, are causing water contamination by consuming freshwater and discharging untreated wastewater back into the rivers. This creates substantial challenges in urban wastewater management and treatment.
- India's water and wastewater management market is rapidly expanding, valued at Rs. 192.4 billion in CY24, and is projected to grow to Rs. 353.5 billion by CY30, with a CAGR of 10.7%. This growth is driven by the increasing pollution of rivers caused by untreated sewage, industrial effluents, and inadequate treatment infrastructure. The rising demand for freshwater, along with industrialisation, is spurring significant investments in advanced water treatment technologies.

.

Chart 37: Market Size of Wastewater Treatment

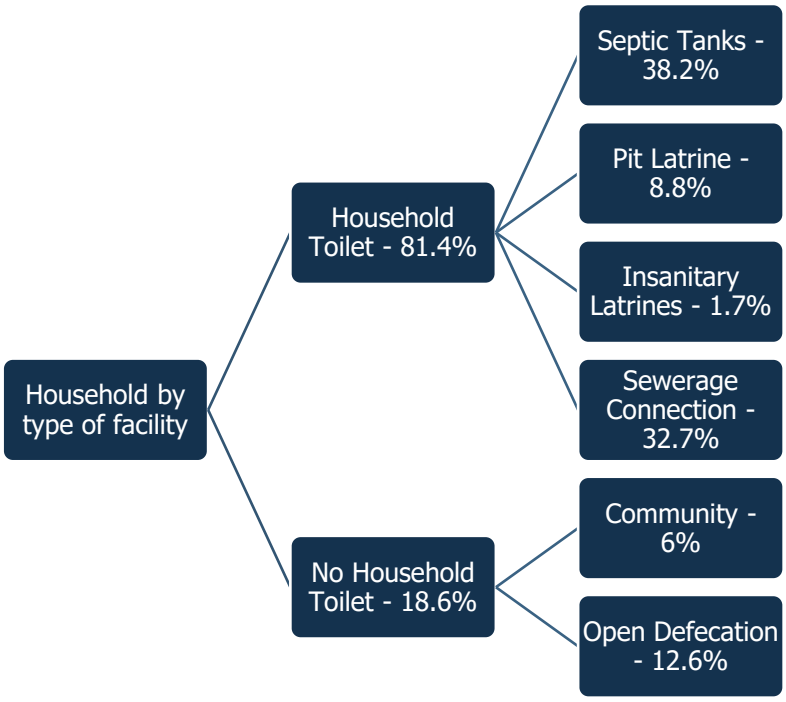


Source - Netscribes, EMIS, CareEdge Research

4.6 Insight on the sanitation & sewage problem in India

- Sanitation and sewage management in India face critical challenges, particularly in urban areas, due to rapid population growth, high density, and unplanned urbanisation. These factors exacerbate the issues, with the urban poor disproportionately affected by the economic and social consequences of inadequate sanitation.
- Poor sanitation impacts public health and the environment, contributing to the spread of waterborne diseases and lowering productivity. A World Bank study by the Water and Sanitation Programme (WSP) highlights that the mortality impact of poor sanitation is significant, but the economic burden on weaker sections, comprising 20% of households, is even more pressing.
- Contaminated water sources, open drains, and untreated sewage pollute ecosystems, further aggravating health risks and undermining efforts to improve public well-being.
- According to the 2011 Census, 81.4% of urban households have toilet facilities within their premises, including water closets, pit latrines, and other types of toilets. However, 18.6% of urban households lack toilet facilities, with 6.0% relying on public toilets and 12.6% resorting to open defecation, highlighting the need for significant improvement in sanitation infrastructure.

Chart 38: Status of toilets in Urban households



Source: CPHEEO, CareEdge Research

- Sewer networks in cities and towns are largely inadequate for collecting and transporting sewage to sewage treatment plants (STPs).
- A NITI Aayog report highlights that 72% of wastewater remains untreated, being discharged into rivers, lakes, or groundwater sources, indicating poor planning and execution of sewerage systems and sanitation facilities by urban local bodies (ULBs).
- The shortcomings in sanitation infrastructure are attributed to insufficient financial resources and the limited capacity of ULBs to implement effective solutions.
- Addressing the sanitation crisis requires better sewer networks, fully functional STPs, and innovative approaches such as decentralised waste management systems.
- Urban local bodies need increased financial support and targeted training to enhance their ability to provide effective sanitation services.
- Improved planning, greater investment, and heightened public awareness are essential to tackle the sanitation crisis, protect the environment, and improve public health.

4.7 Government Initiatives

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Atal Mission for Rejuvenation and Urban Transformation (AMRUT) was launched on 25 June 2015 in selected 500 cities and towns across the country. The Mission focuses on development of basic infrastructure, in the selected cities and towns, in the sectors of water supply, sewerage and septage management, storm water drainage, green spaces and parks, and non-motorized urban transport.

AMRUT Mission has been subsumed under AMRUT 2.0, which was launched on 01 October 2021 and ongoing projects of AMRUT 1.0 was to be funded with central assistance till 31 March, 2023.

AMRUT 2.0 scheme has been launched for the period of 5 years (FY21 to FY26), is designed to provide universal coverage of water supply through functional taps to all households in all the statutory towns in the country and coverage of sewerage/septage management in 500 cities covered in first phase of the AMRUT scheme.

AMRUT 2.0 will promote circular economy of water through development of City Water Balance Plan (CWBP) for each city focusing on recycle/reuse of treated sewage, rejuvenation of water bodies and water conservation. It will help cities to identify scope for projects focusing on universal coverage of functional water tap connections, water source conservation, rejuvenation of water bodies and wells, recycle/reuse of treated water, and rainwater harvesting. Based on the projects identified in CWBP, Mission envisages making cities 'water secure' through circular economy of water.

Mission also has a reform agenda on ease of living of citizens through reduction of non-revenue water, recycle of treated used water, rejuvenation of water bodies, augmenting double entry accounting system, urban planning, strengthening urban finance etc.

Other components of AMRUT 2.0 are:

- Pey Jal Survekshan to ascertain equitable distribution of water, reuse of wastewater, mapping of water bodies and promote healthy competition among the cities /towns.
- Technology Sub-Mission for water to leverage latest global technologies in the field of water.
- Information, Education and Communication (IEC) campaign to spread awareness among masses about conservation of water.

The total indicative outlay for AMRUT 2.0 is Rs. 2,99,000 crore including central share of Rs. 76,760 crores for five years from FY 2021-22 to FY 2025-26.

Sr. No	Mission component	Central Allocation (Rs. Cr)
1	Projects	66,750
2	Incentive for Reforms (8% of project CA allocation)	5,340
3	Administrative & Other Expenses (A&OE) for States/ UTs (3.25% of project CA allocation)	2,169
4	Administrative & Other Expenses (A&OE) for MoHUA (1.75% of project CA allocation)	1,168
5	Technology Sub-Mission (1% of project CA allocation)	667
6	IEC Activities (1% of project CA allocation)	667

Source: AMRUT, CareEdge Research

Under the program, 883 sewerage & septage management projects which amounts to Rs 40.81 billion have been taken up out of which 370 projects costing Rs 82.58 billion have been completed till date. In the Budget FY24, the allocation to AMRUT has increased from Rs 153 billion to Rs 160 billion.

Namami Gange programme

It is an integrated Conservation Mission approved as 'Flagship Programme' by the Union Government in June 2014 with budget outlay of ₹200 Billion to accomplish the twin objectives of:

i. effective abatement of pollution
ii. conservation and rejuvenation of National River Ganga

The Programme has the main objectives of Sewerage Treatment Infrastructure, River Surface Cleaning, Afforestation, Industrial Effluent Monitoring, etc. For conservation of rivers, the Ministry of Jal Sakti has been supplementing efforts with the states and Union Territories by providing financial and technical assistance for abatement of pollution under the programme.

Under the Namami Gange Programme, a total of 450 projects have been undertaken, with an estimated cost of Rs. 38,022.4 crore. Out of these, 270 projects have been successfully completed and put into operation. Most of these projects focus on establishing sewage infrastructure, as untreated domestic and industrial wastewater is the primary cause of pollution in the river. Specifically, 195 sewerage infrastructure projects have been implemented at a cost of Rs. 31,344.1 crore. These projects include the creation and rehabilitation of 6,173.1 million Liters per Day (MLD) of Sewage Treatment Plant (STP) capacity and the installation of approximately 5,253.6 km of sewerage network. Among these, 109 sewerage projects have been concluded, resulting in the creation and rehabilitation of 2,664.1 MLD of STP capacity and the laying of 4,465.5 km of sewerage network.

Jal Jeevan Mission - 'Har Ghar Jal'

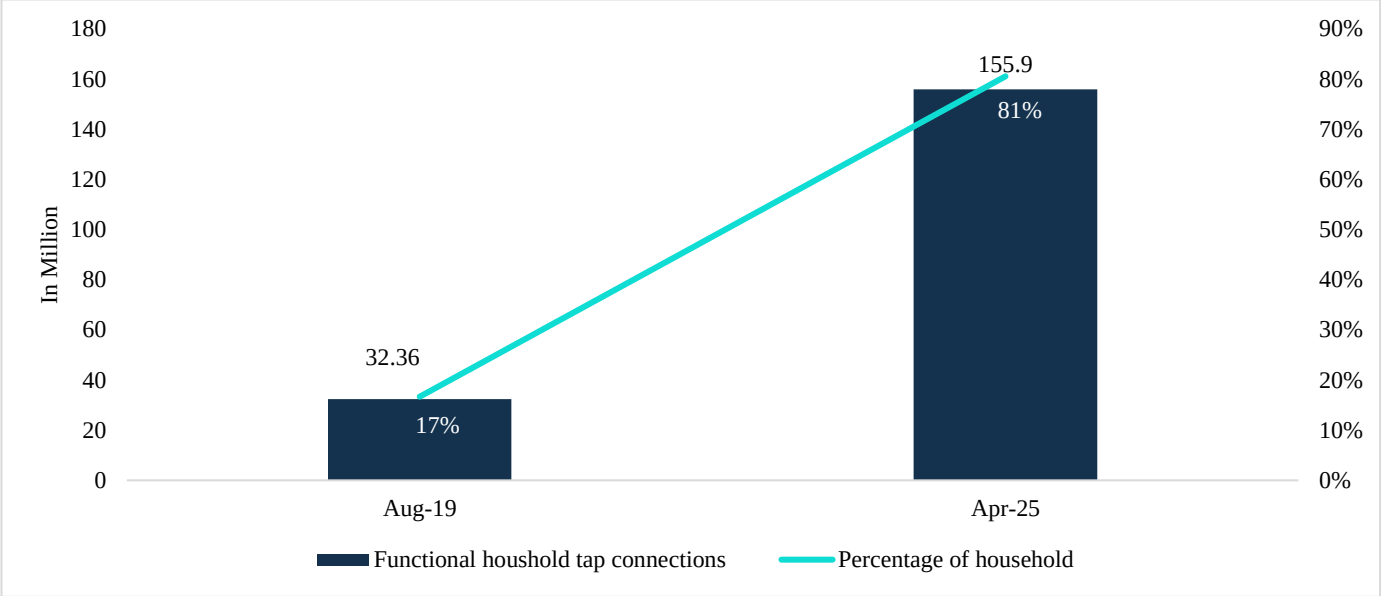
Jal Jeevan Mission (JJM) is a Central Government initiative undertaken by the Ministry of JAL SHAKTI. It aims to ensure piped water access to every household in rural India. The initiative was launched on 15 August 2019 by the Prime Minister of India.

The programme is implemented in partnership with States to assure tap water supply in adequate quantity, prescribed quality, adequate pressure, on a regular and long-term basis in all rural households and public institutions, which includes anganwadi, schools, ashramshalas, public/ community health centres, sub-centres, wellness centres, community centres, gram panchayat buildings, etc., by the year 2024.

Under JJM, 30% weightage was assigned for difficult terrains which include areas under Desert Development Programme (DDP) and Drought Prone Area Programme (DPAP) while allocating the fund, to prioritize the coverage in these areas. Further, provisions have been made in the operational guidelines for planning and implementation of bulk water transfer from long distances and regional water supply schemes for ensuring tap water supply in drought-prone & water-scarce areas/ areas with inadequate rainfall or dependable ground water sources. In addition, provisions have also been made for source recharging, viz. dedicated bore well recharge structures, rain water recharge, rejuvenation of existing water bodies, etc., in convergence with other schemes such as the Mahatma Gandhi National Rural Employment Guarantee Act 2005 (MGNREGA), Integrated Watershed Management Programme (IWMP), 15th Finance Commission tied grants to Rural Local Bodies (RLB)/ Panchayat Raj Institutions (PRI), State schemes, Corporate Social Responsibility funds, etc.

For villages in water-scarce areas, in order to save the precious fresh water, states are also being encouraged to plan new water supply scheme with dual piped water supply system, i.e. supply of fresh water in one and treated grey/ wastewater in another pipe for non-potable/ gardening/ toilet flushing use. Moreover, the households in these areas are to be encouraged to use faucet aerators that save a significant amount of water, in multiple taps that they may be using inside their house.

Chart 39: Functional Household tap connection under Jal Jeevan Mission



Source: Jal Jeevan Mission, CareEdge Research

The total number of households in India as of April 2025 were 193.7 million out of which over 155.9 million households have received tap water connection as of November 2024.

Achievements under JJM:

- 152.7 million new connections have been installed under the program from August 2019 to November 2024.
- Direct support of USD 18.94 Billion has been added under the 15th Finance Commission for 5 years from 2021-2026
- 0.93 million schools, 0.97 million anganwadi centres and 0.39 million public institutions have been connected to water supply.
- 0.53 million village water and sanitation committees with at least 50% women have been formed under the community engagement
- 2,160 water testing labs have been opened for testing the water samples and 2.5 million women have been trained to use the test kits

Swachh Bharat Mission (Urban)

Swachh Bharat Mission (SBM) (Urban) was launched by GoI with the vision of ensuring hygiene, waste management and sanitation across the country in 2019. The SBM (Urban) was implemented under the Ministry of Housing and Urban Affairs. The key focus area under this is eliminating open defecation, eradication of manual scavenging by converting insanitary toilets to sanitary, solid waste manager, behavioral change, general sanitation awareness etc.

Under Swachh Bharat Mission (Urban) 2.0, launched in October 2021 an amount of Rs. 158.83 billion has been allocated to states and union territories for wastewater management including setup of sewage treatment plants and faecal sludge treatment plants.

4.8 Regulatory Overview in this sector

According to the Constitution of India, water supply and sanitation are designated as subjects under the jurisdiction of the states. As a result, states are granted the constitutional right to oversee the planning, execution, operation, maintenance, and financial recovery of projects related to water supply and sanitation.

Local bodies such as Municipal Corporations, Municipalities, Municipal Councils, and Notified Area Committees or Authorities are entrusted with responsibilities by legislation at the local level. Furthermore, specialized agencies may assume these responsibilities on a State or Regional basis. The formulation of the country's economic and social programs is conducted through five-year plans.

The Public Health Engineering Department (PHED) functions as the leading agency at the state level for the planning and implementation of water supply and sanitation programs. In numerous states, statutory Water Supply and Sanitation Boards (WSSBs) have taken over the roles traditionally held by the PHEDs. The main purpose of establishing WSSBs is to introduce a commercial approach to the management of water supply and sanitation, thereby increasing accountability. The Ministry of Housing and Urban Affairs (MoHUA) is responsible for creating policy guidelines for the urban water supply and sanitation sector and provides technical assistance to states and Urban Local Bodies (ULBs). The Central Public Health and Environmental Engineering Organization (CPHEEO) supports MoHUA in the formulation of policies and offers technical advice, including the review and assessment of schemes, as well as the dissemination of new technologies in water supply and sanitation, including municipal solid waste management. Furthermore, State Water Supply and Drainage Boards (SWSDBs) have been established to assist ULBs in the planning, design, and implementation of sewerage and wastewater treatment infrastructure. SWSDBs receive funding from both national and state governments and are empowered to construct treatment plants, which are then handed over to ULBs for their operation and maintenance.

The Ministry of Environment, Forest and Climate Change (MoEFCC) and its affiliated agencies are responsible for mitigating environmental pollution while also planning, promoting, and coordinating environmental policies and programs nationwide. The Central Pollution Control Board (CPCB), established under the Water Act in 1974, functions as a line agency of MoEFCC, tasked with the prevention, control, and reduction of environmental pollution, as well as the formulation of wastewater discharge standards applicable across the country. All sewage treatment plants (STPs) across India are required to comply with the standards set forth by the CPCB. At the state level, state pollution control boards (SPCBs) are charged with the implementation of environmental pollution legislation. Additionally, SPCBs have the authority to strengthen the regulations set by the CPCB. They are responsible for monitoring the operations of all entities that discharge wastewater, including buildings, industries, and sanitation systems of varying scales.

The Central Government acts as an intermediary in mobilizing external assistance in the water supply and sanitation sector and routes the aid via the State plans. It also provides direct grant assistance to some extent to water supply and sanitation projects in urban areas under the various programs of the Government of India.

Other policies and legal regulation frameworks

The Water (Prevention and Control of Pollution) Cess Act, 1977, which came into force in 1992, provided the financial resources for the Central and State Boards by levying taxes on industrial water use. To incentivize the wastewater treatment, a provision of a rebate of 25% on the payable cess is made in the Act.

The Environment (Protection) Act, 1986 empowered the Central Government to prescribe the standards for sewage and effluent and ensure compliance. This is an umbrella act about environmental protection, and it enshrines the "polluter pays principle" into the Indian environmental policy. Under the Environment (Protection) Rules, 1989 the industry specific standards for emission/effluent discharge are prescribed. The Wastes (Management and Handling) Rules, 1989 regulate the business of sewerage and sewage treatment, along with other matters.

The National Environment Policy, 2006 emphasizes the direct and indirect causes of pollution of surface (e.g. river, wetlands) water sources, groundwater, and coastal area and recycling of wastewater before discharging into water bodies. The policy prescribes the action plans for urban cities to address water pollution through appropriate regulatory systems and technological development for treatment, reuse, and recycle of urban wastewater before final discharge into water bodies.

National Urban Sanitation Policy, 2008, focuses on sanitary and safe disposal of human waste and recommends recycling and reuse. The integrated water resources management in planning, development, and management is adopted in India's National Water Policy, 2012. This policy incentivizes decentralized sewage treatment plants, recycling, and reuse of treated water through planned tariff systems, and subsidized treatment of industrial effluents. The National Water Policy focuses on reducing water pollution and the draft revised National Water Policy, 2020 that embraces the imperative of recycling and reuse.

National Faecal Sludge and Septage Management Policy, 2017 focuses to achieve 100% access to safe sanitation, achieve integrated urban sanitation, safe disposal of faecal waste and mandates strict environmental discharge standards, and promotes an appropriate, affordable, and incremental approach to achieving these standards.

The Model Bill for Regulation of Groundwater Development 2016 deals with regulation of ground water in both urban and rural areas and various State Governments enacted the Ground Water Development Act, based on this model bill. These Acts provide the regulation for control on use of chemical fertilizers or pesticides, to regulate the disposal, burial or injection of waste, industrial effluent and to protect the quality of groundwater.

The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 prohibits the manual cleaning of sewers and septic tanks and it aims to eliminate insanitary latrines and rehabilitate identified manual scavengers in alternative occupations.

The Coastal Regulation Zone Notification aims to protect the livelihood of fishers' families, protect the coastal area ecology and generate economic activities in coastal areas. This also aims to reduce the disposal of waste along the coastal regions.

The National Water Mission promotes the recycling of wastewater for meeting water needs of urban areas. The Tariff Policy, 2016 by Ministry of Power mandates the thermal power plants located within 50 km radius of a sewage treatment plant of an urban local body to mandatorily use treated urban waste. The Service Level Benchmarks of the Ministry of Housing and Urban Affairs (MoHUA) mandate the extent of reuse and recycling of sewage in urban areas as 20%.

The National Water Quality Monitoring Programme of India, through its network of SPCBs, advises central and State governments on prevention, control, abatement of water pollution and sets standards on water quality in streams and wells. The Guidelines of National Building Code 2016 emphasizes the reuse of treated sewage and sullage in commercial or residential multi-storied complexes for flushing of toilets, horticulture, and fire-fighting purposes. It also suggests separate storage tanks and separate distribution pipes.

The National Guidelines on Zero Liquid Discharge developed by CPCB for industrial sectors highlights the zero-effluent discharge. The CGWB Master Plan for Artificial Recharge to Ground Water in India, 2013 emphasizes careful monitoring for regarding the treated urban wastewater to avoid any possibility of contamination of ground water. The Prime Minister's Krishi Sinchayi Yojana emphasizes exploring the feasibility of reusing treated municipal used water for peri-urban agriculture.

The vision expressed in the **National Framework on the Safe Reuse of Treated Water, 2021** is – "widespread and safe reuse of treated used water in India that reduces the pressure on scarce freshwater resources, reduces pollution of the environment and risks to public health, and achieves socio-economic benefits by adopting a sustainable circular economy approach" (MoJS, 2020) and accordingly requisite recommendations are made in the framework.

4.9 Key drivers of water treatment

- **Central Government policies push for wastewater treatment and use**

Under the National Sanitation Policy, waste water treatment and reuse of water to enhance alternative water supplies and conservation is promoted. Initiatives like National Lake Conservation Plan, National Wetland Conservation Program are introduced to help identify lakes and wetlands across the country for undertaking conservation, wastewater treatment, pollution abatement, education, and awareness creation etc.

Central Government has also implemented National River Conservation Plan for abatement of pollution across stretches of various rivers and undertaking conservation plan, sewage systems construction, sewage treatment plant construction, electric crematoria, and river front development.

Financial assistance for treatment plants installation is also provided to small scale industries. Apart from this, the Central Government has also issued directions for zero liquid discharge implementation.

- **Development plans to clean River Ganga and improve wastewater treatment and management**

The GoI has launched two flagship programs for cleaning River Ganga i.e., Ganga Action Plan (GAP) (1985) and Namami Gange Programme (2014). The Government has also initiated sectoral plans like Swachh Bharat Mission, AMRUT, Smart City initiatives etc. to improve unsewered and sewer sanitation. Under these initiatives, the State Government, municipal and private sector applicants are given grants and subsidies for the construction of sewage treatment plants and water treatment plants.

- **Agricultural water reuse**

Low quality water is not conventionally used in agricultural production. The two sources of non-conventional water (NCW) are – wastewater used for domestic, municipal, and industrial and saline water from underground, drainage, or surface sources. But many countries are using the NCW sources for agricultural uses as the freshwater sources are limited. The NCW is primarily treated and blended with other water to produce the desired quality and quantity. In India, under Ganga Action Plan - I, the objective was to improve the water quality along with diversion and treatment of domestic sewage and industrial waste. If not properly treated, the low-quality irrigation water might cause severe water and soil contamination. To tackle this, India needs water treatment plants with advanced technology and increased volume across the country.

- **Industrial water reuse**

The industrial water can be recycled and reused by processing the wastewater produced. Various methods are used to perform this depending upon the quality of the wastewater requirements, space constraints, and budget. The benefit of this, is reduction of freshwater cost and reduction in the water footprint. The operational and sustainability of the industries can also be improved with improved water treatment process and production capacity.

4.10 Threats and Challenges in this sector

- **Institutional Challenges**

Urban Local Bodies (ULBs) are tasked with managing and treating domestic wastewater but often lack planning capacity and project implementation. The Comptroller and Audit General (CAG 2017) revealed workforce shortages in municipalities, affecting wastewater collection, treatment, and revenue generation, while highlighting deficiencies in planning, financial management, and project monitoring. In Jharkhand (2016), none of the sampled ULBs had a sewage network, resulting in 175 million litres per day (MLD) of untreated wastewater polluting local water bodies. The current institutional, legal, and policy frameworks are inadequate to address these challenges.

- **Economic Challenges**

The gap between the sewage generation and treatment capacity is large is significant, particularly in smaller cities, due to high capital and maintenance costs. Community involvement in operating Sewage Treatment Plants (STPs) could enhance economic viability, but private investments remain limited owing to excessive costs and uncertain revenues.

- **Technical Challenges**

India relies heavily on outdated wastewater treatment technologies, leading to frequent breakdowns, inefficiencies, and environmental contamination. Most centralised plants target basic pollutants like nitrogen and BOD but are ill-equipped for modern contaminants. Land scarcity in urban areas further complicates STP construction.

- **Social Challenges**

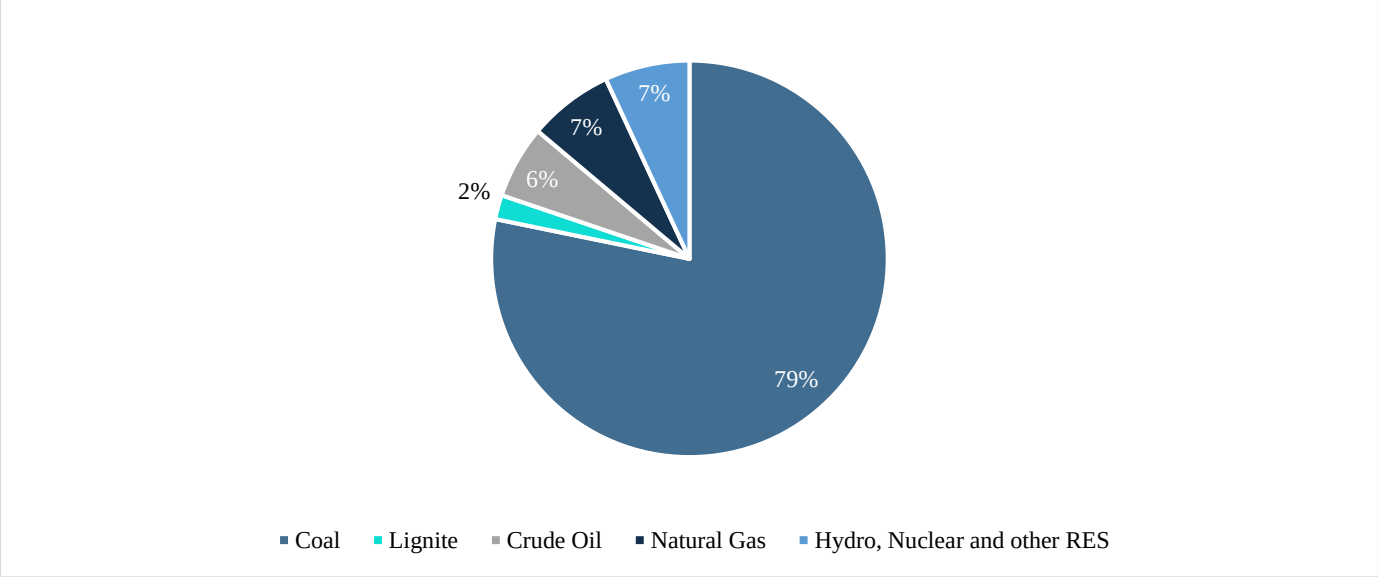
Social resistance to treated wastewater reuse stems from health concerns and cultural beliefs, limiting its use to non-potable purposes like irrigation. Additionally, communities oppose plant construction near residential areas due to perceived health risks and property devaluation. Underground plants could address these concerns but require significant investment. Conventional systems in India struggle with high operational costs, limited treated water demand, and decentralisation challenges.

5 Natural Gas Pipeline

5.1 Overview of the natural gas sector in India

Natural Gas being a clean energy is used for multiple purposes in India. In the 19th and 20th century, it was mainly used for street and household lighting. Now a days, it is used to fuel water heaters, cook stoves, dryers, and other equipment in the residential sector. It is also used in the commercial sector and in appliances to generate cooling and power. In addition, natural gas is used as a base ingredient in the manufacturing of ammonia, anti-freeze, fabrics, glass, steel, plastics, and paint.

Chart 40: Share of Total Energy Generated during FY24(P)



Source: Energy Statistic India 2025, MOSPI

India’s energy mix continues to have a huge dependence on coal and oil. While coal constitutes more than half of the country’s energy mix, coal and oil together constitute more than 80% of the country’s energy mix. However, Government of India is committed to achieve a 15% share of natural gas by 2030 from around 7% in 2023-24 in the overall energy mix. Thus, Natural gas demand in India is expected to register a healthy growth in the years to come. The current industry and regulatory environment bode well to achieve a shift towards gas becoming more prominent in the Indian fuel mix. CGD segment is likely to be one of the leading drivers of growth in natural gas consumption.

5.2 Overview of natural gas production and consumption pattern in India

5.2.1 Trend of Natural Gas Production in India

Natural gas production in FY24 stood at 35,717 MMSCM, indicating a growth of 6.1% from FY23. India's domestic natural gas production grew due to a considerable increase in output from production sharing contract/joint venture (PSC/JV) fields. This surge reflects the country's continued attempts to increase domestic energy generation capabilities. As of YTD25, the natural gas production stood at 32,647 MMSCM. The trend of natural gas production in India is depicted in the table below:

Table 11: Natural Gas Production in India

Particulars (Figures in MMSCM)	2019-20	2020-21	2021-22	2022-23	2023-24	2023-24 (Apr-Feb)	2024-25 (Apr-Feb)
Onshore Production	9,893	9,601	10,471	10,368	10,567	9,693	9,335
Offshore Production	20,635	18,429	22,869	23,409	25,871	23,607	23,790
Gross Production	31,184	28,672	34,024	34,450	36,438	33,300	33,125
Onshore Production	10,254	10,025	10,646	10,536	10,092	9,261	9,059
Offshore Production	21,802	20,232	22,485	23,128	25,625	23,383	23,588
Net Production*	32,056	30,257	33,131	33,664	35717	32,644	32,647

Source: Petroleum Planning and Analysis Cell (PPAC)
Note: (*) Denotes natural gas available for consumption, which is derived by deducting from gross production, the quantity of gas flared/loss by producing companies.

Companies producing Natural Gas use certain quantity of gas for their own use as internal consumption and the rest of the gas is used as a part of technical requirement. After the usage of Natural Gas for their own requirement and internal consumption, the net production for sale of gas to consuming sectors like power, fertilizer, CGD, refinery, petrochemicals etc. was almost 76.1% of the gross production in the month of February 2025.

5.2.2 Trend of Natural Gas Consumption in India

The trend for natural gas consumption in India is depicted below in the table: -

Table 12: Natural Gas Consumption in India

Financial Year	(Figure in)	FY19	FY20	FY21	FY22	FY23	FY24	FY25*
Net Production	MMSCM	32,056	30,257	27,784	33,131	33,664	35,717	32,647
(as % of Total Consumption)	%	53%	48%	46%	52%	56%	54%	49%
LNG import	MMSCM	28,547	32,352	33,198	31,028	26,304	30,917	34,329
(as % of Total Consumption)	%	47%	52%	54%	48%	44%	46%	51%
Total Consumption (Net Production + LNG import)	MMSCM	60,603	62,609	60,981	64,159	59,969	66,634	66,976

Source: Petroleum Planning and Analysis Cell (PPAC)
Note: FY25* refer to the period April 2024 to February 2025

According to the data published by Ministry of Petroleum and Natural Gas, the consumption of gas during FY24 stood at 66,634 MMSCM which is 11% higher than consumption of 59,969 MMSCM in FY23. According to India Energy Outlook, 2021 (IEA), natural gas demand in India is expected to register a healthy growth in the years to come. The Indian government is determined to increase the proportion of natural gas in the country's overall energy mix from approximately 7% in FY24 to 15% by 2030.

India experienced extreme heat and record temperatures in April and May, increasing electricity usage for cooling and putting a strain on the power supply system. Although natural gas accounts fewer percentage of India's energy mix, the country's gas-fired

power generation has expanded dramatically in recent months. India's natural gas consumption is expected to rise further in FY26, driven by increased demand from the electricity and industrial sectors.

5.3 Trends of Import of Liquefied Natural Gas

India is highly dependent on the imported LNG to meet its gas demand with imports contributing to around 46% of total consumption in FY24. India ranks as the fourth-largest LNG importer following Japan, South Korea, and China. The rise in imports is driven by higher gas demand from the power industry during the summer months. With the advent of monsoons in India, gas demand might fall in the following months. The data additionally demonstrates the launch of the Dhamra LNG plant, which increased India's overall LNG capacity. The trend of import of liquefied natural gas in India is depicted below-

Table 13: Import of LNG

Year	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2023-24 (Apr-Feb)	2024-25 (Apr-Feb)
Total LNG Imports (Long Term, Spot) in MMT	21.7	25.6	25.1	23.4	19.9	24	21.7	25.9
Total LNG Imports (Long Term, Spot) in MMSCM	28,740	33,887	33,198	31,028	26,304	31,795	28,742	34,329

Source: Petroleum Planning and Analysis Cell (PPAC)

India has been one of the largest importers of natural gas since 2011. Imports of Natural Gas is further expected to rise as there are import terminals under construction. LNG imports are completely dependent on the completion of import terminals. Since the year 2016, India has expanded the list of countries from which it imports LNG. Major countries that supply gas to India are Russia, Qatar and USA. The first LNG shipment from Qatar to India took place in 2004 at the Dahej Terminal.

5.4 Insight on natural gas pipeline network in India

Table 14: Natural Gas Pipeline Network in India (as on December 31, 2024)

Details		Length (Km)	Total (Km)
Authorized Natural Gas Pipelines	Common Carrier	31,903	33,475
	Tie-in connectivity	792	
	Dedicated	780	
Operational Natural Gas Pipelines	Common Carrier	23,752	25,124
	Tie-in connectivity	202	
	Dedicated	653	
	STPL	517	
Under Construction Natural Gas Pipelines	Common Carrier	9,399	10,676
	Tie-in connectivity	593	
	Dedicated	122	
	STPL	562	

Source: PNRGB

Major demand for natural gas is expected to come from- fertilizer sector, increase in CNG consumption, expansion of CGD network to around 307 geographical areas post Round 11A and Round 12 of CGD bidding and industries using blast furnaces such as steel, oil refineries, long-haul transport, and heating and cooling requirement. Natural gas has seen an increasing usage in transportation and households as adoption of CNG and PNG gains traction. To support this increasing demand, the development of a robust and extensive natural gas pipeline network is essential. The Petroleum and Natural Gas Regulatory Board (PNGRB) oversees the development and regulation of natural gas pipelines in India, ensuring the establishment of a robust and efficient gas infrastructure.

As of March 2024, the country boasts approximately 33,475 kms of authorized natural gas pipelines, with about 24,124 kms operational, which is primarily managed by major operators like GAIL (India) Limited, Gujarat State Petronet Limited (GSPL), Indian Oil Corporation Limited (IOCL) and others. GAIL (India) Limited is a key player in India's gas transmission sector which operates around 16,421 kms of natural gas pipelines, covering 22 states. The company is actively involved in expanding the pipeline network to ensure broader gas distribution. The network primarily serves the western, northern, and southern regions, with major pipelines such as the Hazira-Vijaipur-Jagdishpur (HVJ) Gas Pipeline, East-West Pipeline and Dabhol-Bengaluru Pipeline.

Table 15: Full Operational Common Carrier Pipeline (as on December 31, 2024)

Sr. No.	Name of Natural Gas Pipelines	Entity	Date of Authorization	Auth. Length (KM)	Auth. Capacity (MMSCMD)	Operating Length (KM)	States from which Pipeline passes
1	Assam Regional Network	GAIL	04.11.2009	8	2.50	8	Assam
2	Cauvery Basin Network	GAIL	04.11.2009	240	4.33	243	Puducherry, Tamil Nadu
3	Hazira-Vijaipur-Jagdishpur -GREP (Gas Rehabilitation and Expansion Project)-Dahej-Vijaipur HVJ/VDPL	GAIL	19.04.2010	6,169	107.00	6718	Uttar Pradesh, Madhya Pradesh, Rajasthan, Gujarat
4	Dahej-Vijaipur (DVPL)-Vijaipur-Dadri (GREP) Upgradation DVPL 2 & VDPL		14.02.2011				
5	Kakinada-Hyderabad-Uran-Ahmedabad (East West Pipeline)	PIL	19.04.2010	1,459	85.00	1483	Andhra Pradesh, Gujarat, Maharashtra, Telangana
6	Dahej-Uran-Panvel-Dabhol	GAIL	10.05.2010	815	19.90	943	Gujarat, Maharashtra
7	KG Basin Network	GAIL	12.05.2010	878	16.00	865	Andhra Pradesh, Puducherry
8	Gujarat Regional Network	GAIL	03.12.2010	609	8.31	589	Gujarat
9	Agartala Regional Network	GAIL	13.12.2010	55	2.00	65	Tripura
10	Dadri-Panipat	IOCL	05.01.2011	132	20.00	143	Haryana, Punjab, Uttar Pradesh
11	Mumbai Regional Network	GAIL	14.03.2011	129	7.04	125	Maharashtra
12	Uran-Trombay	ONGC	03.05.2011	24.00	6.00	24.00	Maharashtra
13	High Pressure Gujarat Gas Grid	GSPL	27.07.2012	2,207	31.00	2665	Gujarat
14	Hazira-Ankleshwar (HAPI)	GGL	05.07.2012	73	5.06	73	Gujarat
15	Low Pressure Gujarat Gas Grid	GSPL	19.03.2013	58	12.00	57	Gujarat

Sr. No.	Name of Natural Gas Pipelines	Entity	Date of Authorization	Auth. Length (KM)	Auth. Capacity (MMSCMD)	Operating Length (KM)	States from which Pipeline passes
16	Shahdol-Phulpur	RGPL	11.07.2013	312	3.50	304	Madhya Pradesh, Uttar Pradesh
17	Assam Regional Network	AGCL	20.12.2013	105	2.428	107	Assam
18	Dukli – Maharajganj	GAIL	09.01.2014	5.20	0.08	0	Agartala
19	Uran-Taloja	DFPCL	21.10.2014	42.00	0.70	42.00	Maharashtra
20	Chainsa-Jhajjar-Hissar	GAIL	13.12.2010	455	35.00	440	Haryana, Rajasthan
21	Dadri-Bawana-Nangal	GAIL	15.02.2011	921	31.00	998	Punjab, Haryana, Uttar Pradesh, Uttarakhand, Delhi, Himachal Pradesh

Source: Petroleum and Natural Gas Regulatory Board (PNRGB)

Table 16: Full Operational Tie-in connectivity (as on December 31, 2024)

Sr. No.	Name of Natural Gas Pipelines	Entity	Date of Authorization	Auth. Length (KM)	Auth. Capacity (MMSCMD)	Operating Length (KM)	States from which Pipeline passes
1	Jaigarh – Dabhol	WCPL	18.05.2015	60.00	29.00	60.00	Maharashtra
2	ONGCs WHI North Penugonda to GAH, Peravali SV station	KRPEPL	16.02.2016	7.80	0.05	7.80	Andhra Pradesh
3	ONGC's Madnam field to GAIL's Cauvery Basin Network at SV-2 (Memathur)	GAIL	21.12.2017	29	0.85	30	Andhra Pradesh
4	ONGC's S1-VA fields ex- Odalarevu to GAIL's KG Basin Network at SV-1, Bodaskurru	GAIL	09.01.2018	13.60	5.20	14	Andhra Pradesh
5	Suvali to HVJ/DVPL Network	GAIL	24.01.2017	7	2.00	10	Gujarat
6	ONGC's Bantumilli gas source field to GAIL's KG Basin Network	GAIL	21.12.2017	41	0.90	38	Andhra Pradesh
7	Vedanta Limited's Jaya Fields at Jambusar, Gujarat to South Gujarat Main subnetwork	GAIL	07.03.2022	18	0.1	18	Gujarat

	of GAIL's Gujarat Natural Gas Pipeline Network						
8	ONGC's Bokaro CBM Block to SV-01A on Bokaro-Dharma Section of JHBDPL	GAIL	19.08.2021	23	0.99	24.3	Jharkhand

Source: Petroleum and Natural Gas Regulatory Board (PNRGB)

Table 17: Operational Dedicated Natural Gas Pipeline (as on December 31, 2024)

Sr. No.	Name of Natural Gas Pipelines	Entity	Date of Auth.	Auth. Length (Km)	Authorized Capacity (MMSCMD)	Operating Length (KM)	States from which Pipeline passes
1	Duliajan to Numaligarh	DNPL	26.03.2009	194.00	1.20	192.00	Assam
2	Esaar 's LP gas gathering header to Phillips Carbon Black Ltd. Durgapur	EOGEPL	03.11.2010	8.00	0.70	8.00	West Bengal
3	Essar's LP Gas Gathering Header to Graphite India Ltd in Durgapur	EOGEPL	12.08.2015	3.00	0.06	2.36	West Bengal
4	PLL Dahej Terminal to DGEN Power Plant, Dahej SEZ	TPL	27.08.2012	13.00	8.00	13.00	Gujarat
5	EPS Akoljoni - Sapna Chemical *	GAIL	14.12.2012	3.40	0.01	3.40	Gujarat
6	EPS Nanda - Supreme Glass	GAIL	14.12.2012	0.37	0.01	0.37	Gujarat
7	Dahej GGS to GACL P/L	GAIL	14.12.2012	11.25	0.22	12.12	Gujarat
8	GGS Olpad to CYA. & CHEM.	GAIL	14.12.2012	1.20	0.05	1.20	Gujarat
9	Jolwa EPS to Nahar P/L	GAIL	14.12.2012	0.85	0.04	0.85	Gujarat
10	Jolwa EPS to GACL (MDPE)	GAIL	14.12.2012	7.80	0.13	7.80	Gujarat
11	Kim EPS to Spire cera P/L (MDPE)	GAIL	14.12.2012	1.20	0.01	1.20	Gujarat

Sr. No.	Name of Natural Gas Pipelines	Entity	Date of Auth.	Auth. Length (Km)	Authorized Capacity (MMSCMD)	Operating Length (KM)	States from which Pipeline passes
12	EPS Wasana - Universal Metal (Manglam Alloys)	GAIL	14.12.2012	0.61	0.01	0.61	Gujarat
13	Motera GGS - RIL Sughad	GAIL	14.12.2012	3.72	0.07	3.72	Gujarat
14	Kalol collector line T/O - BVM	GAIL	14.12.2012	1.70	0.02	1.70	Gujarat
15	EPS Nandasan - Nirma	GAIL	14.12.2012	4.97	0.01	4.97	Gujarat
16	EPS Nandasan - Sterling (N)	GAIL	14.12.2012	2.84	0.01	2.84	Gujarat
17	EPS Nandasan - Sterling (K)	GAIL	14.12.2012	0.52	0.02	0.52	Gujarat
18	EPS Wadu - Pioneer	GAIL	14.12.2012	0.35	0.01	0.35	Gujarat
19	Sanand GGS - Jalaram	GAIL	14.12.2012	1.17	0.03	1.17	Gujarat
20	Limbodara EPS - Akash	GAIL	14.12.2012	0.20	0.03	0.20	Gujarat
21	Nandasan EPS - Akik Tiles	GAIL	14.12.2012	2.40	0.01	2.43	Gujarat
22	Nallur - TNEB Thirumakkottai	GAIL	14.12.2012	9.80	0.77	10.21	Tamil Nadu
23	Nallur - Prem Chemco	GAIL	14.12.2012	0.185	0.12	0.21	Tamil Nadu
24	BVG-Neycer	GAIL	14.12.2012	16.55	0.02	16.32	Tamil Nadu
25	AFL	GAIL	14.12.2012	1.70	0.10	1.71	Andhra Pradesh
26	Hitech	GAIL	14.12.2012	0.46	0.06	0.46	Andhra Pradesh
27	Steel Exchange	GAIL	14.12.2012	1.36	0.05	1.36	Andhra Pradesh
28	Dandewala - Gamnewala-RSEB Ramgarh	GAIL	14.12.2012	65.19	0.075 / 0.108	65.32	Rajasthan
29	Langtala to Ramgarh	GAIL	14.12.2012	86.21	0.12	88.00	Rajasthan
30	ONGC Kavitam to GAIL Kavitam SV Station	SCPL	27.08.2013	3.60	0.02	3.80	Andhra Pradesh
31	ONGC Kammapalem isolated well to GAIL SV terminal, Dindi in East Godavari	SEIL	09.01.2014	5.40	0.05	4.75	Andhra Pradesh
32	ONGC's CTF Ankleshwar isolated	RCIPL	20.05.2015	0.53	0.015	0.53	Gujarat

Sr. No.	Name of Natural Gas Pipelines	Entity	Date of Auth.	Auth. Length (Km)	Authorized Capacity (MMSCMD)	Operating Length (KM)	States from which Pipeline passes
	well to GAIL's Common Carrier South Gujarat Network interconnection point						
33	Bhadol Top to Torrent Hazira Akhakol	GSPL	05.08.2015	22.00	0.48	22.00	Gujarat
34	LANCO Kondapalli Pipeline -I	PIL	12.08.2015	12.00	2.00	12.00	Andhra Pradesh
35	Sonamura GCS to GMS-Monarchak	ONGC	12.08.2015	13.00	0.50	10.50	Tripura
21	Nandasan EPS - Akik Tiles	GAIL	14.12.2012	2.40	0.01	2.43	Gujarat
22	Nallur - TNEB Thirumakkottai	GAIL	14.12.2012	9.80	0.77	10.21	Tamil Nadu
23	Nallur - Prem Chemco	GAIL	14.12.2012	0.185	0.12	0.21	Tamil Nadu
24	BVG-Neycer	GAIL	14.12.2012	16.55	0.02	16.32	Tamil Nadu
25	AFL	GAIL	14.12.2012	1.70	0.10	1.71	Andhra Pradesh
26	Hitech	GAIL	14.12.2012	0.46	0.06	0.46	Andhra Pradesh
27	Steel Exchange	GAIL	14.12.2012	1.36	0.05	1.36	Andhra Pradesh
28	Dandewala - Gamnewala-RSEB Ramgarh	GAIL	14.12.2012	65.19	0.075 / 0.108	65.32	Rajasthan
29	Langtala to Ramgarh	GAIL	14.12.2012	86.21	0.12	88.00	Rajasthan
30	ONGC Kavitam to GAIL Kavitam SV Station	SCPL	27.08.2013	3.60	0.02	3.80	Andhra Pradesh
31	ONGC Kammapalem isolated well to GAIL SV terminal, Dindi in East Godavari	SEIL	09.01.2014	5.40	0.05	4.75	Andhra Pradesh
32	ONGC's CTF Ankleshwar isolated well to GAIL's Common Carrier South Gujarat Network interconnection point	RCIPL	20.05.2015	0.53	0.015	0.53	Gujarat
33	Bhadol Top to	GSPL	05.08.2015	22.00	0.48	22.00	Gujarat

Sr. No.	Name of Natural Gas Pipelines	Entity	Date of Auth.	Auth. Length (Km)	Authorized Capacity (MMSCMD)	Operating Length (KM)	States from which Pipeline passes
	Torrent Hazira Akhakol						
34	LANCO Kondapalli Pipeline -I	PIL	12.08.2015	12.00	2.00	12.00	Andhra Pradesh
35	Sonamura GCS to GMS-Monarchak	ONGC	12.08.2015	13.00	0.50	10.50	Tripura
36	ADB GCS to ONGC Colony Badarghat	ONGC	12.08.2015	11.00	0.03	10.79	Tripura
37	ONGC Hazira - KRIBHCO HP Pipeline	ONGC	12.08.2015	5.00	2.00	4.27	Gujarat
38	ONGC Hazira - KRIBHCO LP Pipeline		12.08.2015	5.00	1.00	4.86	Gujarat
39	Essar's Main Compressor Station in Raniganj (East) CBM Block to Matix Fertilizer and Chemicals Ltd (MFCL) in Durgapur	EOGEPL	12.08.2015	30.00	3.00	28.47	West Bengal
40	ONGC Poondi Fields to Maharaj Soaps Industry Private Limited	MSIPL	29.09.2020	0.20	0.002	0.26	Tamil Nadu
41	PLL's Dahej - Koyali Refinery Natural Gas Pipeline (DKPL)	IOCL	20.03.2020	106.00	5.23	106.0	Gujarat

Source: Petroleum and Natural Gas Regulatory Board (PNRGB)

5.5 Expected growth in natural gas pipeline network in India

India's natural gas pipeline network is expected to witness substantial growth over the next decade. Driven by increasing usage across various end-user customer segments, the Government of India has come up with multiple reforms as they target to raise the share of Natural Gas in the primary energy mix to 15% by 2030 from around 7% currently (in FY24).

As per Ministry of Petroleum & Natural Gas (MoPNG, Government of India), as on December 2024, 10,676 km of Natural Gas pipeline (including sub-transmission pipeline & tie in connectivity pipeline) are under various stages of construction. The National Gas Grid aims to increase the pipeline network from the existing 25,124 kms to 35,000 kms by next 2-3 years, covering underserved regions such as the Northeast, Jammu & Kashmir, and parts of central India. Key players like GAIL, Indian Oil Corporation Limited (IOCL), and private entities are actively contributing to this growth. Key projects like the Urja Ganga Gas Pipeline, the North-East Gas Grid, and the Mumbai-Nagpur-Jharsuguda Pipeline are at the forefront of these efforts, contributing to a more connected National Gas Grid. The Northeast region, in particular, is receiving substantial attention with a Rs 41,000 crore investment to build a network connecting cities like Guwahati, Kohima, and Imphal. Additionally, South India will see enhanced connectivity through

pipelines such as the Kochi-Bengaluru-Mangalore line. With the increasing demand for natural gas fueled by industries such as fertilizer, power, and city gas distribution, the pipeline infrastructure is projected to support a steady rise in natural gas consumption over the coming years.

5.6 Key factors driving natural gas pipeline network in India

Demand Drivers for Natural Gas Consumption in India

The various factors driving the demand for natural gas consumption in India are discussed below:

- **Increasing demand from various sectors**

Natural Gas has found applications across various industries with majority of demand coming from power, fertilizer, industrial and CGD sectors. The key factors driving the usage of natural gas in various industries are-

Power Sector- Constrained domestic coal supply and rising cost of imported coal makes natural gas a good alternative fuel for the power sector. Gas based power plants are more efficient than coal-based plants along with higher ramping rates which is a key driver for their usage in the power sector. Further, it has been observed that CO2 emission for coal is 82% higher than natural gas. Thus, increasing the share of natural gas is important to preserve climate and environment.

The consumption of natural gas towards power sector has significantly declined from more than 1/3rd in 2012-13 to around 13% during 2024-25 (Apr- Feb 2025). The share of power sector in the total natural gas consumption is expected to stay range bound over the medium term. However, with the increasing share of renewables in India's energy mix, natural gas can potentially play a key role in enabling grid stability.

Fertilizer Sector- Natural gas, having the highest hydrogen to carbon ratio, is the most preferred feedstock for the production of fertilizers. The demand for fertilizers is envisioned to increase, considering the agriculture productivity growth in India.

As India has to rely on imports to meet the domestic requirements of urea and non-urea fertilizers. As a result, the Indian government is encouraging domestic production of urea which is expected to rise to 30.1 million tonnes by 2025 supported by GOI subsidies and the objective of reducing dependence on imported urea.

With this, fertilizer production using natural gas as a feedstock in India is expected to grow the highest globally. This, in turn, is likely to increase the consumption of natural gas going ahead as the feedstock accounts for around 70%-80% of the total cost of urea manufacturing. Natural gas is primary and preferred feedstock for production of urea. It consumes less energy and has better product yield compared to other inputs.

The consumption of natural gas towards fertilizer industry has been steady and has grown from around 25% to around 29% from the year 2012-13 to 2024-25 (Apr- Feb 2025).

- **Increase in Natural Gas Infrastructure as well as Investments**

India is in the line to become the second largest user of natural gas in Asia as it has plans to boost the share of the natural gas in the energy mix to 15% by 2030 from around 7% in 2024. Over the last decade, the mix of natural gas in India's energy mix has been constrained at around 7% owing to inadequate infrastructure. With the governments' focus on increasing the natural gas consumption, massive investments are expected in developing the natural gas infrastructure. Lot of infrastructural developments are in progress including expansion of LNG import capacity, addition of new gas pipelines, development of City Gas Distribution networks. Around 25,124 km of gas pipelines was operational in India as on December 31, 2024 while 10,676 km of pipelines was under construction.

Some of the other factors that will be driving up the demand are-

- **Investment by Global Firms**

India has been inviting global firms to invest in the opportunities occurring in the oil and gas sector. Government has been pushing for many attractive investments and opportunities to increase the area under oil and gas exploration.

- **Ongoing Deep-water Development**

The ongoing deep-water development will soon lead to the increase in the production of India's natural gas. India will also witness an increase in the LNG trade. This will be further driven by the recent addition of the Ennore and Mundra terminals and the expansion of the Dahej facility.

- **Government Initiatives**

The government's focus on enhancing the share of natural gas in India's energy mix is a key driver for the growth of gas sector. The government has taken several initiatives to boost the sector such as facilitating development of gas infrastructure including LNG terminals, long-distance transmission pipelines and city gas distribution networks. A total of 1544 Kms of pipelines have been laid as part of the National Gas Grid in 2020. The government launched the Indian Gas Exchange (IGX), first nationwide online delivery-based gas trading platform in 2020. The government's favorable policies will help in driving the gas demand growth over the next decade.

- **Cost Competitiveness**

The natural gas is usually cost competitive as compared to various other fuels which is a key demand driver. For instance, it is usually cheaper as compared to petrol and diesel which has led to its increased usage in automobile sector. Similarly, it competes with LPG for domestic cooking and therefore, there is increased switching of residential customers from LPG to natural gas in the past few years.

- **Environmental Awareness and Clean Energy Adoption**

Rising awareness about the health and environmental impacts of traditional fuels such as coal and biomass has led to a preference for cleaner energy options like natural gas. The adoption of electric vehicles powered by natural gas, particularly in urban areas, is on the rise, contributing to the overall demand for cleaner energy

5.7 Natural Gas Infrastructure in India

5.7.1 Import Terminal

Import Terminal or LNG Terminals are facilities which are used for the purpose of degasifying the LNG shipped in by large LNG tankers from various production zones. These terminals are made to provide services such as-

- Berthing of LNG tankers and unloading or reloading of cargoes,
- Storage of LNG in cryogenic tanks (-160°C),
- Regasification of LNG and Injection of this gas into the transmission grid.

As on April, 2025, there are total seven RLNG terminals operating in the country with varying capacity utilization. The existing and potential capacity of LNG regasification terminals in India is presented in the table below:

Table 18: LNG Terminal in India

LNG Terminals (Operational)			
Location	**Promoters**	**Capacity as on 01.04.2025 (MMTPA)**	**% Capacity utilization (April- February, 2025)**
Dahej	Petronet LNG Ltd (PLL)	17.5	98.1
Hazira	Shell Energy India Pvt. Ltd.	5.2	32.5
Dabhol	Konkan LNG Limited*	5	45.1

LNG Terminals (Operational)			
Location	**Promoters**	**Capacity as on 01.04.2025 (MMTPA)**	**% Capacity utilization (April- February, 2025)**
Kochi	Petronet LNG Ltd (PLL)	5	22.3
Ennore	Indian Oil LNG Pvt Ltd	5	25.1
Mundra	GSPC LNG Limited	5	22.2
Dhamra	Adani Total Private Limited	5	41.0
Total Capacity		**47.7**	

Source: Petroleum Planning and Advisory Cell (PPAC)
Note: (*) stands for - To increase to 5 MMTPA with breakwater. Only HP stream of capacity of 2.9 MMTPA is commissioned; (**) stands for- under construction site.

The capacity of RLNG terminals in India is expected to increase assuming all the existing and planned terminals in India would set up as planned. This is to be driven by the new facilities expected to be set up on the east coast including Gangavaram and Dhamra, expansion of existing facilities on the west coast including Mundra and Dahej and construction of new floating terminals.

5.7.2 Awards & Projects in Pipeline

Gas Pipeline infrastructure is an economical and safe mode of transporting the natural gas by connecting gas sources to gas consuming markets. Gas pipeline grid determines the structure of the gas market and its development. Therefore, an interconnected National Gas Grid has been envisaged to ensure the adequate availability and equitable distribution of natural gas in all parts of the country. The vast potential that gas offers in India has prompted energy companies to push plans to expand the LNG terminals capacity in India, a move that will expand the clean fuel's reach to relatively smaller pockets of demand where there is limited pipeline access. A brief of major gas pipeline projects which are under construction are-

Table 19: Under construction Natural Gas Pipelines in India

S. No.	Name of Natural Gas Pipelines	Name of Authorized Entity	Date of Authorization	Authorized Length (KM)	Authorized Capacity (MMSCMD)	Target date of Completion	States from which Pipeline passes
1	Ennore-Nellore	GTIL	02.12.2014	220	36	Apr-20	Andhra Pradesh, Tamil Nadu
2	Kakinada-Vijayawada-Nellore	IMC	19.02.2018	667	18	Mar-24	Andhra Pradesh
3	North-East Natural Gas Pipeline Grid	IGGL	17.11.2020	1,656	4.75	Mar-25	Assam, Mizoram, Manipur, Arunachal Pradesh, Tripura, Nagaland, Meghalaya& Sikkim, West Bengal
4	Kanai - Chhata - Panitar	HPPL	08.07.2019	317	19.2	Mar-24	West Bengal
5	Srikakulam-Angul	GAIL	23.07.2019	690	6.65	Jun-24	Andhra Pradesh, Odisha
6	Mumbai-Nagpur-Jharsuguda	GAIL	15.05.2020	1755	16.5	Jun-24	Maharashtra, Madhya Pradesh, Chhattisgarh and Odisha

S. No.	Name of Natural Gas Pipelines	Name of Authorized Entity	Date of Authorization	Authorized Length (KM)	Authorized Capacity (MMSCMD)	Target date of Completion	States from which Pipeline passes
7	Jamnagar to Dwarka (Gujarat)	GSPL	19.08.2021	100	3	Aug-24	Gujarat
8	Hazaribagh-Ranchi	IOCL	09.02.2023	65	1.03	Feb-26	Jharkhand
9	Gurdaspur-Jammu	GAIL	12.07.2023	160	3.1	Jul-26	UT of Jammu & Kashmir, Punjab
Total				**5,630**			

Source: Petroleum and Natural Gas Regulatory Board (PNRGB)

Table 20: Under Construction Tie-in connectivity (as on December 31, 2024)

Sr. No.	Name of Natural Gas Pipelines	Entity	Date of Authorization	Auth. Length (KM)	Authorized Capacity (MMSCMD)	Target date of Completion	States from which Pipeline passes
1	ONGC's Odelarevu terminal, Mallavaram connecting KVNPL	IMC	06.09.2019	49.1	18	Sep-22	Andhra Pradesh
2	GSPL’s proposed Terminal at Petronet LNG Limited re-gasification expansion facilities, Dahej to GSPL's existing Terminal at Bhadbhut	GSPL	17.09.2019	39	14.77	May-26	Gujarat
3	HSEPL LNG Terminal at Chhara to GSPL’s dispatch terminal at Londhpur	GSPL	17.09.2019	85	18	Dec-22	Gujarat
4	Proposed LNG Terminal at Karaikal Port to Chemplast/ PPCL on existing Narimanam - Kuthalam Natural Gas Pipeline Sub-Network of GAIL's Cauvery Basin Network	AGPKLPL	24.07.2020	8	2	Jul-23	Tamil Nadu and UT of Puducherry
5	ONGC's Jharia CBM Block to SV-28 on Dobhi-Durgapur Section of JHPDBL	GAIL	19.08.2021	6	0.87	Mar-25	Jharkhand

Sr. No.	Name of Natural Gas Pipelines	Entity	Date of Authorization	Auth. Length (KM)	Authorized Capacity (MMSCMD)	Target date of Completion	States from which Pipeline passes
6	Swan LNG Private Limited's FSRU based LNG Terminal at Jafrabad to GPPC Terminal, Jafrabad falling on Darod-Jafrabad section of GSPL's HPGGG	GSPL	19.08.2021	3	18	Aug-24	Gujarat
7	Swan LNG Private Limited's RLNG Terminal at Jafrabad to Hadala falling on Gana-Hadala section of GSPL's HPGGG	GSPL	31.12.2021	198	18	Dec-24	Gujarat
8	Swan LNG Private Limited's RLNG Terminal at Jafrabad to GAIL's terminal at Dahej connecting to its integrated HVJ	GAIL	31.12.2021	170	7	Dec-24	Gujarat
9	EPS 1 of Jharia Block I to SV-28 on Dobhi-Durgapur Section of JHBDPL	PEPL	28.10.2022	9	0.79	Oct-25	Jharkhand
10	ONGC's Raniganj CBM Block to GAIL's JHBDPL Network	GAIL	30.11.2023	28.81	0.47	Nov-26	West Bengal
	Total			**593**			

Source: Petroleum and Natural Gas Regulatory Board (PNRGB)

Table 21: Under Construction Dedicated Natural Gas Pipelines (as on December 31, 2024)

Sr. No.	Name of Natural Gas Pipelines	Name of Authorized Entity	Date of Authorization	Auth. Length (KM)	Authorized Capacity (MMSCMD)	States from which Pipeline passes
1	INOLE to Pashamylaram	APCPL	14.12.2012	14.6	1.5	Telangana
2	PLL Re-gasification Terminal, Dahej to SUGEN Power Plant	TPL	20.03.2020	90	6.5	Gujarat
3	PLL to OPaL, Dahej	OPaL	20.03.2020	17	3.32	Gujarat
Total				**122**		

Source: Petroleum and Natural Gas Regulatory Board (PNRGB)

Table 22: Under Construction Sub-Transmission Pipelines (as of December 31, 2024)

Sr. No.	Geographical Area/ CGD Networks	Authorized CGD Entity	STPL Length (KM)	Transmission PL from Tap-off taken	Transmission PL Entity
1	Jalandhar	JMEPL	4	DBNPL	GAIL
2	East Godavari District (EAAA)	GGPL	51.3	KG basin Network	GAIL
3	West Godavari District	GGPL	53.4	KG basin Network	GAIL
4	Amravati and Yavatmal District	ATGL	0.2	MNJPL	GAIL
5	Udupi District	ATGL	3.1	KKMBPL	GAIL
6	Balasore, Bhadrak & Mayurbhanj Districts	ATGL	0.1	JHBDPL	GAIL
7	Puducherry District	ECNGDPL	8	ETBPNMTPL	IOCL
8	Cuddalore, Nagapattinam & Tiruvarur Districts	ATGL	0.2	ETBPNMTPL	IOCL
9	Gumla, Latehar, Lohardaga, Simdega, Garhwa And Khunti Districts	ATGL	0.18	JHBDPL	GAIL
10	Medak, Siddipet & Sangareddy Districts	TGPL	2	EWPL	PIL
11	Bilaspur, Hamirpur & Una Districts	BPCL	4.7	GAIL	GAIL
12	Ballari & Gadag Districts	BPCL	0.1	GAIL	GAIL
13	Jagatsinghpur & Kendrapara Districts	BPCL	1.8	GAIL	GAIL
14	Chatra & Palamu Districts	BPCL	0.85	GAIL	GAIL
15	Angul & Dhekanal District	BPCL	4.2	JHBDPL	GAIL
16	Kokrajhar, Dhubri, South Salmaramankachar & Goalpara Districts	ATGL	0.4	JHBDPL	GAIL
17	Baksa, Barpeta, Bongaigaon, Chirang, Nalbari & Bajali Districts	ATGL	0.15	JHBDPL	GAIL
18	Tikamgarh, Niwari, Chattarpur and Panna Districts	ATGL	0.6	HVJ	GAIL
19	Darbhanga, Madhubani, Supaul, Sitamarhi and Sheohar Districts	BPCL	74.3	JHBDPL	GAIL
20	Gopalganj, Siwan, West Champaran, East Champaran and Deoria (UP) Districts	BPCL	38.2	JHBDPL	GAIL
21	Fazilka (except area already authorized) (PB), Ganganagar (RJ) and Hanumangarh (RJ)	BPCL	62.7	DBNPL	GAIL
22	Purulia and Bankura Districts	BPCL	1	JHBDPL	GAIL
23	Alipurduar and Koch Bihar Districts	BPCL	1.5	JHBDPL	GAIL
24	Lakhimpur Kheri, Sitapur, Bahraich, Shravasti, Balrampur, Siddharth Nagar & Maharajganj Districts	BPCL	58.1	HVJPL & JHDPL	GAIL
25	Koria, Surajpur, Balrampur & Surguja Districts	BPCL	96	Shadol-Phulpur	RGPL
26	Nizamabad, Kamareddy, Nirmal, Adilabad, Mancherial and Asifabad GA	MNGL	95	EWPL	PIL
	Total		**562**		

Source: Petroleum and Natural Gas Regulatory Board (PNRGB)

5.8 Review of policies promoting natural gas consumption in India

The various factors driving the demand for natural gas consumption in India are discussed below:

Commitment to Net Zero emissions by 2070 made in COP

The United Nations Climate Change Conference (28th session of Conference of the Parties), COP28 took place in December, 2023. The motive of the summit was to make considerable efforts for the global climate policy that the nations have been discussing for several years and for the same, India has promised to trim its emission to net zero by 2070.

Previously, the United Nations Climate Change Conference (27th session of Conference of the Parties) took place in November 2022.

At COP 27, India's negotiations were based on foundational principle of equity and the best available science to draw developed countries' attention to their unfulfilled commitments. The G77+China which represents more than 80% of the world population united to produce just and equitable outcomes. In the COP 26 and COP 27, India contributed to decisions that have explicitly made unprecedented expressions of regret and concern at the failure of developed countries to meet their commitments in climate finance.

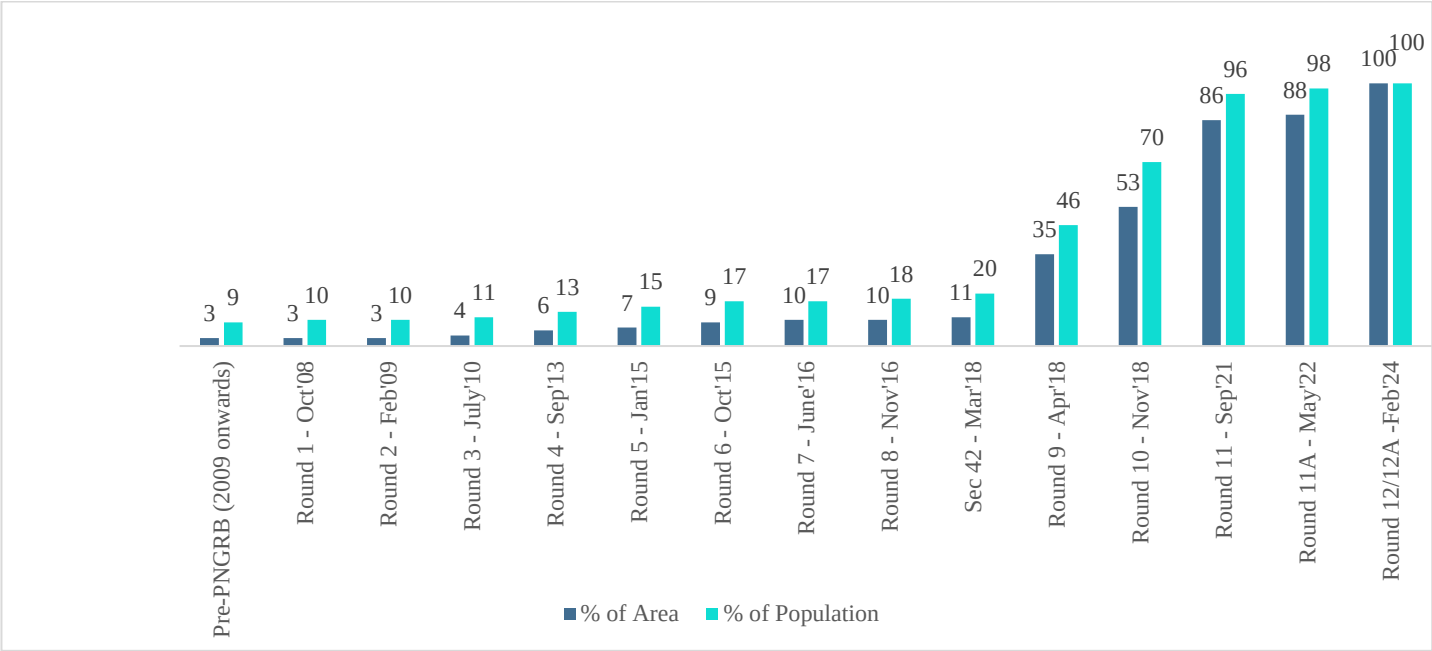
City Gas Distribution Network Development (CGD)-

For the easy accessibility of Natural Gas to public at large, government has pushed to emphasize on the expansion of City Gas Distribution network as it supplies cleaner fuel to the households. There is Government's thrust to enhance the supply and consumption of natural gas through granting authorization to entities for development of CGD network in new Geographical Areas. This has received significant impetus from the Government's commitment towards clean energy under COP 26 as well.

Cumulatively up to the Round 11A of CGD Bidding, CGD network covered 300 geographical areas (98% population and 88% area of India). Further, through the Round 12/12A of CGD Bidding, the CGD network is now expected to cover 307 geographical areas (almost 100% population of India). CGD now constitutes around 21% of total natural gas consumption in India.

Additional estimated investment of Rs. 1,20,000 Crore infrastructure development under Round 9 & Round 10 of CGD Bidding (PNGRB launched the 9th and the 10th CGD Bidding Round on 06th April 2018 and 06th November 2018, for development of CGD networks) would help India generate additional employment, bring technological innovation in the transportation sector and play a significant role in achieving the shift towards a gas-based economy. This capex is over the period of 8 years from the time of award of GA. The above estimate does not include the additional investments expected in the sector towards gas infrastructure development that will be done for the additional geographical areas to be developed through the recently concluded Round 11 of the CGD Bidding. However, an additional investment of Rs 41,000 crore is expected under Round 12 for developing gas infrastructure across 7 more geographical areas.

Chart 41: City Gas Authorization in India (Category-wise) (cumulative %)



Source: PIB

Compressed Natural Gas (CNG) consumption continues to grow in India, led by increasing natural gas infrastructure, and the share of CNG in the transportation sector is expected to rise significantly. A shift in the use of vehicles from diesel and petrol to CNG has helped reduce carbon emissions and is driving demand for natural gas.

Further, Piped Natural Gas (PNG) is a safer mode than LPG as it is lighter than air and in case of any leakage, it dissipates directly in the air. The flow of PNG can be easily controlled by various checks/ valves installed in the system. As PNG is supplied through pipe, the supply is uninterrupted and round-the-clock. As a result, there is no need to store cylinders in the kitchen helping economies the available spaces in households. Lastly, the existing LPG appliances and equipment can be used on PNG with minor modifications thereby avoiding any material cost in the transition process from fossil fuel to PNG. As of February, 2025, total PNG connections in the country stood at 1,47,64,293 connections (including 1,46,99,171 domestic PNG connections, 44,869 commercial PNG connections, and 20,253 industrial PNG connections).

Out of total natural gas consumption, CGD share of consumption of natural gas stands at 21% for the period April-Feb, 2025. With the significant Government impetus and expansion of the CGD network to 307 geographical areas, the natural gas consumption by the CGD segment is likely to grow.

National Gas Grid Expansion (Pradhan Mantri Urja Ganga Project)

The Pradhan Mantri Urja Ganga Project aims to expand India's natural gas pipeline network, connecting different regions of the country to enable easier access to natural gas. This policy is a critical step in ensuring that natural gas can be supplied to more urban and industrial areas, thereby encouraging greater consumption.

The expansion of the gas grid has made natural gas accessible to more cities and industries, boosting consumption in areas where it was previously unavailable. The policy also supports the development of city gas distribution (CGD) networks, promoting the use of natural gas for cooking, transportation, and industry

Fuel Substitution Policies

In an effort to reduce air pollution and greenhouse gas emissions, the Indian government has encouraged the substitution of coal with natural gas in industries such as power generation, cement production, and fertilizers. The government has also provided incentives for industries to shift to cleaner fuels.

This policy has led to a gradual increase in the use of natural gas in industries. However, the shift has been slow due to factors like high fuel costs and limited infrastructure. Despite the government's push, coal remains dominant due to its affordability and availability

Natural Gas as a Transport Fuel

The government has made efforts to promote the use of natural gas in the transportation sector. India's growing fleet of CNG-powered vehicles, including buses, taxis, and auto-rickshaws, has been bolstered by tax incentives and the development of refueling infrastructure

CNG is increasingly being used as a transport fuel, especially in cities with high pollution levels. The policy has led to a rise in natural gas consumption in the transport sector, reducing the reliance on petrol and diesel. However, the expansion of CNG infrastructure has been limited in some regions, slowing down widespread adoption

National Clean Air Programme (NCAP)
Launched in 2019, the National Clean Air Program (NCAP) aims to reduce air pollution in Indian cities, partly through the adoption of cleaner fuels, including natural gas. The programme envisages to achieve reductions up to 40% or achievement of National Ambient Air Quality Standards for Particulate Matter10 (PM 10) concentrations by 2025-26.

82 cities under NCAP have been provided annual target of 3-15% reduction of PM10 levels to achieve overall reduction of air quality up to 40% PM10 levels, and 49 cities under XVth Finance Commission air quality grant, have been given an annual target of 15% reduction in annual average Particulate Matter10 (PM10) concentrations and improvement of good air quality days (Air Quality Index less than 200).

5.9 Threats and Challenges in the Natural Gas sector

- **Unified Tariff Regulation for natural gas pipeline**

The government announced a new unified natural gas pipeline tariff Regulation in 2020 which changed the tariff regime for gas transmission pipelines. As per the earlier policy, the consumers were charged on the basis of their distance from the source of gas and the number of pipelines used. However, the new policy brought out a uniform tariff regime with one tariff for gas transported to consumers within 300km from the source of natural gas and another tariff for consumers beyond 300 km. The objective of this reform is to reduce the cost of gas transportation for consumers farther from sources of gas and make it affordable in all parts of the country. However, this will lead to higher cost for consumers located near the source of gas as they will end up subsidizing the consumers farther from the source of gas.

- **Bidding Criteria**

As per PNGRB regulations, CGD networks for new areas have to be awarded through a competitive bidding process. Under this, the bidders are evaluated against a specific set of criteria. In the earlier bids, there were only two bidding criteria including network and compression tariff and most of the bidders made aggressive bids (at nearly nil rates). The quoting of low tariff may expose these aggressive bidders to competition once the marketing exclusivity period is over as any new entrant can use the network of these existing players at a minimal cost. However, this issue has been partly mitigated with the revised bidding criteria (effective since Round 9) which has set floor rates for these tariffs to prevent unreasonable bidding. Also, there is a shift in focus under these revised criteria towards expansion of CGD network.

- **Limited Marketing Exclusivity**

The development of CGD network including pipeline network, CNG stations, city gas station is capital intensive and takes some years. The high fixed costs coupled by the low margins owing to competition from alternate fuels result in long payback period for

CGD players. The Regulations provide marketing exclusivity to the CGD players for a period of eight years (earlier 5 years) from the date of authorization which restricts entry of new players in the respective Geographical area during this period. However, the effective operating period is lower as it usually takes 2 to 3 years to develop the network. Therefore, post expiry of marketing exclusivity period, players may be exposed to competition risk from new entrants.

- **Challenges for EPC Projects Execution**

EPC companies face several challenges in executing natural gas pipeline projects. These include complex engineering demands due to difficult terrain, high-pressure systems, and integration with existing infrastructure. Procurement delays and cost fluctuations for key materials like steel pipes also pose risks. Construction is often hindered by land acquisition issues, weather conditions, and a shortage of skilled labor. Environmental regulations and community opposition can delay approvals and escalate project costs.

- **Other challenges**

In the present scenario, India has only limited reserves of natural gas, though further discoveries and infrastructures are being made from recent explorations. Limited reserves and constant increase in demand can lead to surge in the price of the Natural Gas.

- Extraction of Natural Gas leads to large cavities in the ground. It requires massive complex treatment plants and pipelines for its delivery.
- Constructions of Natural Gas pipelines and import terminals are very expensive. Huge amount of investments is required for the same.

6 Peer Comparison

6.1 Company Profile

6.1.1 Vishnu Prakash R Punglia Limited.

- **Description:** Vishnu Prakash R Punglia Ltd is an engineering, procurement, and construction (EPC) company engaged in the business of construction and infrastructure development in India. Its principal business operations are broadly divided into four categories: Water & Sanitation Programs; Railway Projects; Road Projects and Sewage, Civil & Others.
- **Year of Incorporation:** 1986
- **Headquarters:** Mumbai, India
- **Services Provided:**

Water Sector	Water dams, Water Tanks, Reservoirs, Water Treatment Plants, Water supply schemes, Overhead tanks, Pipelines, Irrigation Channels etc.
Sewerage Sector	Sewerage treatment Plants, Sewer Tank drain
Railway Sector	Railway Tracks, Railway Stations and allied buildings, Platforms and Bridges
Road Sector	Development of roads and highways, bridges and Flyovers
Tunnelling Works	Constructing tunnels in hydropower, railways, metro rail, roads, and highways
Buildings and Ware Houses Works	Construction of multistorey buildings and warehouses for the storage of food grains and other materials

- **Key Projects:**
    - In FY24, the company has achieved competencies to bid for large value projects and has successfully bagged large value projects which includes 2 in Uttarakhand for Rs 8,987 million, one in Uttar Pradesh for Rs 4,960 million and one for Rs 6,344.1 Million in Madhya Pradesh.
    - In FY23, the company had the railway project worth Rs 304 crores.
    - In FY22, the company received a work order through JV from the Uttar Pradesh government, worth Rs 237 crores, under the 'State Water & Sanitation Mission, Namami Gange & Rural Water Department'.

6.1.2 Bondada Engineering Limited.

- **Description:** Bondada Engineering Limited provides engineering, procurement, construction (EPC), and operations and maintenance (O&M) services for the telecom and renewable energy sectors in India. It specializes in telecom infrastructure design, tower maintenance, and OFC route maintenance, and offers end-to-end services for solar photovoltaic power plants, including design, installation, and O&M. The company also provides solar EPC services and installs modular cleaning systems for solar plants. It is operational in five states across India.
- **Year of Incorporation:** 2012
- **Headquarters:** Hyderabad, India
- **Services Offered:**

EPC Service	O&M Service
Telecom Tower EPC	Telecom Tower O&M
Telecom OFC EPC	Telecom OFC O&M
Solar EPC	Solar O&M

- **Key Projects:**
  - In FY23, Bondada Limited had secured a major project in its BSNL 4G saturation initiative, with an order for 1,238 locations valued at Rs 1,156 crore.
  - The company has also completed its first ever IPP project with capacity of 2.80 MW having PPA with BHEL for 25 years.

6.1.3 EMS Limited

- **Description:** EMS Limited operates in wastewater treatment plants (WWTPs) and water supply and sanitation projects (WSSPs) in India. The Company specializes in providing turnkey services for water and wastewater collection, treatment, and disposal. It offers solutions for engineering, design, construction, and installation of water, wastewater, and domestic waste treatment facilities. The Company is also involved in the construction of flyovers, roads, and other infrastructure projects.
- **Year of Incorporation:** 1998
- **Headquarters:** Delhi, India
- **Services Offered:**

Integrated water & Sewerage solution provides	Electrical Transmission and Distribution	Building and Road works
Water Supply Systems	Design and construction of power transmission and distribution infrastructure	Design and construction of buildings & allied works
Water and Waste Treatment Plants	Designing and installing electricity transmissions	Design, construction, operation and maintenance of public infrastructure facilities and utilities
Industrial Waste Treatment Project (IWTP)		HAM Projects related to Road Network
Hybrid Annuity Model (HAM) Projects under Sewerage Sector		
Operation and maintenance of Wastewater Scheme Projects (WWSPs)		
O & M of Industrial Waste Projects (IWP)		

- **Key Projects:**
  - The company has Supplied, Layed, Joined, Tested & Commissioned PCCP Pipe of 1500 mm in Uttar Pradesh

- 24 MLD Sewage Treatment Plant, Main Sewage Pumping Station, Intermediate Pumping Station Zone-3, sewerage Network of Zone-3 in Uttar Pradesh
- Sewage Treatment Plant of capacity 30MLD including MPS (45 MLD) and all appurtenant structures and allied works in Uttar Pradesh
- Water Supply Distribution Network Improvement with house service connections and providing Sewer Network with STP in Rajasthan

6.1.4 Likhitha Infrastructure Limited.

- **Description:** The company is in the field of laying of Cross-Country Pipeline of hydrocarbons and City Gas Distribution Projects. The company is engaged in the business of Pipeline Laying providing comprehensive erection, testing and commissioning of Oil & Gas Pipelines, City Gas Distribution Projects and Operation and Maintenance (O & M) Services. It is operational in fourteen states across India and is presently working with all major PSU's and CGD companies.

- **Year of Incorporation:** 1998

- **Headquarters:** Hyderabad, India

- **Revenue Classification:** The company derives its revenue entirely from India

- **Services Offered:**

Pipeline Infrastructure	O&M Service
Cross Country Pipeline Laying	Management Services for CGD networks
City Gas Distribution Network	Deploying manpower and tools required for replacement of existing pipelines, emergency repair and maintenance, shifting and compressor hook up of pipelines with associated facilities

- **Key Projects:**
  - The company has executed Trans-National Hydrocarbon (Multi-product) Pipeline Project between India and Nepal. It has secured an order valued at Rs 106.12 crore from Hindustan Petroleum Corporation (HPCL) on March 12, 2024. The project involves the laying and construction of a steel pipeline, along with related works, for the Haldia Panagarh Pipeline Project.
  - The company has laid 12.75" OD 111.00 Km LPG Pipeline from IOCL Muzaffarpur terminal to IOCL Motihari Terminal, combined station works, and associated works at SV Stations under the Muzaffarpur - Motihari Pipeline Project (MMPL) for Indian Oil Corporation Limited worth Rs 76,550.93 million

6.1.5 Suyog Telematics

- **Description:** Suyog Telematics Limited is a telecommunication infrastructure provider, providing solutions by building and operating telecom towers and related assets, thereby providing these passive infrastructure assets on shared basis to Telecommunication Service Providers. Its products include Ground based to Towers, Rooftop Towers, COW Towers, GBM Towers and Camouflage Towers. The company has 4,400+ Telecom Towers and 5,200+ tenancies as of September 2024 across 26 States & UTs.

- **Year of Incorporation:** 1995

- **Headquarters:** Mumbai, India
- **Services Offered:**

Telecom Towers (Passive Infrastructure)	Small Cell Infrastructure	Rooftop Towers and Pole Sites
Strategic Site Selection and Infrastructure Leasing	Optical Fiber Cable (OFC) Networks	Operation and Maintenance Services

- **Key Projects:** NA

6.1.6 Annu Projects

- **Description:** Annu Projects is one of the diversified companies in the EPC sector, involved in fields ranging from fiber optics to sewerage projects and also undertakes gas pipeline projects. With its machinery division, the company offers solutions for different industries. It operates in eleven states across India.

  Annu Projects has shown the second-highest CAGR in terms of gross profit between FY22 and FY24 among the peers listed in the section.
- **Year of Incorporation:** 2003
- **Headquarters:** New Delhi, India
- **Services Offered:**

Telecom Infrastructure	Sewerage Infrastructure	Gas Pipeline
Laying OFCs for all the telecom operators on Pan India basis	laying of PE pipes and installation of man holes	Laying of zero safety gas pipe laying for house connection
	RCC work and stone soiling for road work	Building of distribution gas Network

- **Key Projects:**

  Telecom Infrastructure

  - The Company has finished the installation, end to end integration, testing and commissioning of work of underground OFC. The Company has created 3,386.67 km route of OFC network for Bharat Broadband Network Limited.
  - The Company completed the installation, testing and commissioning of OFC and optical access route for defence network for specified part of package totalling to approximately 1,853 km in the states of Bihar and Jharkhand.
  - The Company completed the comprehensive maintenance of existing OFC and incremental laying and replacement of damage OFC under Phase I of BharatNet in Bihar Telecom Circle. This was a direct project from Bharat Sanchar Nigam Limited.

Sewerage Infrastructure

- The Company completed (i) the designing and building of one sewage treatment plant having installed capacity 3.5 MLD; and (ii) survey, review the designs, redesign where necessary, and built new underground sewerage network of about 34.21 km length. The total contract value for this EPC project, undertaken in Rajmahal town, District Sahibganj, Jharkhand, for the Jharkhand Urban Infrastructure Development Company Limited, amounts to Rs Rs 475.47 million.

- The Company has completed the laying of HDPE pipes of various diameter under the Sewerage Scheme for Ponda Town in Ponda Talukar, Goa Phase I and III having a total contract value of Rs 282.46 million and Rs 312.72 million, respectively. This was also a direct project from Sewerage and Infrastructural Development Corporate of Goa Limited.

6.2 Peer Benchmarking

Table 23: Revenue from Operations

Particulars (in Rs Millions)	FY22	FY23	FY24	9MFY25	CAGR (FY22-FY24)
Vishnu Prakash R Punglia Limited	7,856.13	11,684.04	14,738.65	8,323.60	36.97%
Bondada Engineering Ltd.	3,343.54	3,705.88	8,007.22	NA	54.75%
EMS Limited	3,599.17	5,381.62	7,933.11	6,850.39	48.46%
Likhitha Infrastructure Limited	2,572.12	3,649.55	4,216.81	3,845.88	28.04%
Suyog Telematics Ltd	1,263.39	1,436.44	1,666.14	1,425.20	14.84%
Annu Projects	1,115.62	1,298.08	1,539.82	870.10	17.48%

Source: Company Annual Reports

Table 24: Gross Profit

Particulars (in Rs Millions)	FY22	FY23	FY24	9MFY25	CAGR (FY22-FY24)
Vishnu Prakash R Punglia Limited	1,113.39	1,942.15	2,728.04	1,617.89	56.53%
Bondada Engineering Ltd.	1,715.79	1,870.42	2,796.14	NA	27.66%
EMS Limited	1,338.41	1,846.74	2,452.82	2,258.71	35.38%
Likhitha Infrastructure Limited	1,031.90	1,267.08	1,391.21	1,004.75	16.11%
Suyog Telematics Ltd	1,080.50	1,235.14	1,492.78	1,266.10	17.54%
Annu Projects	224.09	261.72	453.72	226.34	42.29%

Source: Company Annual Reports

Table 25:Gross Profit Margin

Particulars	FY22	FY23	FY24	9MFY25
Vishnu Prakash R Punglia Limited	14.17%	16.62%	18.51%	19.44%
Bondada Engineering Ltd.	51.32%	50.47%	34.92%	NA
EMS Limited	37.19%	34.32%	30.92%	32.97%
Likhitha Infrastructure Limited	40.12%	34.72%	32.99%	26.13%
Suyog Telematics Ltd	85.52%	85.99%	89.60%	88.84%
Annu Projects	20.09%	20.16%	29.47%	26.01%

Source: Company Annual Reports

Table 26: EBITDA Margin

Particulars	FY22	FY23	FY24	9MFY25
Vishnu Prakash R Punglia Limited	11.06%	13.40%	14.24%	13.19%
Bondada Engineering Ltd.	6.15%	8.04%	8.55%	NA

EMS Limited	31.32%	27.87%	25.70%	27.72%
Likhitha Infrastructure Limited	24.16%	22.76%	22.18%	18.61%
Suyog Telematics Ltd	68.58%	64.64%	70.43%	71.51%
Annu Projects	9.45%	11.76%	18.58%	15.27%

Source: Company Annual Reports

Table 27: Profit After Tax

Particulars (in Rs Millions)	FY22	FY23	FY24	9MFY25	CAGR (FY22-FY24)
Vishnu Prakash R Punglia Limited	448.47	906.43	1,221.85	423.52	65.06%
Bondada Engineering Ltd.	108.71	171.31	463.08	NA	106.39%
EMS Limited	788.50	1,088.51	1,526.63	1,374.12	39.14%
Likhitha Infrastructure Limited	461.21	602.97	652.27	518.67	18.92%
Suyog Telematics Ltd	413.82	463.06	633.12	543.30	23.69%
Annu Projects	35.20	71.85	173.87	72.73	122.25%

Source: Company Annual Reports

Table 28: Net Profit Margin

Particulars	FY22	FY23	FY24	9MFY25
Vishnu Prakash R Punglia Limited	5.71%	7.76%	8.29%	5.09%
Bondada Engineering Ltd.	3.25%	4.62%	5.78%	NA
EMS Limited	21.91%	20.23%	19.24%	20.06%
Likhitha Infrastructure Limited	17.93%	16.52%	15.47%	13.49%
Suyog Telematics Ltd	32.75%	32.24%	38.00%	38.12%
Annu Projects	3.16%	5.53%	11.29%	8.36%

Source: Company Annual Reports

Table 29: Return on Equity

Particulars	FY22	FY23	FY24	9MFY25
Vishnu Prakash R Punglia Limited	28.26%	28.82%	16.95%	NA
Bondada Engineering Ltd.	18.42%	20.79%	27.58%	NA
EMS Limited	20.54%	22.09%	19.07%	NA
Likhitha Infrastructure Limited	23.93%	24.02%	20.99%	NA
Suyog Telematics Ltd	21.98%	19.77%	21.22%	NA
Annu Projects	7.93%	13.96%	25.23%	6.72%

Source: Company Annual Reports; * Figures are not annualized, hence not comparable

Table 30: Return on Capital Employed

Particulars	FY22	FY23	FY24	9MFY25
Vishnu Prakash R Punglia Limited	24.66%	26.48%	17.80%	NA
Bondada Engineering Ltd.	19.33%	16.78%	29.30%	NA
EMS Limited	28.43%	27.24%	22.65%	NA
Likhitha Infrastructure Limited	30.33%	31.08%	27.63%	NA
Suyog Telematics Ltd	26.60%	20.16%	21.68%	NA
Annu Projects	10.41%	18.92%	30.07%	8.79%

Source: Company Annual Reports; * Figures are not annualized, hence not comparable

Formulas Used

Parameter	Formula
Revenue	Revenue from Operations
COGS	Revenue from Operations - Purchase Stock in Trade-Changes in inventories of finished goods, stock-in-trade and work-in-progress- Cost of Material Consumed- Construction expense
Gross Profit	Revenue from Operations - COGS
EBITDA	Gross Profit--Employee benefits expense-Power and fuel-Other expenses-Other Operating Expense
EBIT	EBITDA - Depreciation & Amortization
Profit Before Tax	EBIT + Other Income - Finance Cost
PAT	Profit Before Tax - Tax expense - Exceptional Items
Debt	Long term Borrowings + Short term Borrowings
Cash	Cash + Bank
Gross Profit Margin	Gross Profit / Revenue from operations
EBITDA Margin	EBITDA/ Revenue from operations
EBIT Margin	EBIT/ Revenue from operations
PAT Margin	Profit after Tax/ Revenue from operations
Total Equity	Equity Share Capital+ Other Equity reserves & surplus + Noncontrolling Interest
Capital Employed	Total Equity + Long term Debt + Short Term Debt
Debt to Equity	Debt/ Total Equity
Return on Equity (ROE)	PAT/ Total Equity
Return on Equity	PAT/ Equity
Return on Capital Employed (ROCE)	EBIT/ Capital Employed
Current Ratio	Current Assets/ Current Liabilities
Asset Turnover Ratio	Revenue from Operations/Average Fixed Assets

Bibliography
IMF – World Economic Outlook
Ministry of Statistics and Programme Implementation
Reserve Bank of India
World Bank Database
NITI Aayog
Union Budget
Knight frank
Department for Promotion of Industry and Internal Trade
Telecom Regulatory Authority of India
Maia Research
Ministry of Communications
Technavio
Central Pollution Control Board
National Inventory of STPs
CPCB
Netscribes
EMIS
Press Information Bureau
CPHEEO
Atal Mission for Rejuvenation and Urban Transformation
Jal Jeevan Mission
Energy Statistic India 2025
Petroleum Planning and Analysis Cell (PPAC)
Petroleum and Natural Gas Regulatory Board (PNRGB)

Contact

Tanvi Shah	Director – Advisory & Research	tanvi.shah@careedge.in	022 6837 4470
Vikram Thirani	Director – Business Development	vikram.thirani@careedge.in	022 6837 4434

CARE Analytics and Advisory Private Limited

(Wholly-owned subsidiary of CARE Ratings Ltd.)
303B, B wing Times Square' Building Andheri - Kurla Rd, Gamdevi, Marol, Andheri East, Mumbai, Maharashtra 400059
Phone: +91-22-68374400

Connect:

About:

CareEdge is a knowledge-based analytical group offering services in Credit Ratings, Analytics, Consulting and Sustainability. Established in 1993, the parent company CARE Ratings Ltd (CareEdge Ratings) is India's second-largest rating agency, with a credible track record of rating companies across diverse sectors and holding leadership positions in high-growth sectors such as BFSI and Infra. The wholly-owned subsidiaries of CareEdge Ratings are (I) CARE Analytics & Advisory Private Ltd previously known as CARE Risk Solutions Pvt Ltd, and (II) CARE ESG Ratings Ltd, previously known as CARE Advisory Research and Training Ltd. CareEdge Ratings' other international subsidiary entities include CARE Ratings Africa (Private) Limited in Mauritius, CARE Ratings South Africa (Pvt) Ltd, and CARE Ratings Nepal Limited.