Crisil
Intelligence

Allied Engineering Works Ltd.

Market assessment of smart meters, IIOT automation and wires & cables

Final Report

July 2025

Crisil Limited
MUMBAI

by S&P Global

Contents

List of Tables

List of Figures

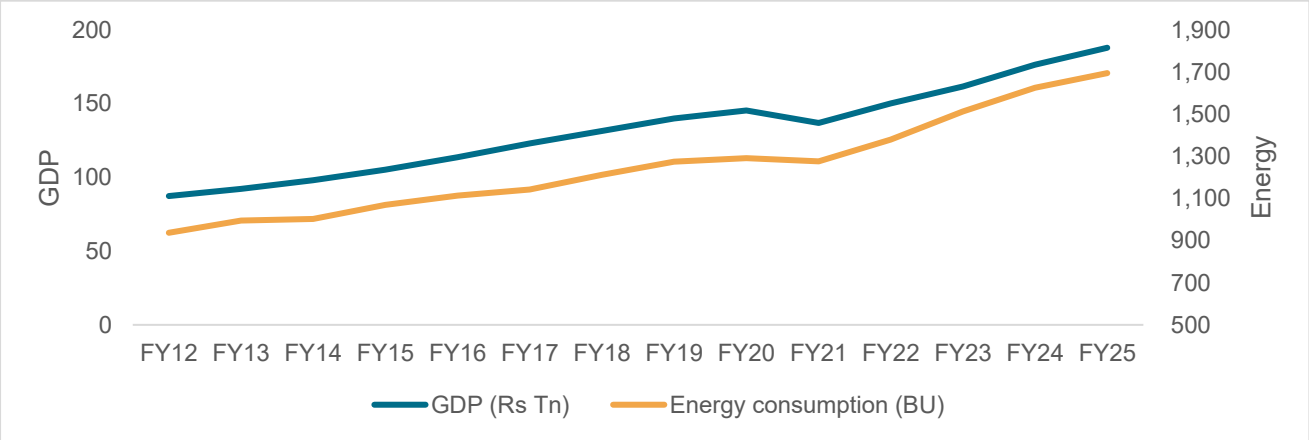
1 India macroeconomic indicators and trends

1.1 Correlation between GDP and energy consumption

Historically, India's power demand has exhibited a strong positive correlation with its Gross Domestic Product (GDP), driven by key factors such as rapid industrialization, urbanization, and economic expansion. This correlation is evident in the country's energy landscape, where the energy deficit across states and union territories has been steadily declining, reaching a low of 0.1% in fiscal 2025. Over the past four decades, India's GDP has experienced significant growth, with a CAGR of 6.14% since fiscal 1985, resulting in a substantial increase in the country's GDP to Rs. 188 trillion in fiscal 2025. In tandem, the country's power demand has also witnessed a steady rise, growing at a CAGR of 6.2% to reach 1,695 billion units in fiscal 2025 over the same period. A closer analysis of the correlation between national power demand and GDP, from fiscal 2012 onwards, reveals a strong relationship, with a correlation coefficient (Multiple R) of 98.7%. This suggests that nearly 99% of the variation in power demand can be explained by changes in GDP, underscoring the critical link between economic growth and energy consumption in India. As the country continues to urbanize and industrialize, it is likely that power demand will remain closely tied to GDP growth, highlighting the need for sustained investments in the power sector to support India's ongoing economic development.

The graph below illustrates a historical pattern of synchronized growth between GDP and energy consumption, depicting a strong correlation between the two indicators.

Figure 1: Correlation between GDP and energy consumption



Source: MoSPI, CEA, Crisil Intelligence

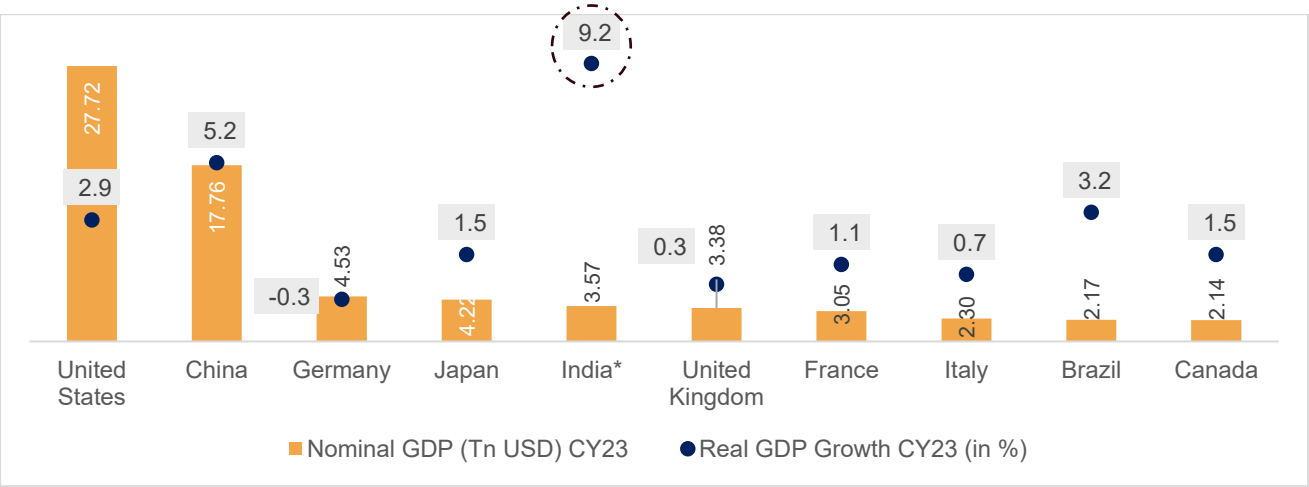
1.2 Economic indicators

India’s real GDP at constant (fiscal 2012) prices was Rs. 176.5 trillion (first revised estimates) for fiscal 2024 vis-à-vis the final estimates of Rs.161.6 trillion for fiscal 2023 as per data released by the National Statistical Office (NSO) in February 2025. This translates into a growth of 9.2% over fiscal 2023. As per second advanced estimates by NSO, India’s real GDP is estimated to grow at 6.5% in fiscal 2025. India’s real GDP in fiscal 2025 at Constant Prices is estimated to attain a level of Rs.187.95 trillion in fiscal 2025.

India has become the fifth largest economy in the world in fiscal 2023 (based on nominal GDP), according to the International Monetary Fund’s (IMF) World Economic Outlook (WEO) published in April 2024. World Bank has

forecasted India's real GDP to grow at 6.7% in fiscal 2025. Additionally, as per IMF GDP Forecasts (January 2025), India's GDP growth is estimated at 6.5% for 2026, the highest among the top 10 economies.

Figure 2: Comparison of India's economy with other major nations



**India GDP data as of February 2025 as per NSO for Financial Year 2024,*

Source: World Economic Outlook Database (October-2024) by IMF; IEA, CEA, Crisil Intelligence

Indian GDP has been growing consistently. In the last 10 years, except for years affected by the COVID-19 pandemic, India's growth has been highest amongst the top 10 economies. With the receding risk of global recession, India has been identified as an economic growth centre by various international agencies as well as global rating firms. As per the IMF's WEO published in October 2024, economic activity was surprisingly resilient through the global disinflation of 2022–23. The IMF estimated global growth at 3.3% in 2023 and projected it to continue at the same pace (~3.2%) in 2024 and 2025. Growth in India is projected to remain strong at 6.5% in 2024 and 6.5% in 2025, with the robustness reflecting continuing strength in domestic demand and a rising working-age population. Going forward, Crisil Intelligence expects GDP growth to improve to 6.5% in fiscal 2026 in base case scenario. Crisil Intelligence assumes the upcoming monsoon season to be normal and commodity prices to remain soft. Private consumption is expected to recover further as a result of tax benefits and increased allocations for key schemes announced in the recent Union Budget, as well as easing interest rates and food inflation. Investment growth hinges on private capex as the government continues to pursue fiscal consolidation. Emerging global risks from potential US tariff hikes are a downside risk for domestic growth.

1.3 Outlook

1.3.1 Consumer price index

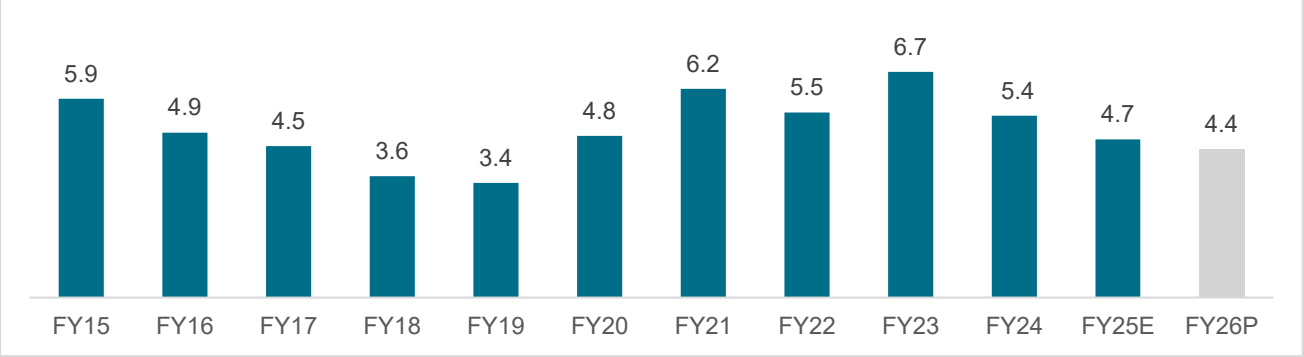
Consumer Price Index (CPI) inflation dipped below the Reserve Bank of India's (RBI) 4% target to a seven-month low of 3.6% in February 2025 from 4.3% in January 2025, driven by a slide in food inflation to 3.7%, the lowest reading since May 2023.

In fiscal 2026, food inflation is expected to ease further supported by a healthy rabi crop, assuming normal southwest monsoon that benefits the kharif crop and expectations of soft global food prices. A high base for food inflation this fiscal will also provide some relief. Non-food inflation could see some more hardening lifted by a low base this fiscal and some impact of a weaker rupee. A sharper-than-expected weakening in the rupee, price

shock to global oil prices due to any geopolitical turmoil and risks from climate change could impose upside pressures on the forecast. Overall, Crisil Intelligence expects CPI inflation to moderate to 4.4% in fiscal 2026 from an estimated 4.7% this fiscal 2025.

On the other hand, core inflation crossed 4% for the first time since November 2023 and touched 4.1% in February 2025 (vs 3.6% in January 2025), as surging gold and silver prices pushed up inflation in the personal care and effects category.

Figure 3:CPI inflation (%, y-o-y)



E: Estimated; P: Projected;

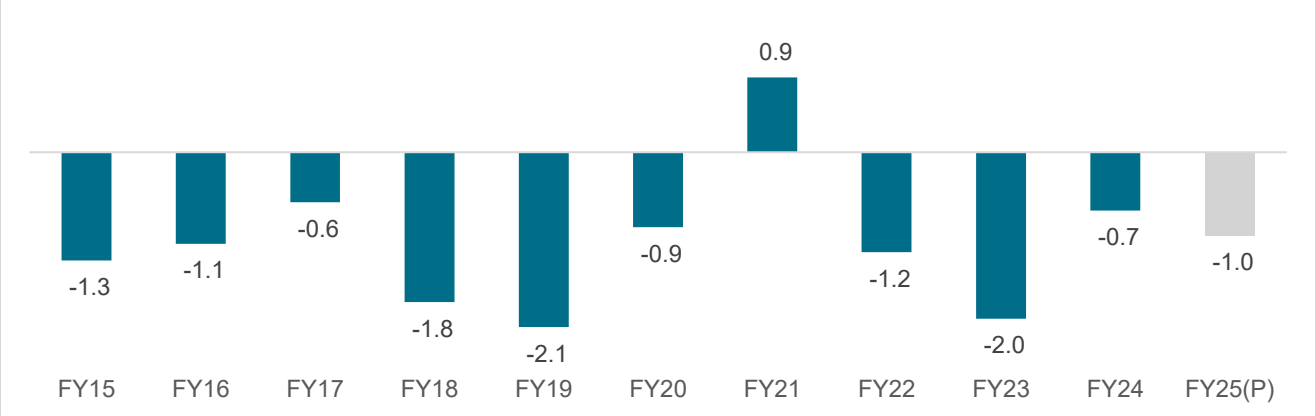
Source: NSO, CEIC, Crisil Intelligence

1.3.2 Current account deficit

India's current account deficit (CAD) was unchanged at USD 11.2 billion (1.2% of GDP) in the second quarter (Q2; July-September) of fiscal 2025 compared with USD 11.3 billion (1.3% of GDP) in the corresponding quarter a year-ago. Sequentially, though, the metric, which reflects a country's external payments position, widened slightly from USD 10.2 billion (1.1% of GDP) in the first quarter of fiscal 2025.

Crisil Intelligence expects CAD at ~1.0% of GDP in fiscal 2025, as against 0.7% last year. In addition, the impact of geopolitical issues will remain a monitorable.

Figure 4: Current account deficit (As a % of GDP)



(P) Projected; Source: RBI, SBI, Crisil Intelligence

1.3.3 Fiscal deficit

The fiscal deficit in 2020 reached a high of 9.2% of GDP during the pandemic. It has since decreased significantly. The fiscal deficit during fiscal 2024 stood at 5.6% of the GDP and was better than the previous estimates of 5.8% due to higher revenue realisation and lower expenditure according to the data released by the Controller General of Accounts (CGA) on May 31, 2024. Numerically, the fiscal deficit--the gap between expenditure and revenue, was at Rs. 16.53 trillion.

Gross market borrowings have been revised upward to Rs. 14.82 trillion for fiscal 2026 from Rs. 14.01 trillion estimated for the current fiscal 2025. Fiscal deficit is estimated to be 4.4% of GDP for fiscal 2026 as compared to 4.8% of the GDP estimated for current fiscal 2025.

Figure 5: Fiscal Deficit as % of the GDP

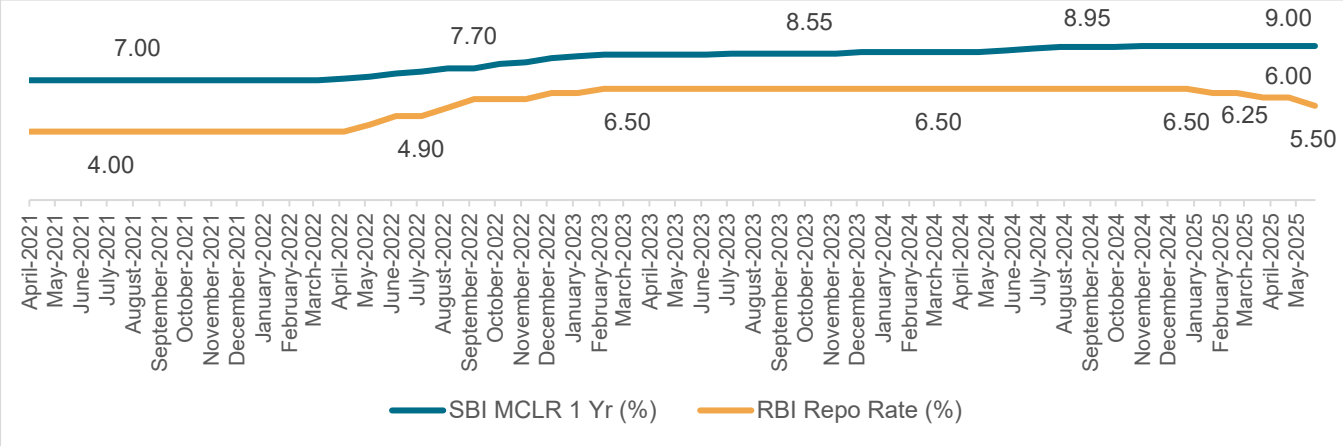
RE: Revised Estimates, BE: Budget Estimate

Source: RBI, Provisional Accounts for 2023- 2024 by Controller General of Accounts, Budget for FY26, Crisil Intelligence

1.3.4 Interest rates

The Monetary Policy Committee (MPC) in its June 2025 meeting cut the repo rate by 50 bps more than the 25-bps cut in the previous meeting in April 2025. MPC changed the stance from accommodative to neutral, while emphasising that monetary policy space to support growth was shrinking. This signals that monetary policy actions will be more data-dependent hereon. It announced 100 bps cut to the cash reserve ratio (CRR), which will proceed in four tranches between September and November 2025. The MPC frontloaded monetary easing by undertaking a steeper-than-expected rate cut. Crisil Intelligence expect one more rate cut in fiscal 2026, and a hold thereafter. A sharp fall in inflation since the previous policy review allowed the MPC to increase monetary support. A healthy monsoon, coupled with low crude prices are likely to keep inflation aligned to the RBI's 4% target in fiscal 2026.

Figure 6: Repo rate cuts mark further monetary easing (%)

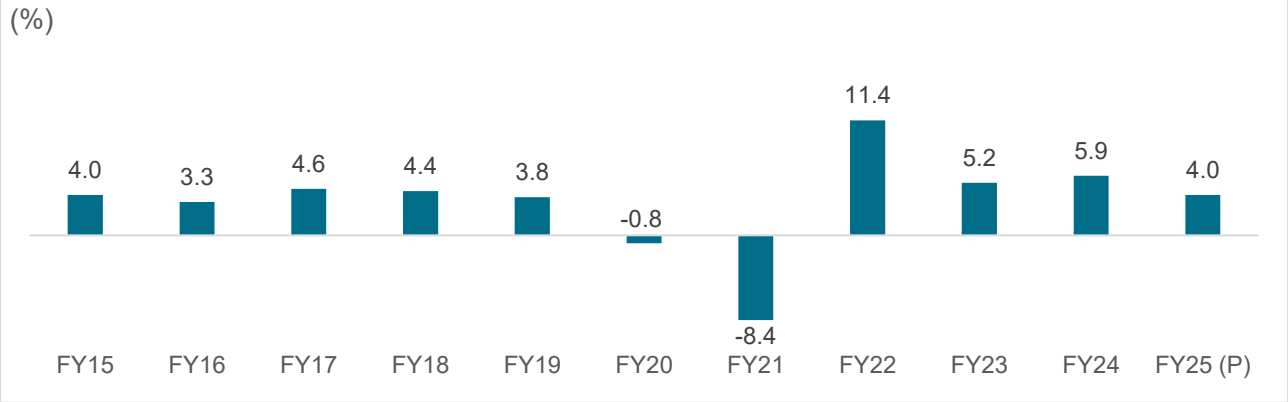


Source: RBI, SBI, Crisil Intelligence

1.3.5 PMI and IIP Trend

The Index of Industrial Production (IIP) is an indicator that measures the changes in the volume of production of industrial products during a given period. The cumulative growth rates of the three sectors, Mining, Manufacturing and Electricity for the fiscal 2024 over the corresponding period of the previous year were 7.5%, 5.5% and 7.1%, respectively.

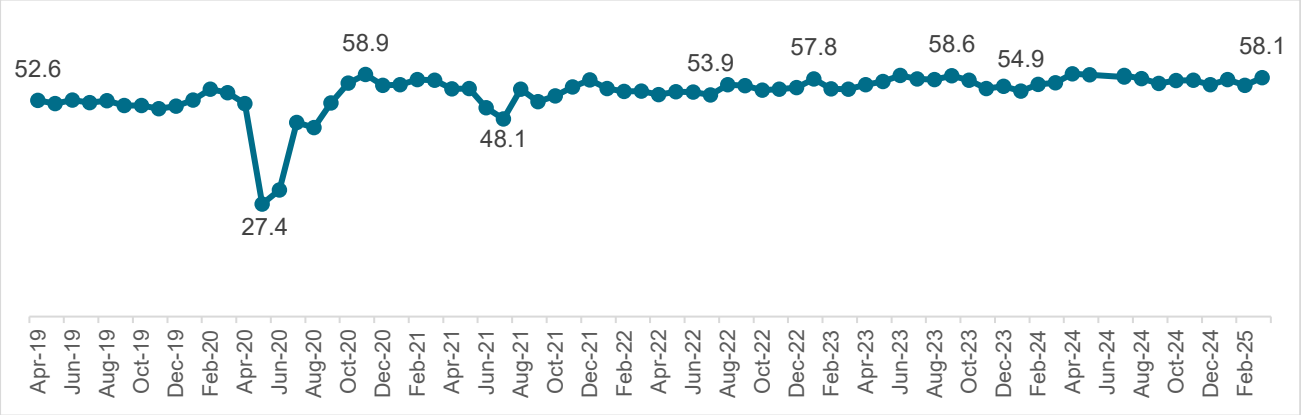
Figure 7: Growth trend in Index of Industrial Production



P: Provisional; Source: NSO, MOSPI, Crisil Intelligence

Rising from December's one-year low of 56.4 to 58.1 in March 2025, the seasonally adjusted HSBC India Manufacturing Purchasing Managers' Index™ (PMI®) signaled a robust improvement in the health of the sector. The rate of expansion was the quickest since last July and outpaced its long-run average.

Figure 8: Manufacturing PMI



Source: Industry, HSBC, S&P Global, Crisil Intelligence

Fiscal consolidation, elevated interest rates and prolonged high food inflation have weighed on the economy this fiscal. Investment growth has been sluggish given lower government capex and subdued private investments.

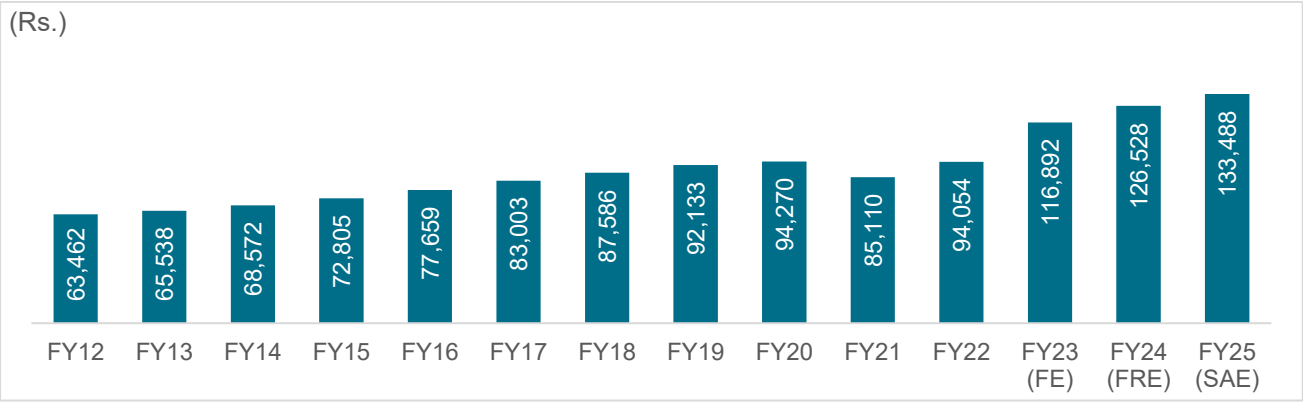
Based on the first advance estimates, growth is expected to quicken in the second half (6.8% vs 6.0% in the first half. Agricultural growth is likely to improve as higher reservoir levels bode well for the rabi output. This, along with easing food inflation and a revival of government capex is likely to support growth.

1.3.6 Per capita GDP

As per NSO's revised estimates published in February 2025, India's per capita income is expected to rise to Rs 126,528 in fiscal 2024 from Rs 68,572 in fiscal 2014 with a CAGR of 6.3%. In fiscal 2025, per capita income increased to Rs. 133,488 in fiscal 2025, a growth of 5.5% over fiscal 2024.

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

Figure 9: All-India per capita net national income (at constant prices)

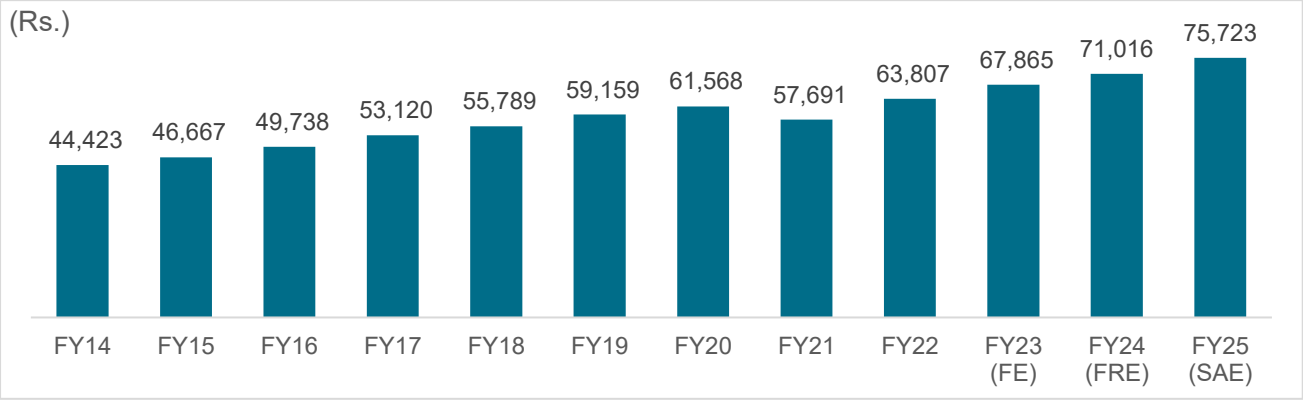


FE: Final estimates; FRE: first revised estimates; SAE: Second advanced estimates
Source: Economic Survey, NSO, MOSPI, Crisil Intelligence

1.3.7 Private Final Consumption Expenditure

The Private Final Consumption Expenditure (PFCE) is defined as the expenditure incurred on final consumption of goods and services by the resident households and non-profit institutions serving households (NPISH). India's per capita PFCE is expected to rise to Rs. 75,723 in fiscal 2025 from Rs. 44,423 in fiscal 2014 with a CAGR of 5.0%.

Figure 10: All-India per capita PFCE (at constant price)

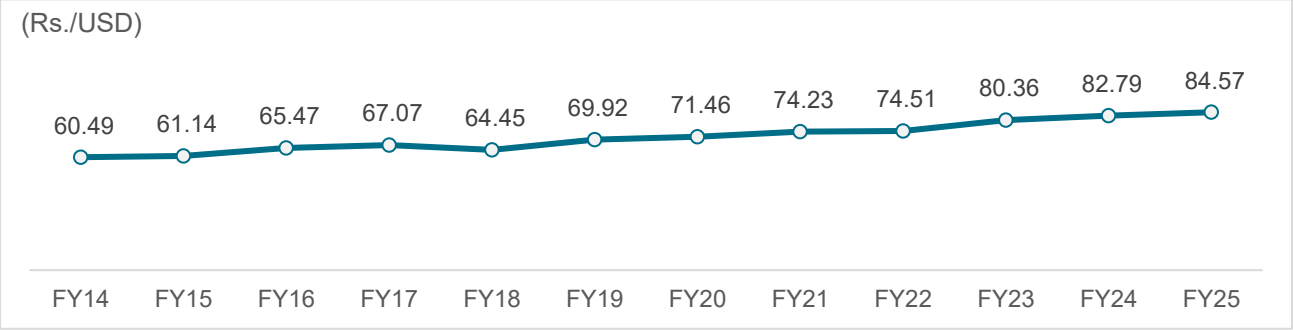


Source: NSO, MOSPI, Crisil Intelligence

1.3.8 Currency

In January 2025, the rupee further weakened to 86.3 per dollar from 85 per dollar previous month. A stronger dollar, wider trade deficit, increased foreign portfolio investment (FPI) outflows and a rise in crude oil prices contributed to the currency's weakening. FPI outflows touched USD 8.6 billion in January 2025 vs inflows of USD 3.1 billion in December 2024. The rupee depreciation has been sharper since December 2024. The rupee depreciated in January 2025, crossing 86 per dollar on January 13 and further weakening to 87 by the end of the month. The decline was part of a broader trend with the dollar gaining strength against most emerging market currencies except the Brazilian real and Russian rouble. Overall, the rupee's value declined 1.5% on month and 3.8% on year.

Figure 11: Trend in the exchange rate (annual average)



Source: Financial Benchmarks India Pvt Ltd, CEIC, Crisil Intelligence

Crisil Intelligence expects the rupee to remain volatility in fiscal 2026 and average ~87 against the dollar. While the current account deficit is expected to remain manageable, it could face some risks due to disruptions in global growth and geopolitical uncertainties. However, India's healthy macroeconomic parameters will provide some cushion.

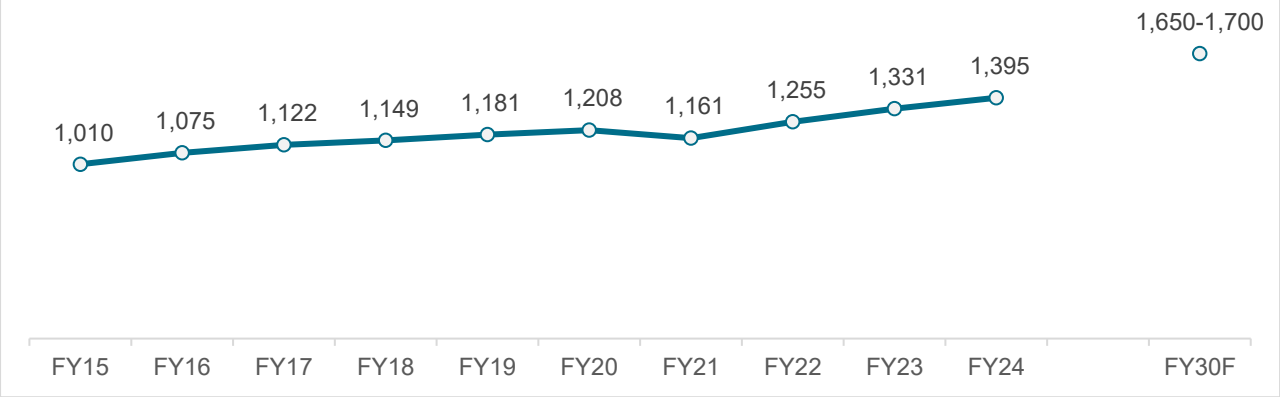
1.4 Overview of other demographic factors

1.4.1 Per capita electricity consumption

As per Central Electricity Authority (CEA), the per capita electricity consumption rose to 1,395 kWh in fiscal 2024 (provisional data), from 1,010 kWh in fiscal 2015 at a CAGR of 3.65%, primarily led by increasing economic activities, rising domestic consumption, rural and household electrification.

Per capita consumption is expected to gradually improve as power demand picks up on the back of improvements in access to electricity, in terms of quality and reliability, rising per capital income, increasing EV penetration, railway electrification, intensive rural electrification, resulting in the realisation of latent demand from the residential segment, increased penetration of consumer durables. Crisil Intelligence expects India's per capita electricity consumption to grow at ~3.0-3.5% CAGR to reach 1,650-1,700 kWh by fiscal 2030.

Figure 12: Per capita electricity consumption in India (in kWh)

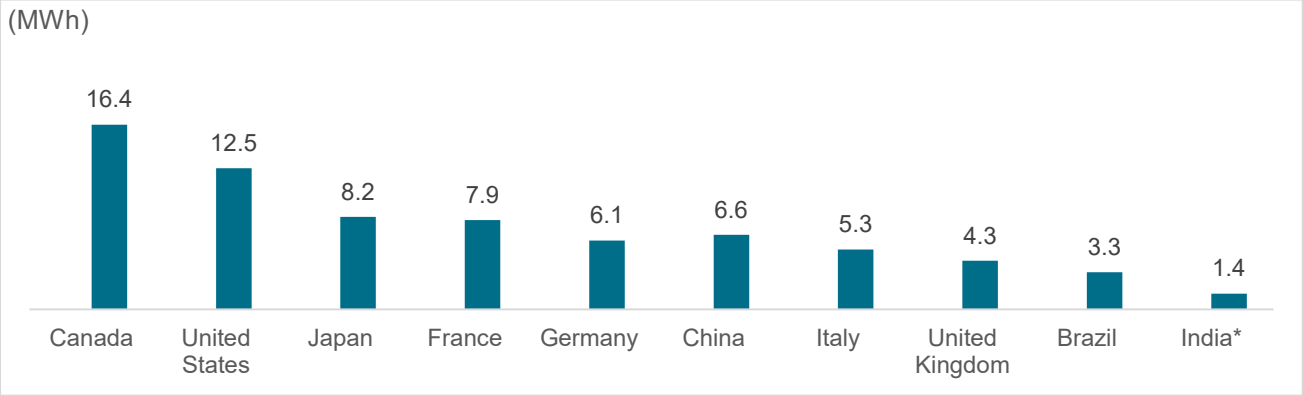


F: Forecast

Source: Central Electricity Authority of India (CEA), Crisil Intelligence

Despite this healthy increase, the per-capita electricity consumption of India remains significantly lower than other major as well as developing economies.

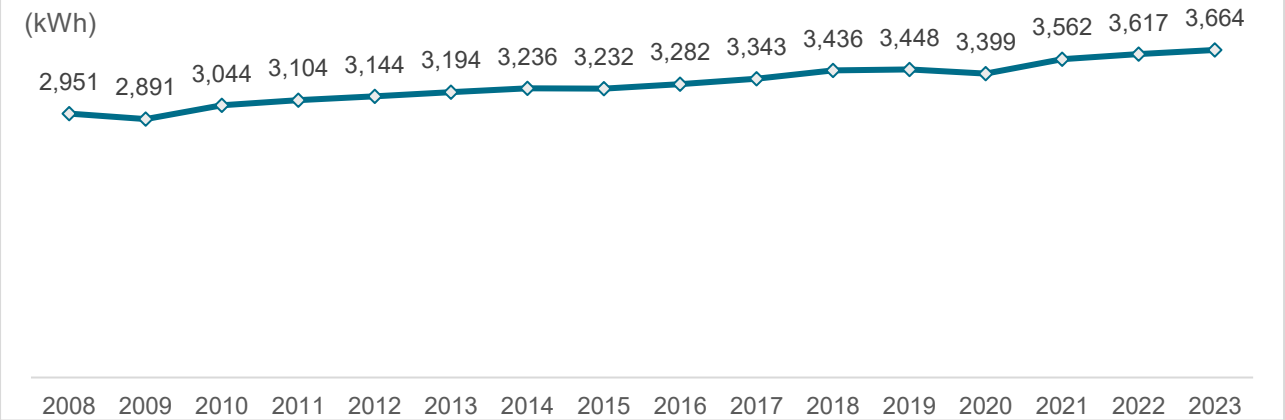
Figure 13: Per capita electricity consumption of key economies 2023



**India FY2024; Source: World Bank, IMF, EIA, Crisil Intelligence*

Global per capita consumption has grown steadily led by developing nations. In developed nations, although total power usage has moved northwards, consumption on a per capita basis has remained firm owing to efficiency measures. On the other hand, developing nations have shown a strong uptick in per capita electricity usage as large-scale electrification programmes continue to connect rural areas and living conditions of the population improve. With millions still not connected to the electric grid, the uptick is expected to continue in the short to medium term.

Figure 14: Average Per capita electricity consumption: Global



As per the latest data published by EIA.

Source: World Bank, IMF, EIA, UN, Crisil Intelligence

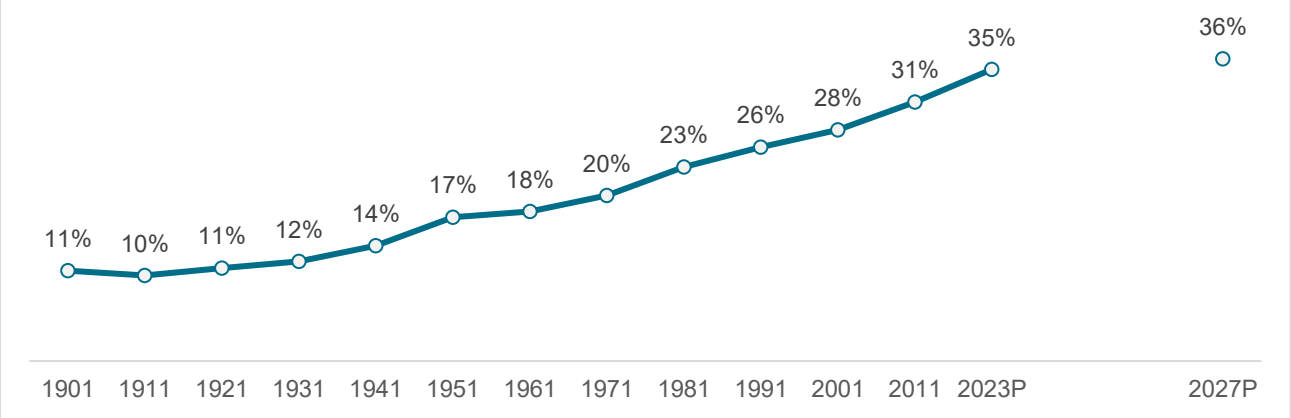
1.4.2 Urbanization

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

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

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

Figure 15: Urban population as a % of the total population of India



P: Projected

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

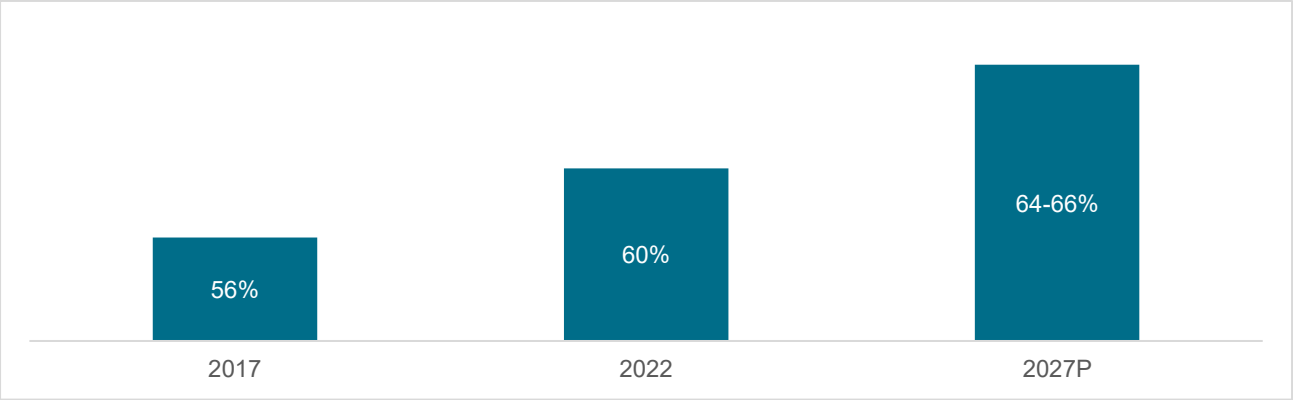
1.4.3 Nuclearisation

The nuclearisation of the family refers to the trend of families becoming smaller and more fragmented, where individuals are moving away from larger, extended family structures and living as either independent individuals or as part of a smaller nuclear unit. This shift is driven by various factors, including urbanization, increased mobility, changing social values, and economic pressures, which have led to a decline in traditional joint family systems.

The nuclearization of families in India has reached a significant milestone, with nuclear families accounting for 60% of households as of 2022, marking a substantial shift in the country's demographic landscape. This trend has far-reaching implications for the economy, as nuclear families tend to have distinct consumption patterns and priorities. As a result, the demand for high-end goods and services is on the rise, presenting opportunities for businesses to tap into this growing market.

This trend is expected to continue, with forecasts predicting a substantial increase in the number of nuclear households over the next few years. By 2027, it is estimated that about 64-66% of the households would comprise nuclear families.

Figure 16: Nuclearisation in India (as % of total households)



P: Projected; Source: Crisil Intelligence

1.4.4 Aatmanirbhar Bharat Abhiyan

Production Linked Incentives (PLIs) in the 14 sectors for the *Aatmanirbhar Bharat* vision received an outstanding response, with the potential to create 6 million new jobs (as per government estimates).

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

- Phase I: Businesses including MSMEs
- Phase II: Poor, including migrants and farmers.
- Phase III: Agriculture
- Phase IV: New horizons of growth
- Phase V: Government reforms and enablers

Table 1: Sector-wise focus of *Aatmanirbhar Bharat* Vision

Sector	Government spends	Key schemes
Renewable energy	~Rs 1,300 billion	• Rs 45 billion Production Linked Incentive Scheme 'National Programme on High Efficiency Solar PV Modules'. This was further increased by Rs 195 billion in the budget for fiscal 2023, taking it to Rs 240 billion; in tranche-I 8.7 GW and in tranche II 39.6 GW capacity were allocated for domestic solar module manufacturing capacity under the PLI scheme. • PM Surya Ghar Muft Bijli Yojna: This scheme has a proposed outlay of Rs. 750 billion and aims to light up 10 million households (rooftop solar) by providing up to 300 units of free electricity every month. • Public procurement (preference for 'Make in India') to provide for purchase preference (linked with local content) in respect of renewable energy (RE) sector • Implementation of Pradhan Mantri Kisan Urja Suraksha Utthan Mahabhiyan (PM KUSUM) scheme; MNRE, in November 2020, scaled up and expanded the PM

Sector	Government spends	Key schemes
		KUSUM scheme to add 30.8 GW by 2022 with central financial support of Rs 344 billion. The scheme has been extended till March 31, 2026 • Approved Models & Manufacturers of Solar Photovoltaic Modules (Requirement for Compulsory Registration) Order, 2019 • List of manufacturers and models of solar PV modules recommended under ALMM order • Scheme of grid connected wind-solar hybrid power projects • Basic customs duty (BCD) of 25% on solar cells and 40% on modules, respectively, effective April 1, 2022
Power distribution companies (discoms)	~Rs.970 billion	• Rs 1.35 trillion liquidity infusion for discoms via Power Finance Corporation/ Rural Electrification Corporation (PFC/ REC) against receivables • Rebate for payment to be received by generation companies (gencos) to be passed on to industrial customers • Revamped distribution sector scheme (RDSS) to help discoms improve their operational efficiencies and financial sustainability by providing result-linked financial assistance; outlay of Rs 3,037.58 billion over 5 years i.e., fiscals 2022 to 2026. The outlay includes an estimated government budgetary support (GBS) of Rs 976.31 billion.
New energy	~Rs. 388 billion	• Rs 181 billion under production linked incentive (PLI) scheme for Advanced Chemistry Cell (ACC) Battery Storage in India launched in October to achieve 50 GWh manufacturing capacity • Green Hydrogen Policy launched in February 2022 to facilitate production of green hydrogen/green ammonia • PLI scheme on green hydrogen manufacturing with an initial outlay of Rs 197.44 billion with an aim to boost domestic production of green hydrogen • BCD exemption on critical minerals (cobalt, lead, zinc, etc.), scrap of lithium-ion batteries proposed in Budget 2025-26
Nuclear energy	Rs. 200 billion	• Nuclear energy mission announced in Budget 2025-26 • 100 GW of nuclear power capacity by 2047 • Budgetary allocation to support R&D for indigenous development of small modular reactors (SMR) • Private sector participation in the development of Bharat small reactors, R&D of SMR and newer technologies

Source: Official portal of the Government of India; various ministries, PIB press releases, Crisil Intelligence

1.4.5 Total energy demand

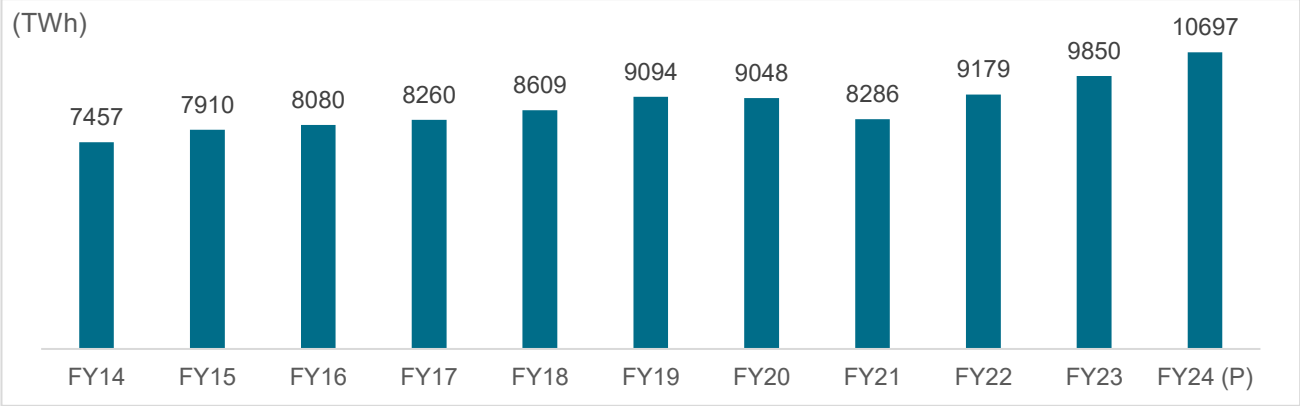
Energy can be classified into Primary and Secondary energy sources. Primary energy sources are those that are either found or stored in nature. Common primary energy sources are coal, oil, natural gas, and biomass (such as wood). Other available primary energy sources include nuclear energy from radioactive substances, thermal energy stored in earth's interior, and potential energy due to earth's gravity. Primary energy sources are

mostly converted into industrial utilities into secondary energy sources, e.g., coal, oil or gas converted into steam and electricity.

The key components of an energy balance are the Total Primary Energy Supply (TPES) and Total Final Consumption (TFC) of energy commodities. TPES reflects the total energy available within the country, while TFC breaks down the energy usage by various sectors like industry, transport, residential, and services.

Increased urbanisation and industrialization have led to growing need for energy coupled with sustainability focus, it has necessitated the supply of clean energy. As per India Energy Statistics 2025, India has experienced a healthy growth in total consumption of primary energy. A growth from 26,822 Petajoule (PJ) (equivalent to 7,457 TWh) during fiscal 2014 to 38,479 PJ (equivalent to 10,697 TWh) in fiscal 2024(P) reflecting a notable rise at a CAGR of 3.7%. The total primary energy supply has increased by 7.8% y-o-y in fiscal 2024. Among the various energy resources, Coal and Lignite accounted for the highest growth, with a combined increase of approximately 11.87% during fiscal 2024 (P) compared to the previous year.

Figure 17: Trend of total consumption of Energy in India

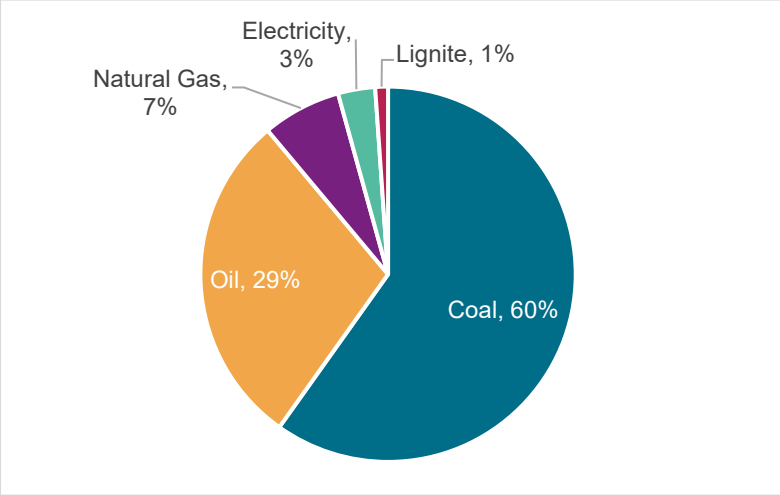


(P) Provisional: 1 Petajoule= 0.278 TWh

Source: India Energy Statistics 2024 by MOSPI; Crisil Intelligence

The consumption of primary energy from Coal and Lignite was highest, which accounted for about 60% of the total consumption during fiscal 2024(P) followed by Crude Oil (29%) and Natural Gas (7%). About 69% of the total coal and 84% of the lignite consumed in the country are used in the production of electricity. The share of electricity in energy consumption has been in the range of 27-28%.

Figure 18: Resource wise share of primary energy consumption (for FY24 (P))



Electricity from Hydro, Nuclear and other RE sources

(P) Provisional: 1 Petajoule= 23884.589 Tonnes of oil equivalent

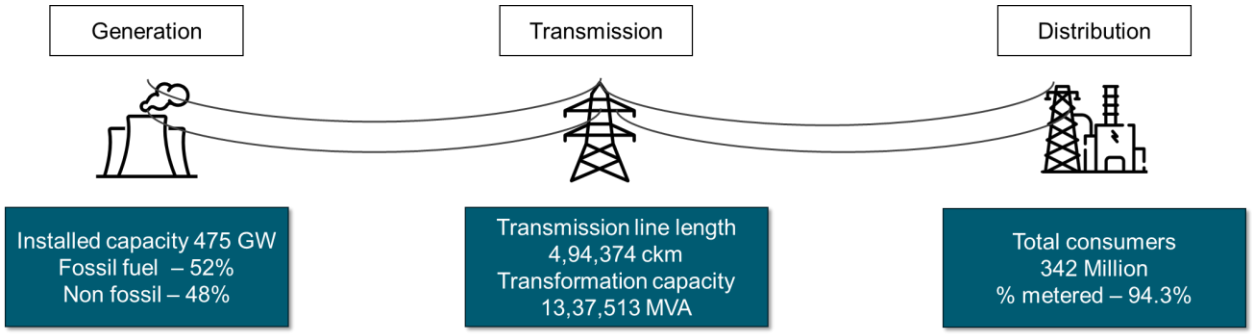
Source: India Energy Statistics 2024 by MoSPI; Crisil Intelligence

India's energy demand will continue to provide fuel for future economic growth and is bound to grow exponentially in the coming years. As per IEA, the country's primary energy demand is anticipated to reach 1250-1500 mtoe (equivalent to 14,000 – 16,000 TWh) by 2030. As the third-largest global power producer and energy consumer, after China and the US, India currently accounts for approximately 7% of worldwide primary energy consumption, a share expected to rise to around 9.8% by 2050.

2 Overview of Indian power sector

2.1 Introduction to generation, transmission & distribution

India has a widespread power network with interconnected regional grids. The power generation profile is dominated by conventional (coal, lignite, natural gas, oil, hydro and nuclear power) sources, although, non-conventional sources (such as wind, solar, and biomass and municipal waste) are rapidly gaining traction. Transmission and Distribution infrastructure has expanded over the years for evacuation of power from generating stations to load centres through the intra-state and inter-state transmission system (ISTS). The summary of installed generation and transmission capacity as of fiscal 2025 is given below.



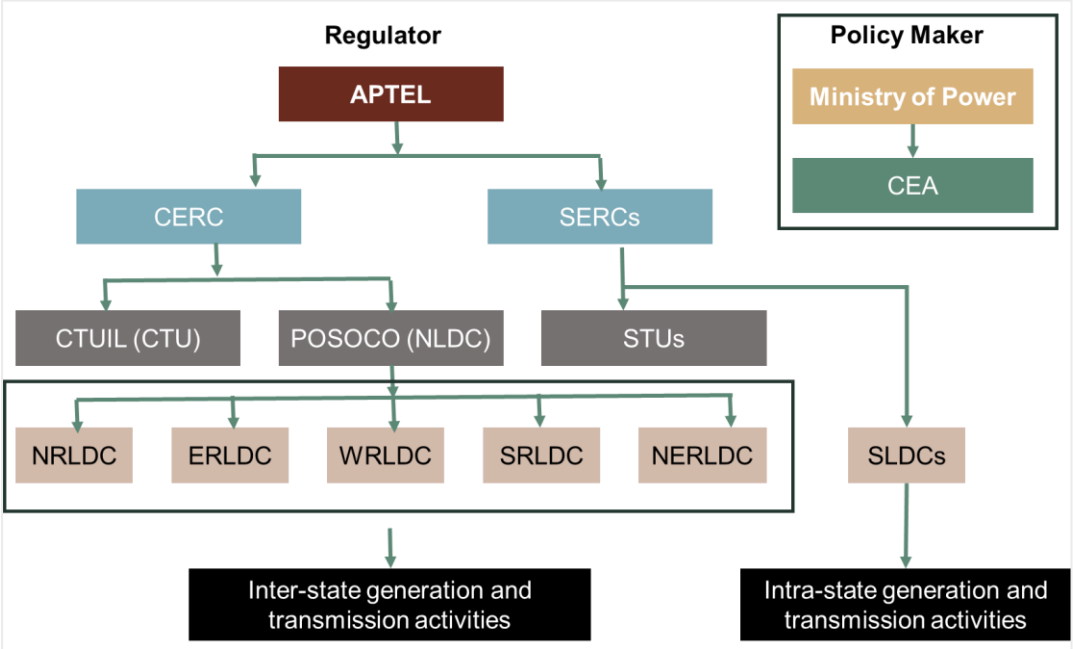
Source: CEA, Crisil Intelligence

2.2 Regulatory framework

Electricity is a concurrent subject in India with the Ministry of Power (MoP), Government of India (GoI), mainly being responsible for creating the overall policy framework for the power sector in the country. All state-level policies and issues come under the purview of the respective state governments.

At the national level, the Central Electricity Regulatory Commission has been established, and at the state level, the State Electricity Regulatory Commissions (SERCs) have been set up by the state governments to regulate electricity markets, encourage competition and private investment. This division of power allows for both national-level policies and state-specific regulations to be implemented in the electricity sector. The State Governments have a major role, particularly in creation of generation capacity, state level transmission and distribution. The Central Government assists the States in the attainment of this objective by developing national electricity policy, national electricity plan and other rules, guidelines and schemes in consultation with the State Governments and the Central Electricity Authority (CEA) for development of the power sector, providing supply of electricity to all areas and protecting interests of consumers and other stakeholders keeping in view availability of energy resources, technology available to exploit these resources, economics of generation using different resources, and energy security issues.

Figure 19: Institutional and structural framework



Note:

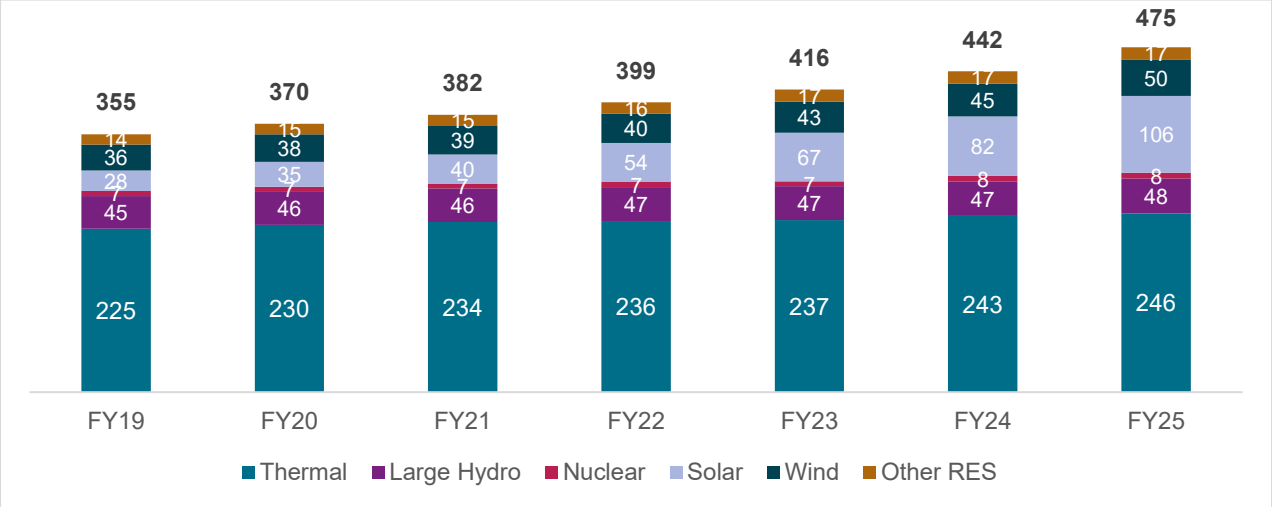
APTEL - The Appellate Tribunal for Electricity; CERC- Central Electricity Regulatory Commission; CEA- Central Electricity Authority; WRLDC- Western Regional Load Despatch Centre; ERLDC- Eastern Regional Load Despatch Centre; SRLDC- Southern Regional Load Despatch Centre; NLDC: National Load Despatch Centre (Now called as GRID-INDIA); NRLDC- Northern Regional Load Despatch Centre; NERLDC- North-Eastern Regional Load Despatch Centre. SLDC- State Load Despatch Centre; CTU- Central Transmission Utility; STU- State Transmission Utility.

Source: Crisil Intelligence

2.3 Installed capacity

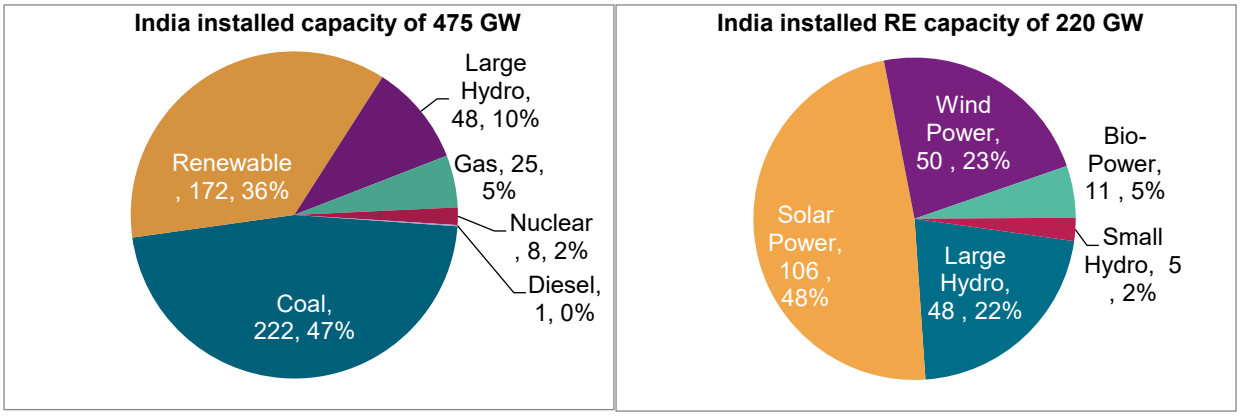
The total installed generation capacity as of March 2025 was 475 GW, of which ~120 GW of capacity was added over fiscal 2019-25. The overall installed generation capacity has grown at a CAGR of 4.9% over fiscals 2019–25. Coal and Lignite-based installed power generation capacity has maintained its dominant position over the years and accounts for ~46.7%. However, RE installations (including large hydroelectric projects) have reached ~220 GW capacity as of March 2025, compared with 63 GW as of March 2012, constituting ~46.3% of total installed generation capacity. This growth has been led by solar power, which rapidly rose to ~106 GW from 0.9 GW over the same period.

Figure 20: Historical Fuel-wise installed capacity (GW)



Thermal include coal, lignite and gas; Other Renewable energy sources (RES) include biogas, bagasse, small hydro and waste-to-energy
Source: CEA, Crisil Intelligence

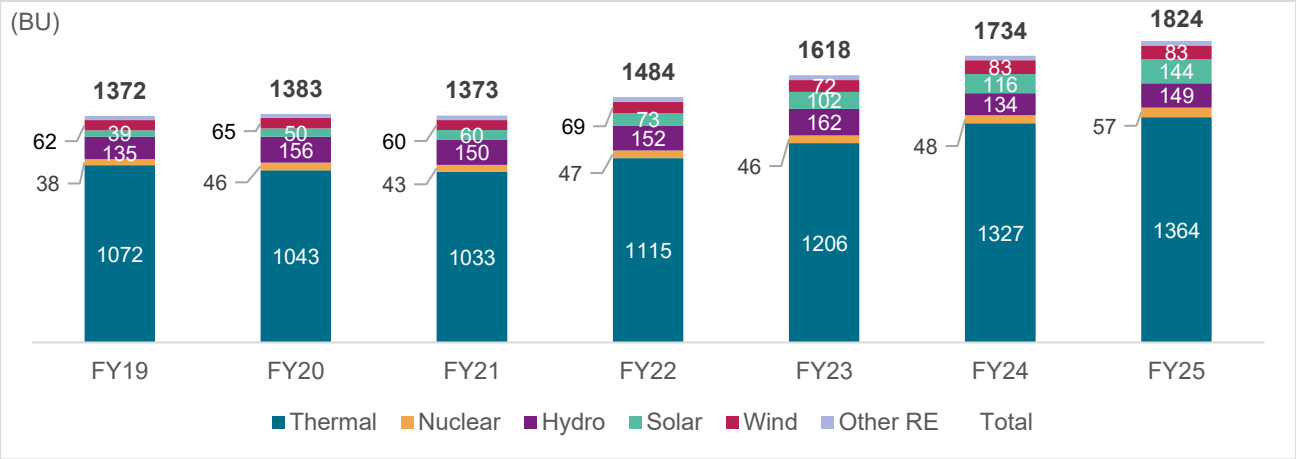
Figure 21: Details of source wise installed capacity as of March 2025 (GW, % share)



Source: CEA, Crisil Intelligence

The share of renewable energy (including large hydro) in the total supply mix was ~5% in fiscal 2015, which has now increased to 22.13% in fiscal 2025. The RE generation has increased at a CAGR of ~17% in the last 10 years. The share of solar and wind energy was ~12.5% of the total energy supplied during fiscal 2025. The share of large hydro was ~8.1% and the remaining 1.5% is from other RE sources.

Figure 22: Source wise energy supplied (billion units)

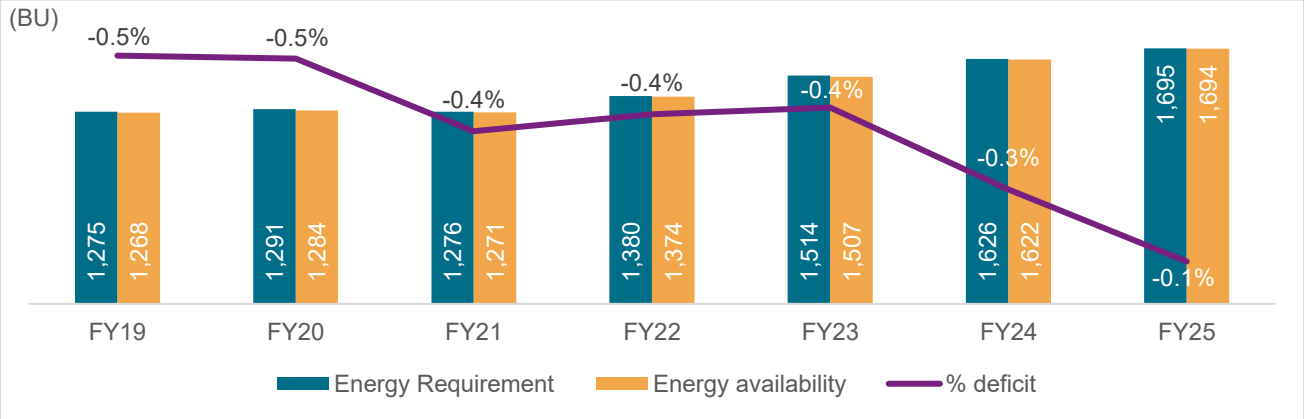


Source: CEA, Crisil Intelligence

2.4 Review of existing power demand-supply scenario

India's electricity requirement and availability has risen at a CAGR of ~4.9% between fiscals 2019 and 2025. The energy deficit declined to 0.3% in fiscal 2024 and 0.1% in fiscal 2025 from 0.5% in fiscal 2019 due to an increase in capacity addition growth of 4.5% over the same period. Strengthening of inter-regional power transmission capacity over the past five years has supported the rapid fall in deficit levels as it reduced supply constraints on account of congestion and lower transmission corridor availability, thereby lowering the deficit to 0.1% in fiscal 2025.

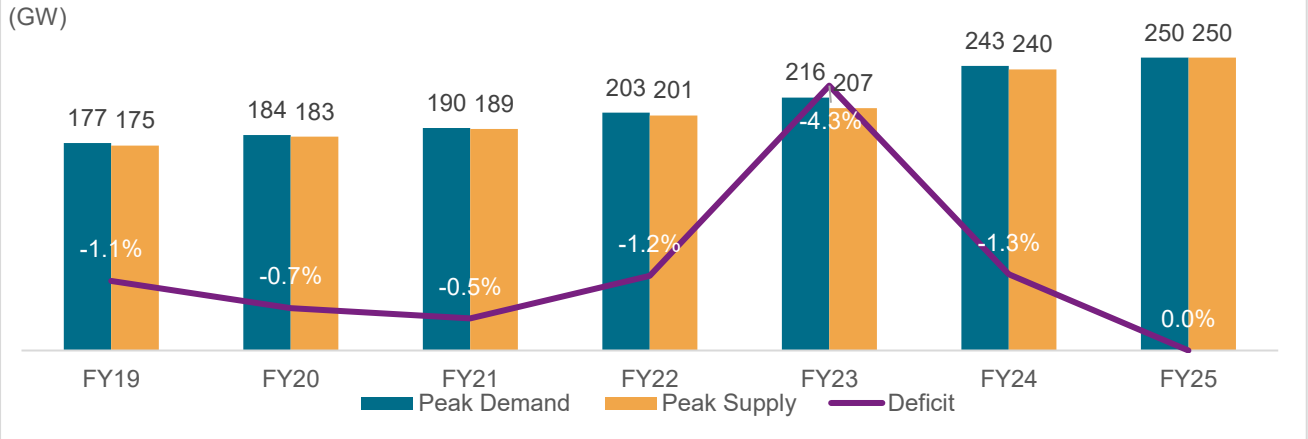
Figure 23: Aggregate power demand supply



Source: CEA, Crisil Intelligence

Peak electricity demand in India has grown from 177 GW in fiscal 2019 to 250 GW in fiscal 2025 clocking an average growth rate of 5.9%. The constant rise in peak demand can be attributed to economic growth, seasonal vagaries, and an increasing daily average temperature that India has experienced over the last decade. In Q1 fiscal 2025, power demand surged by 13% on year led by heatwaves and a 6.7% on-year growth in GDP. Prolonged and severe heatwaves were especially prominent in the northern part of the country which was also impacted by deficient rainfall in July 2024.

Figure 24: Peak power demand and supply



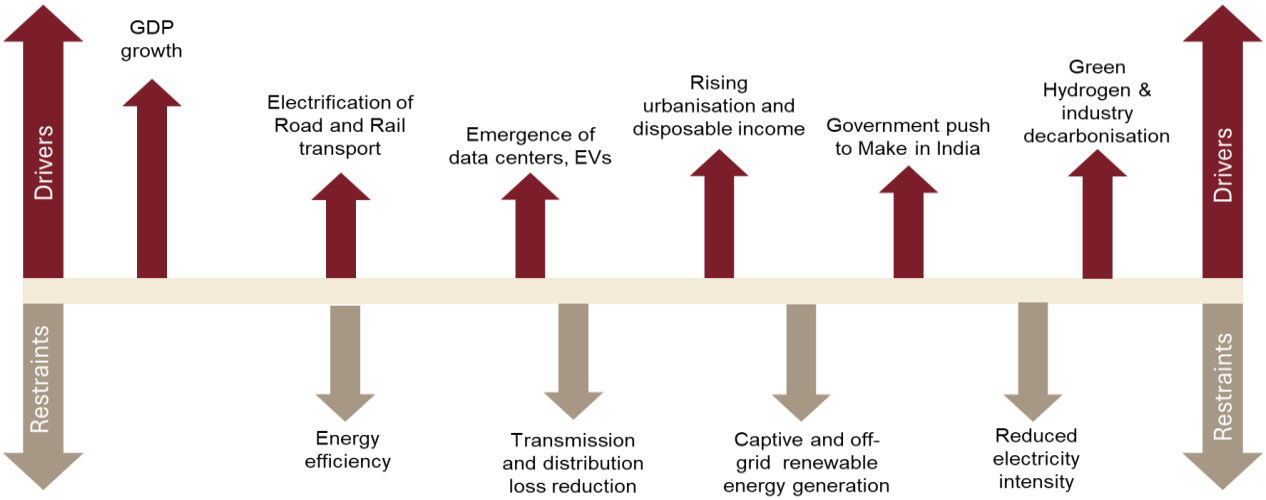
Source: CEA, Crisil Intelligence

2.5 Power sector growth outlook

2.5.1 Long-term drivers and constraints for demand growth

Power demand is closely associated with a country's GDP. A booming economy automatically leads to a surge in power demand. India is already the fastest-growing economy in the world, with an average GDP growth of 5.5% over the past decade. The trickle-down effect of *Aatmanirbhar Bharat* relief package, government spending on infrastructure through the National Infrastructure Pipeline, commissioning of the dedicated freight corridors, expansion of the services industry, rapid urbanisation, and increased farm income from agriculture-related reforms are key macroeconomic factors fostering power demand. Significant policy initiatives such as 24x7 power for all, Sahaj Bijli Har Ghar Yojana (SAUBHAGYA) scheme to provide electricity connections to all households, green energy corridor to facilitate the evacuation of RE power, green city scheme to promote the development of sustainable and eco-friendly cities, Production-Linked Incentive (PLI) scheme, and low corporate tax rates (15% "Made in India" corporate tax for new manufacturing companies incorporated on or after 1st October 2019 and has commenced manufacturing on or before March 31, 2024), among others, have aided large scale manufacturing in India, further boosting power demand in the country.

Figure 25: Factors influencing power demand



Source: Crisil Intelligence

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

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

To become a net zero carbon emission emitter by 2030, the government aims to achieve 100% electrification of Indian Railways by fiscal 2026. This leads to incremental power demand of around 23 BUs on average every year between fiscals 2026 to 2030. The power sector is poised to witness most of the incremental demand from railway electrification; however, lower energy consumption for electrification per kilometer due to energy efficiency improvements will partially offset the demand.

Metro rail has seen substantial growth in India in recent years, and the rate of growth is set to double or triple in the coming years, with multiple cities seeking metro rail services to meet daily mobility requirements. Around 712 km of metro rail is under construction and 1,878 km is proposed to be added. These developments are expected to add incremental power demand of 5-6 BUs every year on average between fiscals 2025 to 2029. Currently, metro rail projects constitute a marginal share of total incremental demand, but the share is expected to increase due to a large quantum of upcoming metro projects.

Further, EV charging requirements are likely to boost power demand over the medium term, with a gradual increase in the share of EVs in the vehicle population. Crisil Intelligence projects that the adoption of EVs will boost power demand by 12-13 BUs annually on average over fiscals 2025 to 2029. Considering the EV penetration and various policy push by the government, India is likely to have around 1.0-1.3 million EV charging stations by 2030.

Declining transmission and distribution (T&D) losses, an increase in off-grid/rooftop projects with storage and open access transactions to enhance power availability

T&D losses have been declining, and the reduction in losses is expected to continue further aided by a slew of government measures, primarily the Revamped Distribution Sector Scheme (RDSS). RDSS is a reform-based and result-linked scheme for improving the quality and reliability of power supply to consumers through a financially sustainable and operationally efficient distribution sector. As a result, the power demand is expected to be reduced by 20-25 BUs on average every year between fiscals 2026 to 2030 owing to lower T&D losses.

Further, with a boost to rooftop solar and the declining cost of renewable energy generation, decentralized distributed generation is expected to increase, reducing power demand from the grid. As of fiscal 2025, over 21 GW of rooftop solar (including off-grid) has been installed. By fiscal 2030, 32-33 GW of rooftop capacities are expected to come on-stream, resulting in a reduction of 2-3% in base demand.

Captive consumption has been on a rising trajectory since fiscal 2013. The top four industries, namely iron and steel, sugar, aluminium, and steel account for 65% of the total captive consumption. Captive consumption is expected to maintain its growing trajectory going forward, driven by increasing production in the mentioned industries. These industries are expected to add ~3-4 GW of captive capacity over the next five years, adding on average 290-300 BUs of demand over the period, which may lead to a reduction in demand from the grid. Moreover, about 3 GW annual increase in average power requirement is also expected in the next 5-6 years by diversified industries.

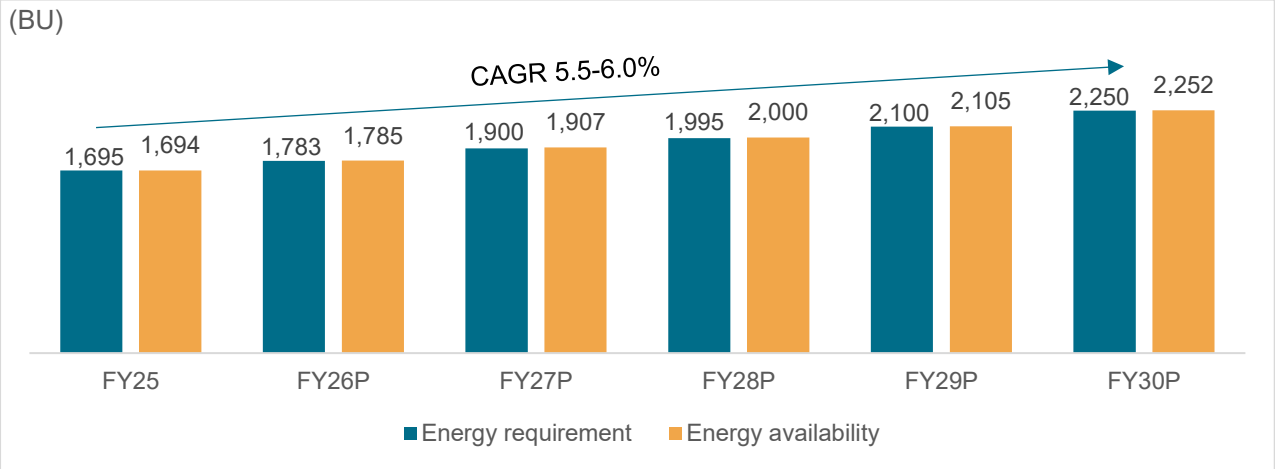
With higher tariffs and increasing operating expenses, commercial and industrial (C&I) consumers are opting for renewable energy through rooftop or open access to optimize production costs. Thus, this segment opens an avenue for more and more RE installations and provides an opportunity for RE players to expand their market.

As per National Smart Grid Forum (NSGF), there are over 70 GW of large DG sets in India which are used in commercial buildings, government and private office buildings, industrial areas, IT parks, data centers, shopping malls, hotels, hospitals, educational campuses and residential complexes, etc. By replacing DG sets with battery rooftop solar connected to BESS across the country is one of the reliable solution to build flexibility for the Indian grid. The reduction in emissions from DG sets will help meet the NDC targets as well.

2.5.2 Outlook on energy requirement and peak demand

Despite the high base of preceding three years, Crisil Intelligence expects power demand to grow by 5.5-6.0% in the next five years which will be supported by infrastructure-linked capex, strong economic fundamentals along with expansion of the power footprint via strengthening of T&D infrastructure, coupled with major reforms initiated by the GoI for improving the overall health of the power sector, particularly that of state distribution utilities, are expected to improve the quality of power supply, thereby propelling power demand.

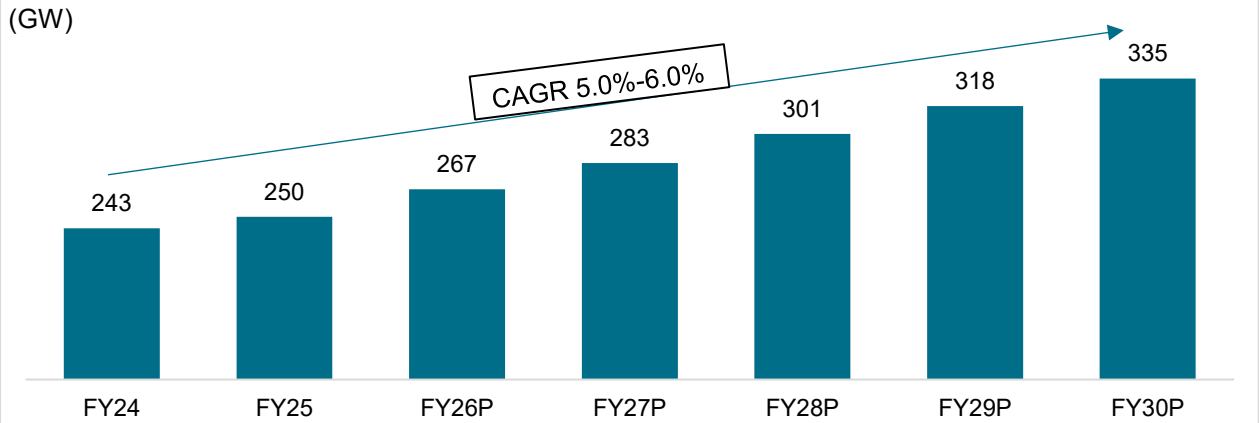
Figure 26: Energy demand outlook (fiscals 2026-30)



P: Projected, Source: CEA, Crisil Intelligence

Peak demand is expected to grow at an annual average of 5-6% over fiscal 2024-30 to reach nearly 335 GW by fiscal 2030 with an expected persistent high temperatures, rising urbanization, economic growth and infrastructure push leading to higher power consumption.

Figure 27: Peak demand to increase by 85 GW between fiscals 2025 and 2030 to cross 300 GW



P: Projected, Source: CEA, Crisil Intelligence

2.5.3 Capacity addition outlook

As per CEA India's installed power capacity is expected to reach 609.6 GW by fiscal 2027 and increase to 900 GW by fiscal 2032, from its current capacity of 475 GW in March 2025. However, as per Crisil Intelligence estimates, the capacity additions in the conventional power generation segment are projected to be around 32-35 GW cumulatively from fiscals 2026 to 2030, driven by higher than decadal average power demand. However, the need for generation capacity equipped for flexible operations to ramp up-down quickly is critical to meet peak demand as generation from renewable capacities is intermittent in nature. Crisil expects 28-30 GW of coal-based power to be commissioned over fiscals 2025-30. Coal capacity additions are expected to be driven entirely by

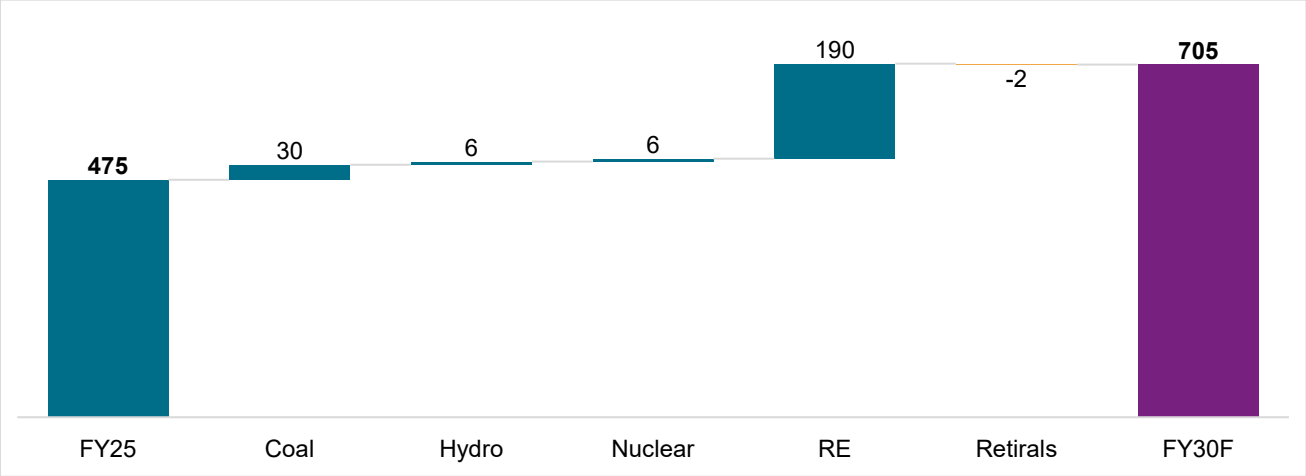
the central and state sectors, as major private gencos continue to focus on expanding RE capacity. 2-3 GW of coal-based capacity is expected to retire as per CEA's National Electricity Plan 2023.

Nuclear power capacity additions of 6-7 GW are expected during the period as ongoing projects at Kakrapara, Kalpakkam, and Rajasthan are nearing completion. Nine reactors with a total capacity of 7.3 GW are under construction which are expected to be commissioned by 2030.

Crisil expects 6-7 GW of large hydro power installations by fiscal 2030. As per CEA, about 74 GW of storage capacity (27 GW PSP and 47 GW BESS) would be required by 2032. However, Crisil estimates 40-45 GW of energy storage solutions including 8.5-9.5 GW pumped hydro storage projects (PSP) capacity additions and 32-35 GW of Battery Energy storage system (BESS) over fiscals 2026-2030.

By fiscal 2030, RE capacity (excl. large hydro) of over 180-190 GW is expected to be driven by various government initiatives, favourable policies, competitive tariffs, innovative tenders, development of solar parks and green energy corridors, etc. RE capacity is estimated to account for about 50% of the installed capacity of 700-710 GW by fiscal 2030. RE is expected to account for over 80% of the additional capacity between fiscal 2026 and 2030.

Figure 28: All India installed estimated capacity addition by fiscal 2030 (in GW)



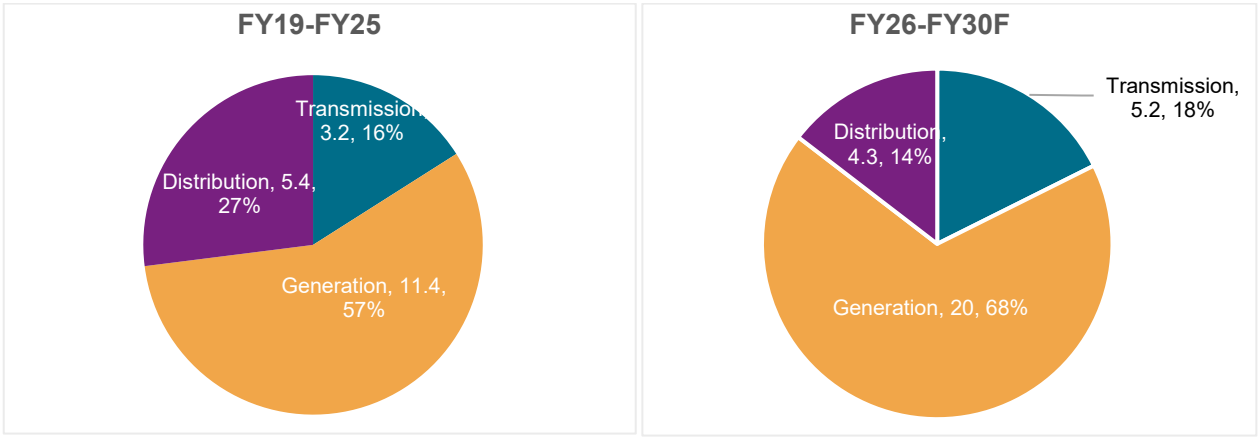
RE includes solar, wind, small hydro, and other renewable sources

Source: CEA, Crisil Intelligence

2.5.4 Investments in generation, transmission, and distribution infrastructure

The total investment in the power sector between fiscals 2019-25 was about Rs. 20 trillion. Crisil Intelligence expects investments of Rs 29-30 trillion in the power sector over fiscals 2026-30. Generation segment investments are being driven by capacity additions with robust growth in RE installations, followed by distribution investments led by the RDSS scheme.

Figure 29: Segment-wise break-up of total investments (Rs. Tn, % share of total)



Source: Crisil Intelligence

Investments in the generation segment are expected to double from Rs ~11.4 trillion to ~Rs 19.0-20.0 trillion over fiscals 2026-30. Capacity addition from RE sources is expected to be 220-225 GW from fiscal 2025 to 2030, and 40-45 GW from conventional sources over the same period. Investments in RE capacity, which are expected to double over the next five years, in line with capacity additions, will constitute over 70% of overall generation investments.

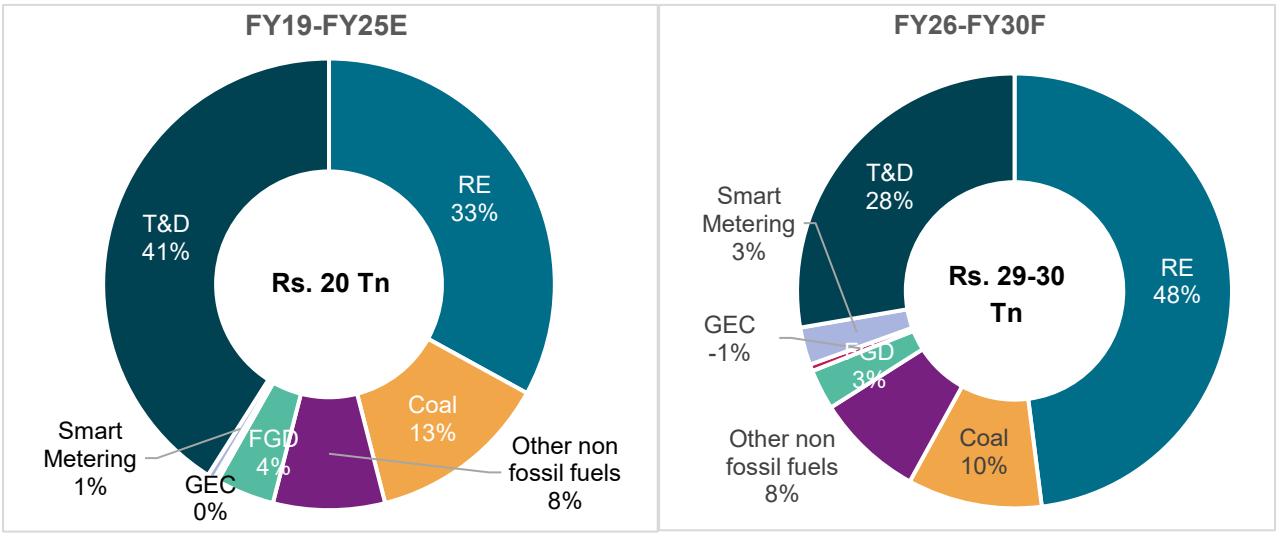
To achieve the RE generation target, a strong transmission infrastructure is needed to integrate large scale RE capacities into the grid. This is expected to lead to transmission investments of Rs 5.0-5.5 trillion between fiscals 2026-2030 from ~Rs 3.2 trillion between fiscals 2019-2025 led by upcoming ISTS projects.

The distribution segment is expected to attract investments worth Rs 4.0-4.5 trillion over fiscals 2026 to 2030 vis-à-vis ~Rs 5.4 trillion between fiscals 2019-2025. This is driven by the government's thrust on the RDSS scheme, entailing an outlay of Rs 3.04 trillion for state discoms, to be allocated until fiscal 2026. About 50% of the outlay is allocated for deployment of 250 million smart metering program and gross budgetary support of Rs. 240.15 billion has been sanctioned for smart metering projects, with Rs 4.06 billion released as of February 2025.

So far, Rs 2.52 trillion worth of DPRs have been sanctioned by nodal agencies (PFC and REC) as of December 2024, of which Rs. 1.3 trillion have been sanctioned for smart metering works including distribution transformers and feeder/boundary meters. While the amount is sanctioned, disbursement under the scheme will be contingent upon the work undertaken that was proposed under the DPR. Fulfilment of the conditions, which primarily involve operational efficiency parameters, strengthening of distribution infrastructure, and regulatory compliance, will entail significant investments in the distribution segment.

The chart below provides a detailed view of the power sector's sub-sectors, which are slated to receive investments between fiscal 2026-30.

Figure 30: Breakup of investments in power sector



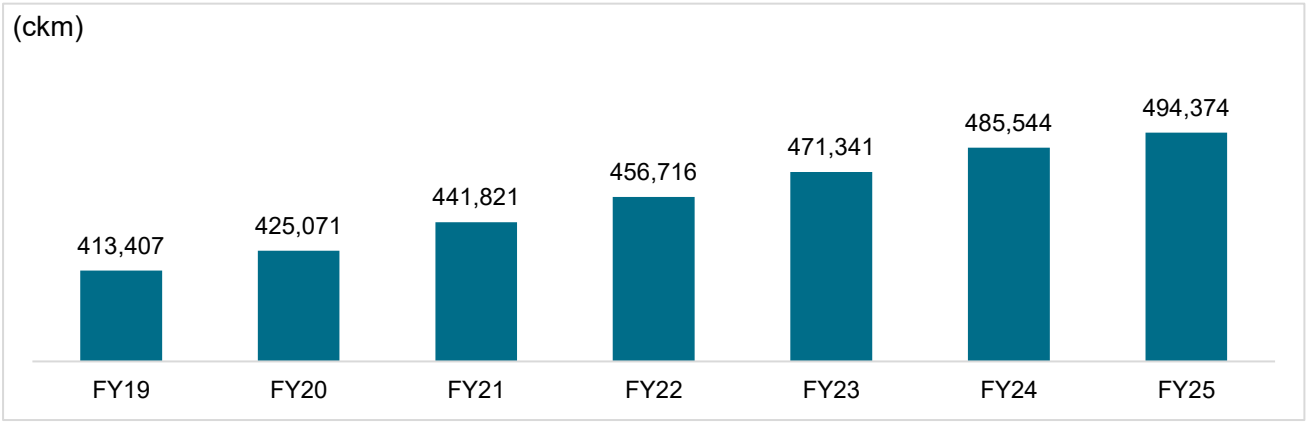
FGD: Flue Gas Desulphusrisation, GEC: Green Energy Corridor
E: Estimates, F: Forecast; Source: Crisil Intelligence

2.6 Overview of power transmission sector

2.6.1 Review of transmission infrastructure growth

Robust generation capacity addition over the years and government's focus on 100% rural electrification through last mile connectivity has led to extensive expansion of the T&D system across the country. The total length of domestic transmission lines rose from 413,407 circuit kilometres (ckm) in fiscal 2019 to 494,374 ckm in fiscal 2025.

Figure 31: Total transmission line network in the country (220 kV and above)



Source: CEA, Crisil Intelligence

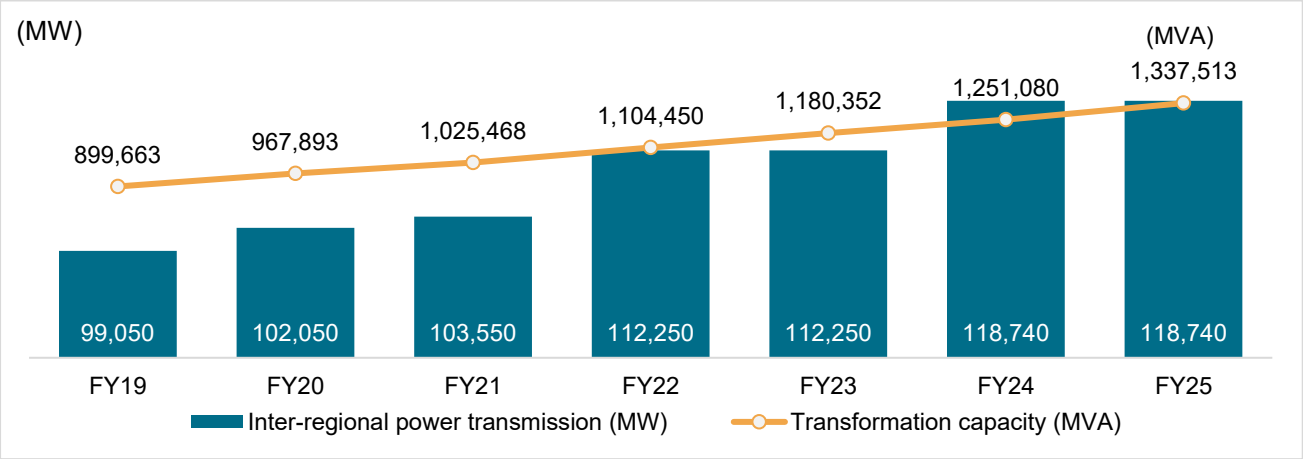
There has been significant growth in the transmission system, particularly at higher voltage levels and substation capacities. This growth is driven by the increasing demand for an expanded transmission network to efficiently

transport bulk power over long distances. At the same time, efforts are being made to optimize the right of way, minimize losses, and enhance grid reliability.

The total transmission line length (above 220 kV) has increased at 3.0% CAGR from fiscal 2019 to fiscal 2025. This increase can also be attributed to an increase in the commissioning of the 765-KV lines, growing at a CAGR of ~6% over the same period. 765 kV lines have higher transfer capacity and lower technical losses thereby reducing the overall number of lines and rights of way required to deliver equivalent capacity. Performance in a transmission line improves as voltage increases and as 765 kV lines use one of the highest voltage levels, they experience comparatively lesser amount of line loss. 800 kV lines have also shown strong growth momentum, rising to 9.5% CAGR over the last 5 fiscals, majorly owing to strong investments by the central sector.

The inter-regional power transmission capacity of the National Grid has grown strongly from 99,050 MW in fiscal 2019 to 1,18,740 MW in fiscal 2025, at a CAGR of 3.1%. Subsequently, substation transformation capacity rose from 8,99,663 MVA in fiscal 2019 to 13,37,513 MVA in fiscal 2025, growing at a CAGR of ~6.8%.

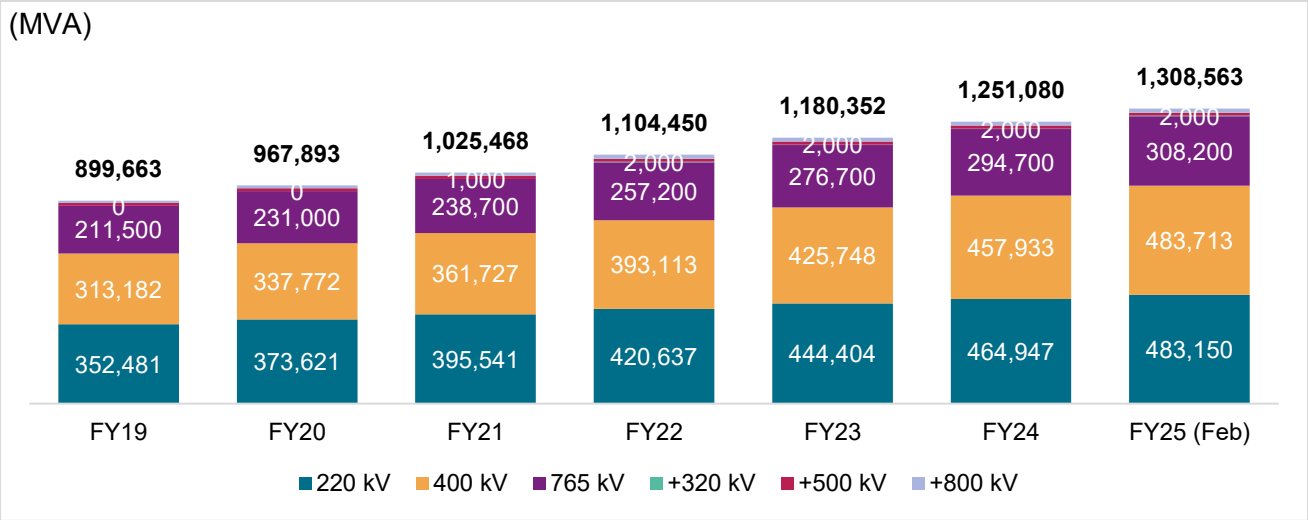
Figure 32: Growth in transformation capacity and inter-regional power transmission capacity



Source: CEA, Crisil Intelligence

The growth in sub-station capacities has majorly seen traction in 220 kV, 400 kV and 765 kV segments, contributing to 32%, 41% and 24% of the incremental additions between fiscals 2019 and fiscal 2024.

Figure 33: Voltage wise substation transformation capacity in the country



Source: CEA, Crisil Intelligence

2.6.2 Key growth drivers for growth in transmission sector

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

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

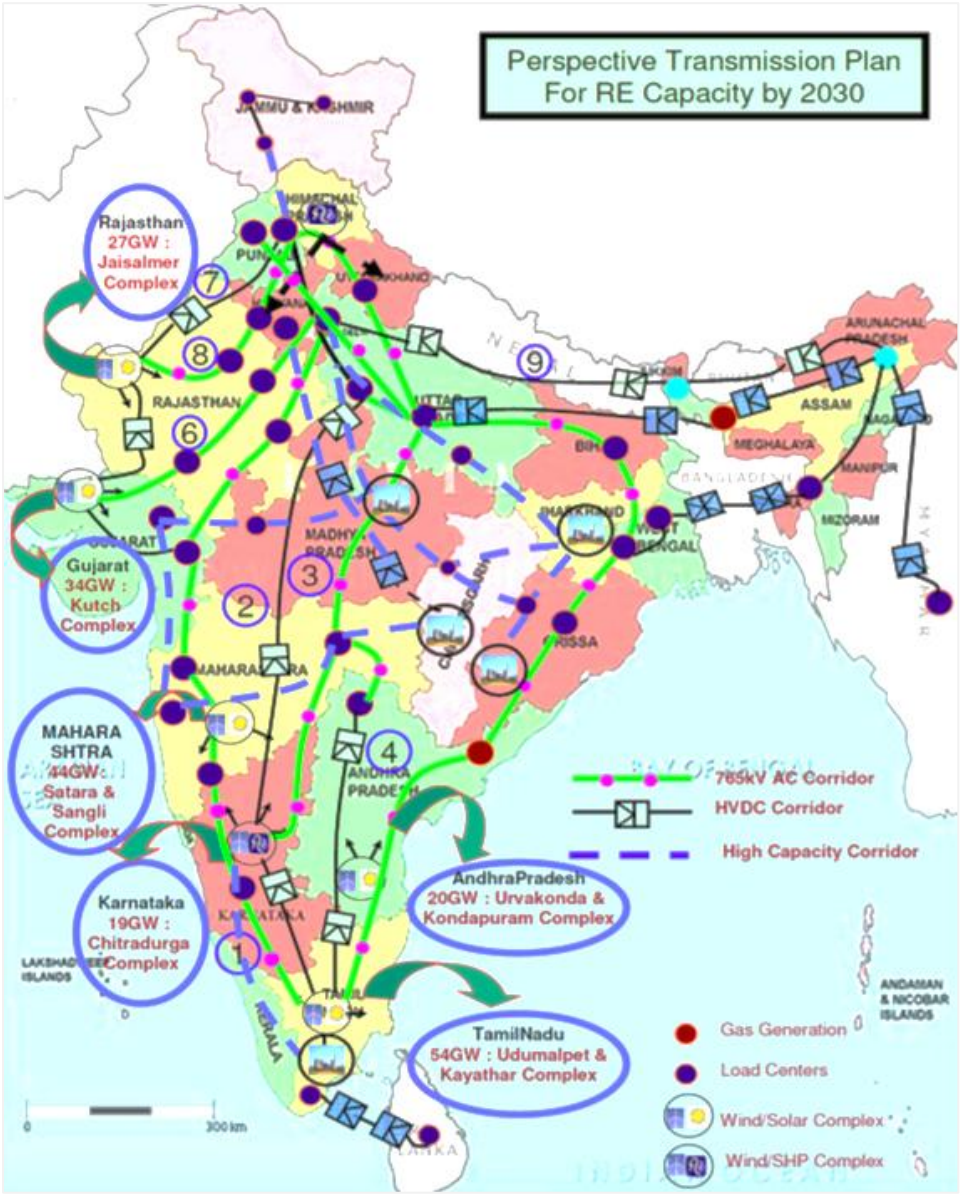
As per Central Transmission Utility of India Limited (CTUIL), the total power generation capacity (including renewable energy and energy storage) at a pan India would rise to ~776 GW in fiscal 2030 from ~462 GW in fiscal 2024. However, the upcoming generation capacity will not be spread evenly across India. Most of the upcoming renewable capacities would be concentrated in the northern (specifically in Rajasthan), western and southern regions of India, while significant thermal capacities would commission close to the coal mines in eastern and central regions of India. The addition of such large quantity of generation capacities would necessitate the investments in transmission segment to supply power to different demand centres.

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

As a result, to reduce the demand-supply mismatch, government has planned to increase the interregional power transfer capacity to 167,540 MW by fiscal 2032. Moreover, the share of inter-regional transmission capacity is expected to increase from 13.9% in fiscal 2012 to 18.6% in fiscal 2032 (inter-regional transmission capacity as a fraction of total installed generation capacity), resulting in growth of investment in the power transmission sector.

Strong renewable energy capacity additions to also drive transmission capacity

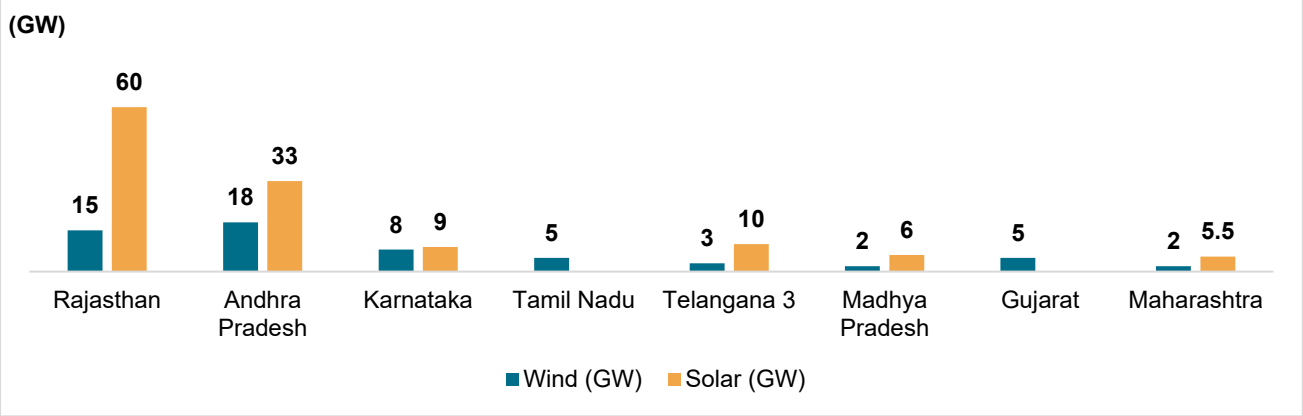
The Green Energy Corridor (GEC) projects and Renewable Energy Zones (REZs) are critical infrastructure initiatives designed to facilitate the large-scale integration of renewable energy into the national grid. The GEC initiative, implemented in two phases, focuses on strengthening intra-state and inter-state transmission networks to evacuate power from renewable-rich states like Rajasthan, Gujarat, Tamil Nadu, Karnataka, and Madhya Pradesh. Phase I targeted 33 GW of RE evacuation, while Phase II aims to integrate an additional 20 GW by 2026 with funding support from the Government of India and international lenders like KfW (Germany). Under Phase-II, MNRE has also sanctioned implementation of 13 GW of RE Projects along with 12 GWh BESS in Ladakh in February 2024. In January 2022, the government approved GEC Phase-II with a total target of 10,750 ckm which is further revised to 7,574 ckm. The scheme will facilitate grid integration and power evacuation of 20 GW of RE power projects.



Source: PGCIL, Crisil Intelligence

REZs identify high-resource potential areas for wind and solar development, ensuring dedicated transmission planning and streamlined land acquisition to accelerate RE deployment. MNRE/SECI have identified REZs totaling 181.5 GW for likely benefits by the year 2030. These REZ's are located in eight states as detailed below:

Figure 34: Potential RE zones identified by MNRE/SECI



Source: CEA: Transmission System for Integration of over 500 GW non fossil fuel-based Capacity by 2030

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

Power deficit in India has been on a declining trajectory with energy deficit shrinking to 0.3% for fiscal 2024 as compared 3.6% in fiscal 2015. Thus, with healthy availability of power, India is evaluating opportunities to tap neighbouring countries for better integration and synergies.

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

2.6.3 Outlook on transmission capacity additions

The power transmission sector in the country has grown steadily in recent years, mainly due to the rising demand for electricity and the increasing capacity of power generation plants, particularly renewable energy plants. A major factor driving the further expansion of the grid is the need to evacuate electricity from upcoming renewable energy projects. Green energy corridors and a transmission system for renewable energy zones are already being built to make it easier to integrate renewable energy into the grid. The following are the major transmission capacity additions as envisaged till fiscal 2030:

Table 2: Under-construction transmission lines (in ckm)

Sl. No.	FY	WR	SR	NR	ER	NER	Total
1.	2024-25	3,479	1,611	7,367	-	711	**13,168**
2.	2025-26	1,862	1,260	6,186	238	230	**9,776**
3.	2026-27	1,880	273	-	-	271	**2,424**

Sl. No.	FY	WR	SR	NR	ER	NER	Total
4.	2027-28	-	-	-	-	-	-
5.	2028-29	470	280	2,028	-	-	**2,778**
6.	2029-30	-	-	-	-	-	-
	Total	**7,691**	**3,424**	**15,581**	**238**	**1,212**	**28,146**

Note: WR: Western Region, SR: Southern Region, NR: Northern Region, ER: Eastern Region, NER: North-Eastern Region

Source: CEA, CTUIL ISTS Interim Rolling plan 2029-30, Crisil Intelligence

Table 3: Under-construction transformation capacity (in MVA)

Sl. No.	FY	WR	SR	NR	ER	NER	Total
1.	2024-25	42,500	18,000	57,185	1,250	320	**119,255**
2.	2025-26	31,000	27,000	49,215	1,500	1,720	**110,435**
3.	2026-27	18,500	2,000	-	500	-	**21,000**
4.	2027-28	-	-	-	-	-	-
5.	2028-29	4,630	1,630	6,630	-	-	**12,890**
6.	2029-30	-	-	-	-	-	-
	Total	**96,630**	**48,630**	**113,030**	**3,250**	**2,040**	**263,580**

Note: WR: Western Region, SR: Southern Region, NR: Northern Region, ER: Eastern Region, NER: North-Eastern Region

Source: CEA, CTUIL ISTS Interim Rolling plan 2029-30, Crisil Intelligence

Table 4: Under planning/ approval/ bidding transmission lines (in ckm)

Sl. No.	FY	WR	SR	NR	ER	NER	Total
1.	2024-25	-	-	-	-	-	-
2.	2025-26	810	-	644	400	40	**1,894**
3.	2026-27	2,330	3,430	8,533	450	-	**14,743**
4.	2027-28	2,470	540	-	50	75	**3,315**
5.	2028-29	608	-	1,964	70	-	**2,642**
6.	2029-30	1,320	-	-	2,340	1,210	**4,870**
	Total	**7,538**	**3,970**	**11,141**	**3,310**	**1,325**	**27,284**

Note: WR: Western Region, SR: Southern Region, NR: Northern Region, ER: Eastern Region, NER: North-Eastern Region

Source: CEA, CTUIL ISTS Interim Rolling plan 2029-30, Crisil Intelligence

Table 5: Under planning/ approval/ bidding transformation capacity (in MVA)

Sl. No.	FY	WR	SR	NR	ER	NER	Total
1.	2024-25	-	-	-	-	-	-
2.	2025-26	95,100	500	3,890	3,000	-	**102,490**
3.	2026-27	74,000	55,000	55,200	3,000	50	**187,250**
4.	2027-28	26,500	23,500	-	-	-	**50,000**
5.	2028-29	22,760	-	7,500	-	-	**30,260**
6.	2029-30	9,000	-	-	-	-	**9,000**
	Total	**231,360**	**79,000**	**68,090**	**6,000**	**50**	**384,500**

Note: WR: Western Region, SR: Southern Region, NR: Northern Region, ER: Eastern Region, NER: North-Eastern Region

Source: CEA, CTUIL ISTS Interim Rolling plan 2029-30, Crisil Intelligence

In the National Electricity Plan (volume II – Transmission) released by CEA, the Transmission system has been planned for integration of over 600 GW RE capacity to the grid by fiscal 2032. The plan also aims to add more than 191,000 ckm of transmission lines and 1,270 GVA of transformation capacity at 220 kV and above between

fiscals 2023-2032. It also includes the addition of 33 GW of high voltage direct current HVDC bi-pole links and plans to increase inter-regional transmission capacity from 119 GW in December 2023 to 168 GW by 2032.

Table 6: Transmission lines and sub-station capacity addition by 2031-32

Transmission System	Units	As on 31.03.2024	Likely addition during 2022-27	Likely additions during 2027-32	Likely at the end of 2031-32 (31.03.2032)
Transmission lines	ckm	485,544	114,687	76,787	648,190
Sub-stations	MVA	1,251,080	776,330	497,855	2,345,135
Inter-regional transmission capacity	MW	118,740	30,690	24,600	167,540

Source: CEA, Crisil Intelligence

2.7 Overview of power distribution sector

Power distribution is the final and most crucial link in the electricity supply value chain which is directly connected to the consumers. However, the distribution sector is facing various challenges, such as unreliable power supply, high AT&C losses, old and overloaded network, low-cost recovery, low consumer satisfaction, etc., resulting poor financial health of Discoms and distribution companies are not able to undertake corresponding investments in infrastructure augmentation.

In the last few years, the distribution sector has received greater attention and various reforms measures/ Rules have been notified by MoP for improving financial viability of Discoms and equipping them to provide 24x7 reliable & quality power to consumers. Several initiatives have also been introduced to bring down AT&C losses within the definitive regulatory framework.

2.7.1 Key challenges in the power distribution sector

Discom challenges	Description
High AT&C losses	AT&C losses have consistently remained a major challenge in the electricity distribution sector. Nevertheless, over the past five-six years, a notable reduction in AT&C losses has been observed at the national level, with a decline from 22% to 16%. However, certain major states, including Bihar, Jharkhand, Maharashtra, Madhya Pradesh, continue to grapple with losses exceeding 20%. Furthermore, the annual billing loss has consistently exceeded 150 BU since 2012, resulting in an average revenue loss of approximately Rs. 700-750 billion per annum, underscoring the need for sustained efforts to mitigate these losses and improve the sector's financial viability. Illegal electricity connections and pilferage of electricity also leads to commercial loss and one of the several reasons for high AT&C losses.
Tariff not reflective of costs	The cost of supply of power encompassing power purchase cost, transmission, distribution, and administrative expenses exceeds the revenue generated by Discoms. This disparity is primarily attributed to the prevalence of heavily subsidized tariffs and cross-subsidization policies, which are mandated by state governments. Many Discoms are compelled to sell electricity at tariffs that are

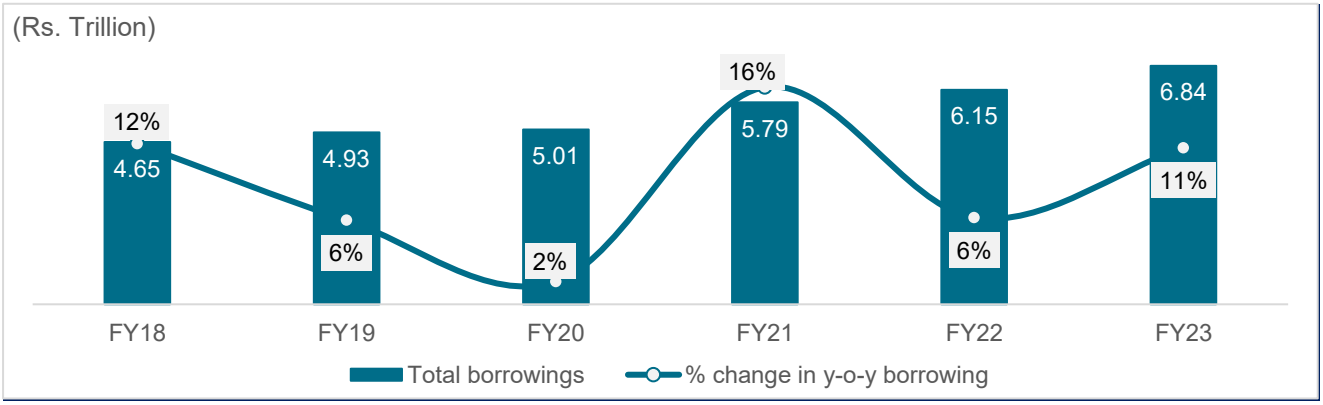
Discom challenges	Description
	below the cost of supply, particularly to agricultural and residential consumer segments, thereby exacerbating the financial strain on these utilities.
Rising debt burden	The total outstanding debt of discoms stood at around Rs 6.8 trillion as of March 2023, or around 2.5% of GDP. This debt has risen from around Rs 5.4 trillion in fiscal 2021. Four states – Tamil Nadu, Maharashtra, Uttar Pradesh and Rajasthan, accounted for about 55% of the total debt, with Tamil Nadu alone accounting for 23%.
High accumulated losses	Despite improvements in billing and collection efficiency, accumulated losses for the sector were nearly Rs 6,479 billion as of fiscal 2023, up by 11% from Rs. 5,841 billion in fiscal 2022
24x7 reliable power supply and quality	The power quality can be affected due to voltage surges/sags, momentary or extended interruptions, harmonic distortion, electrical noise, lightning damage. As per the latest data available from CEA, ▪ System Average Interruption Frequency Index (SAIFI) was 171.64 no. of interruptions per consume/year, and ▪ System Average Interruption Duration Index (SAIDI) was 116.12 hours per consumer/year The indices are above the targeted value set for fiscal 2025 which was 120 and 90, respectively. In countries like Europe SAIDI ranges from 20-120 mins/customer/year and SAIFI ranges from 0-2 interruptions/customer/year depending on size of DSO. In US, SAIDI was reported as 366.6 minutes/year and SAIFI was reported as 1.35 interruptions/year in 2023.
Poor customer services	The prevalence of high complaint volumes, prolonged resolution times, and low customer satisfaction scores underscores the need for significant improvements in customer service practices and accountability mechanisms. As per the REC's Consumer Services Rating of Discoms for fiscal 2024, only 33% of Discoms have received an A or A+ grade, indicating a substantial scope for enhancement in addressing consumer-level grievances. This suggests that Discoms must prioritize the timely resolution of complaints and ensure a reliable supply of power to meet the expectations of their customers, thereby fostering a more satisfactory and responsive consumer experience.
Lack of real time analytical insights	The lack of automated systems and real-time data analytics restricts Discoms' ability to monitor and manage their networks effectively, leading to inefficiencies in energy distribution, transmission, and consumption. This, in turn, can result in unnecessary energy losses, reduced power quality, and increased operational costs

2.7.2 Key performance indicators of distribution sector entities

2.7.2.1 Current state of discom financial health

As per PFC's Report on Performance of Power Utilities for fiscal 2023, the aggregate losses for discoms increased from Rs 269.47 billion in fiscal 2022 to Rs 572.23 billion in fiscal 2023. Total borrowings by distribution utilities increased from Rs 6,148.53 billion as on March 31, 2022, to Rs 6,843.79 billion as on March 31, 2023.

Figure 35: Total borrowings for discoms

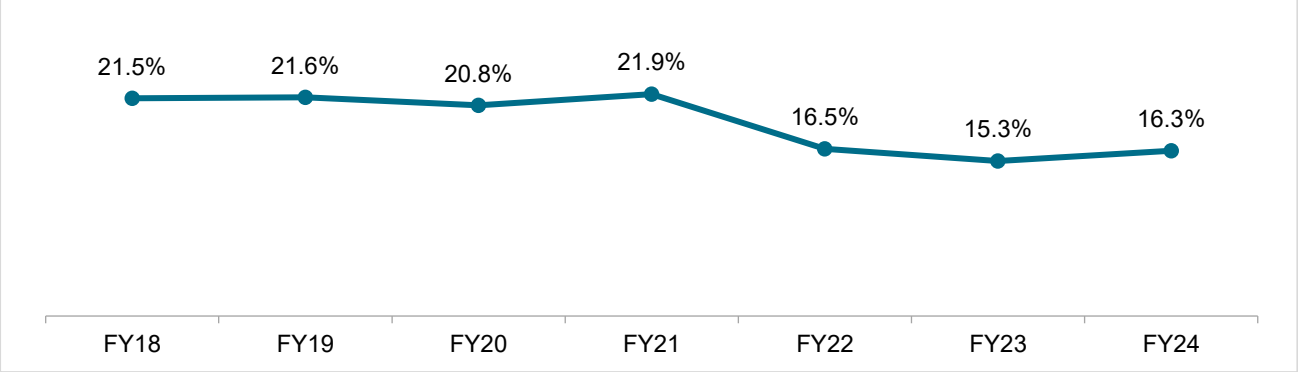


Source: MoP, PFC, Crisil Intelligence

2.7.2.2 Review of AT&C loss and ACS-ARR gap of state discoms

The AT&C losses for distribution utilities improved significantly from 21.9% in fiscal 2021 to 16.5% in fiscal 2022 due to an increase in collection efficiency from 92.5% to 97.2%. Collection efficiency increased due to improvement in subsidy disbursal by the state governments. The aggregate subsidy receipts of 109% were received in fiscal 2022. The AT&C loss further improved to 15.3% in fiscal 2023. However, the collection efficiency decreased by 1.2% from 97.6% in fiscal 2023 to 96.4% in fiscal 2024 which has led to an increase in AT&C loss in fiscal 2024 to 16.3%.

Figure 36: AT&C loss trajectory (%)

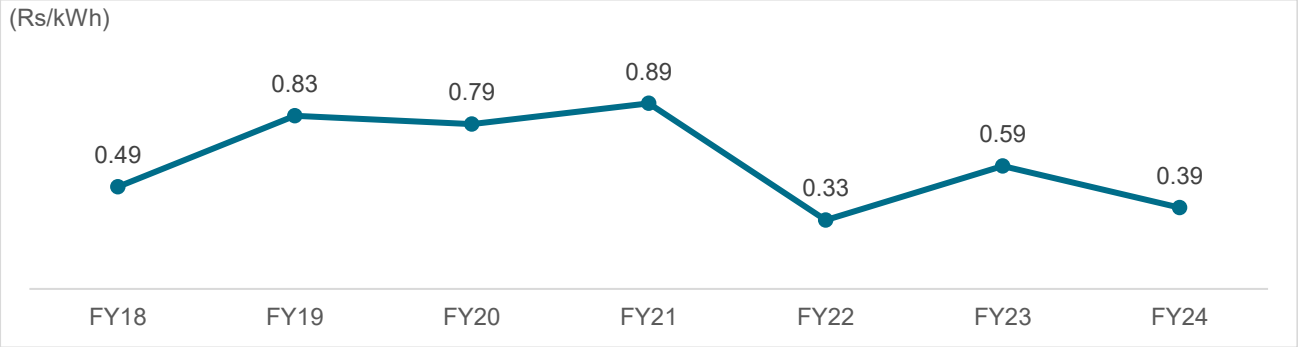


Source: PFC, Crisil Intelligence

The cash adjusted Average Cost of Supply (ACoS), and Average Revenue Realized (ARR) gap narrowed to Rs. 0.33/kWh as of March 2022 driven by higher subsidies disbursement by state governments and better cash

collections. In fiscal 2023, the gap again increased to Rs. 0.59/kWh due to an increase in power purchase cost. However, during fiscal 2024, the gap decreased by Rs. 0.20/kWh to Rs. 0.39/kWh.

Figure 37: ACS-ARR gap



Source: PFC, Crisil Intelligence

2.7.3 Government measures to improve distribution sector performance

The Indian power sector is undergoing a significant transformation driven by economic growth and rising customer expectations. The Government of India has implemented various reform initiatives to improve the operational and financial performance of Discoms. These initiatives include rural electrification, network strengthening, IT enablement, and improving energy efficiency. The goal is to revamp the power distribution system and provide better services to customers.

Some of the key initiatives include Integrated Power Development Scheme (IPDS) which introduced IT and ERP systems in Discoms, Ujjwal DISCOM Assurance Yojana (UDAY) which provided for gradual takeover of Discom's debt by State Governments and RDSS which targets nationwide deployment of prepaid smart meters along with other performance improvement measures.

Despite these efforts, discoms continue to face challenges related to financial sustainability, quality of service, integration of renewable energy, and customer centricity. A key issue has been the lack of real-time measurement and end-to-end energy accounting, which has hindered the performance of Discoms. To address this, smart metering has been introduced as a solution to not only resolve legacy issues but also enable modern services for customers. By providing accurate and timely data, smart metering is expected to improve the overall efficiency and effectiveness of the power distribution system.

Revamped Distribution Sector Scheme

The RDSS was launched in July 2021 with an outlay of Rs. 3.03 trillion available till fiscal 2026. It is a reforms-based and results-linked scheme that aims to reduce pan-India AT&C losses to 12–15% (from 21.5% at the start of the scheme) and bring down the ACS-ARR gap to zero. For availing funds available under this scheme, states must prequalify a set of criteria, including publishing audited financial reports, non-creation of additional regulatory assets, and upfront liquidation of dues or subsidies to discoms.

The Government of India's Smart Meter National Programme ("SMNP") under the RDSS is a key driving factor for the installation of smart energy meters. The programme focuses on modernizing the electricity distribution infrastructure through the large-scale deployment of smart energy meters and aims to replace 250 million

conventional meters with smart energy meters, enhancing energy management, reducing transmission and distribution losses, and improving consumer engagement. Approximately Rs.1.5 trillion has been earmarked for prepayment meters.

Prepaid Smart metering is one of the critical interventions envisaged under RDSS. This provides for prepaid Smart metering for consumers, system metering at feeder and distribution transformer (DT) level with communicating feature along with associated Advanced Metering Infrastructure (AMI) would be implemented under TOTEX mode (Total expenditure includes both capital and operational expenditure) thereby allowing the Discoms for measurement of energy flows at all levels as well as energy accounting without any human interference. Proper and accurate energy accounting is the key to identification of high loss areas and theft prone areas, whereby, utilities billing and collection efficiencies will improve significantly, thereby reducing the AT&C losses of Discoms.

Under the RDSS, implementation of prepaid smart metering is currently being prioritised for:

i. All electricity divisions of 500 cities under AMRUT with AT&C losses of more than 15%
ii. All union territories of India
iii. MSMEs, industrial and commercial consumers
iv. All government offices at the block level and above
v. Other areas with high losses.

Given the focus on reducing AT&C losses and improve billing efficiency, the MoP has mandated Discoms to undertake energy accounting on periodic basis. The Manner and Intervals for Conduct of Energy Audit (Accounting) in electricity distribution companies Regulations, 2021 were issued in October 2021. As per the regulations, the Discoms are required to conduct quarterly energy accounting and annual energy audit through energy managers and energy auditors certified by BEE (Bureau of Energy Efficiency). This exercise could help the utilities to get a detailed understanding of technical and commercial losses in the system, identify areas of high losses, energy thefts/pilferage and accordingly plan efficiency improvement steps, prioritize intervention areas.

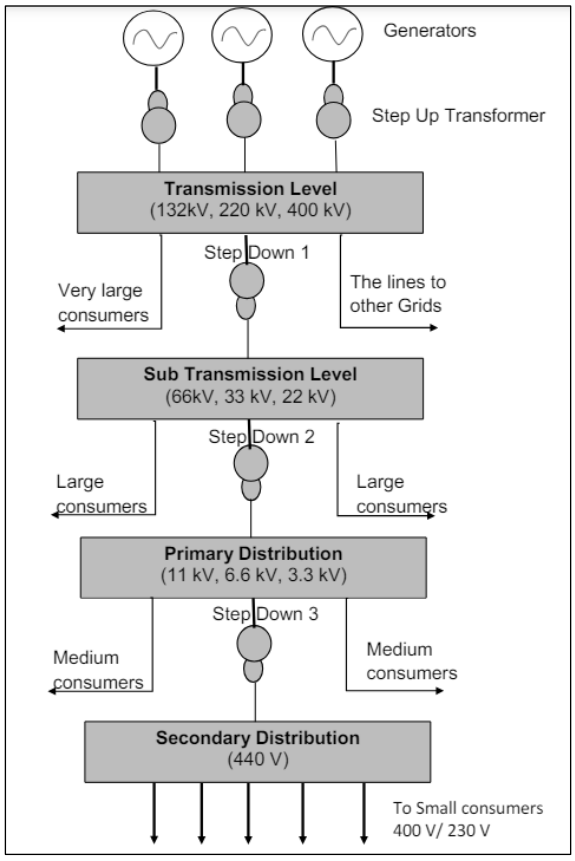
Smart meters reduce AT&C losses by ensuring accurate metering and billing, eliminating manual errors and tampering that contribute to commercial losses. They enable real-time monitoring and detection of power theft, unauthorized connections, and meter bypassing, allowing utilities to take immediate corrective action. With automated data collection and remote transmission, smart meters minimize human intervention, preventing meter reading manipulation and billing fraud. Additionally, they support better load management and demand response, optimizing grid performance and reducing technical losses caused by overloading and inefficient power distribution.

Further, the significance of smart meters extends beyond just energy management. They play a crucial role in integrating solar and other distributed energy resources (DER) and EV infrastructure with the electricity grid. This integration is vital for the future of sustainable energy and transportation, making smart meters an essential component of modern energy infrastructure.

2.7.4 Review of existing distribution network

The electricity is generated mostly at voltages between 11 kV to 33 kV which is stepped up to 132kV, 220 kV or 400 kV or 765 kV for transmitting to various parts of the country through inter-state transmission network and

within State through intra-state transmission network. For distribution purposes, the electricity is suitably stepped down to 66 kV, 33 kV, 22 kV, 11 kV and 0.4 kV for supplying to the consumers. In some states/UTs, some additional voltages like 6.6 KV or 3.3 KV are also in practice.



Source: CEA

As on March 2022, the total number of Power Sub-stations (66/11 kV, 33/11 kV and 22/11 kV) in the country was 39,965 with a total installed capacity of 4,82,810 MVA**.** The total number of 66/33/22 kV feeders in the country were around 36,804 with total length of 5,89,304 ckm and the total number of 11 kV feeders in the country were 2,30,979 with total length of 49,35,279 ckm. The number of Distribution Transformers (DT) at all-India level as on March 2022 stood at 1,46,74,261 with an installed capacity of 6,89,192 MVA.

2.7.5 Power distribution network addition targets by fiscal 2030

The Distribution perspective plan 2030 was prepared by CEA in Feb 2024 for assessment of requirement for development of the distribution sector to provide 24x7 quality power, reduction of AT&C losses, and to provide reliable power to its consumers. The plan has been prepared based on energy requirement and peak demand as forecasted in the 20th EPS of CEA.

The sub-transmission power substation capacity at the end of fiscal 2030 has been projected to meet the peak demand of 335 GW forecasted for fiscal 2030.During fiscal 2023-30, it is planned to add 17,835 no. of 66/33/22 kV feeders in the country with total addition in feeder length of 1,88,690 ckm and 92,920 no. of 11 kV feeders in the country with total addition of feeder length of about 9,68,503 ckm.

In order to reduce the AT&C losses further, utilities need to concentrate on reducing technical losses. Improving the HT/LT ratio can reduce technical losses as well as improve voltage profile at consumer end. HT/LT ratio can be increased either by adopting a High Voltage Distribution System (HVDS) system or increasing HT line length. Regarding DT's it is planned to add about 46,57,854 number of DTs with a total added DT capacity of 2,38,464 MVA in the country during the said period. These DT additions are planned for meeting the customer's electricity demand growth & using HVDS to reduce technical losses by bringing the HT line closer to the load center.

LT lines of about 97,74,634 ckm (1-phase – 4,99,556 ckm and 3-phase -12,69,774 ckm) would be added by fiscal 2030. Out of the total LT lines, about 69% of LT lines would be 3 phase lines in the country.

Table 7: Details of infrastructure proposed for distribution sector by 2030

Description	*Unit*	*March 2022*	*March 2030 (Forecast)*	*% increase*
Substation (66/33/22 kV)	*Nos.*	39,965	52,157	31%
Substation Capacity (66/33/22 kV)	*MVA*	48,2810	62,4332	29%
Feeders (66/33/22kV)	*Nos.*	36,804	54,639	48%
Feeders (66/33/22kV)	*Ckm*	58,9304	77,7994	32%
Feeders (11kV)	*Nos*	230979	323899	40%
Feeders (11kV)	*Ckm*	49,35,279	59,03,782	20%
Distribution transformer	*Nos*	1,46,74,261	1,93,32,115	32%
Distribution transformer	*MVA*	6,89,192	9,27,656	35%
LT Feeders (1 & 3-ph)	*Ckm*	79,45,758	9774634	23%
Consumers	*Nos (in million)*	330	520	58%

Source: CEA, Crisil Intelligence

3 Smart meter market in India

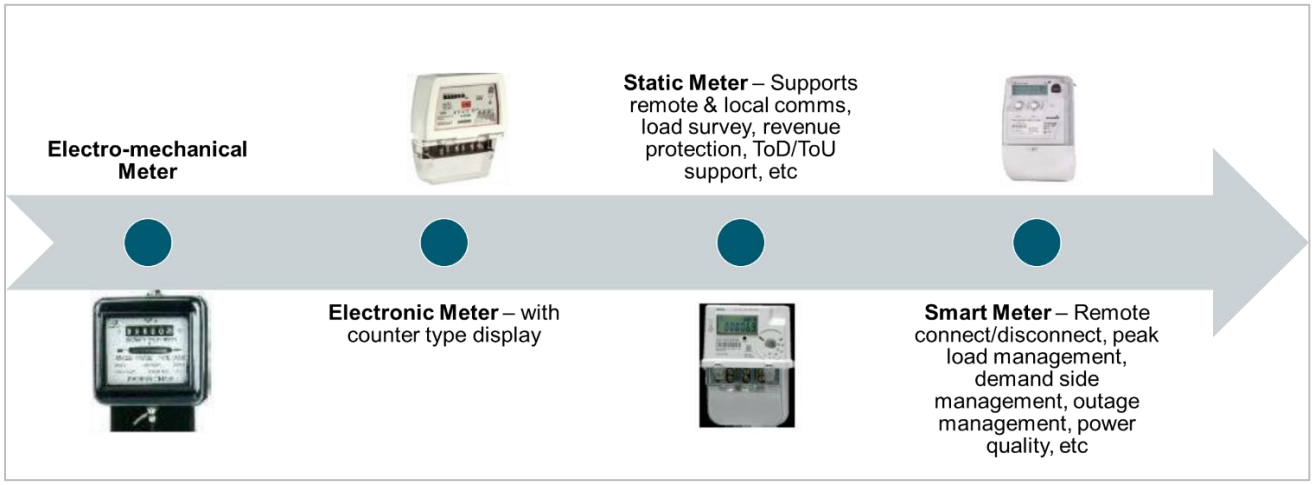
3.1 Evolution of electricity meters

The evolution of electricity meters started with the advent of Electrolytic meters in 1881 and evolved through Electromechanical, Electronic & Static meters to Smart Meters. Electromechanical meters had limitations such as limited measurement parameters, highly prone to electricity theft, wear and tears. Electromechanical meters were replaced with static meters under the Accelerated Power Development and Reforms Programme (APDRP) which was launched in 2005, with digital displays offering high accuracy and reliability.

Traditionally dominated by mechanical meters, the energy meter market shifted towards digital and electronic meters and is now leaning towards smart energy meters. Smart metering is more than just a passing trend; it is a key part of India's long-term energy strategy. As India works to modernize its energy infrastructure, the role of smart meters is becoming increasingly important. Unlike traditional meters, which require manual readings and are prone to errors, smart meters provide accurate and up-to-date information, enabling consumers to optimize their energy use and reduce costs.

The deployment of electricity meters is widespread across various sectors, including power generation, transmission infrastructure, substations, and distribution. Agricultural, Domestic, Commercial and Industrial sectors are the big users. Additionally, these meters are utilized in diverse infrastructure applications, such as water utilities, transportation systems (including railways, metro infrastructure, airports, and highways), telecommunications (including telecom base transceiver stations and digital telephone exchanges), industrial and commercial facilities, residential complexes, large sports and recreational facilities, and healthcare institutions.

The evolution of electricity meters has led to the development of smart meters for non-utility users as well. They incorporate advanced features such as Transmission Control Protocol/Internet Protocol (TCP/IP) connectivity via Ethernet, radio, or GSM, enabling remote disconnection of power supply. These advanced meters, known as panel meters or multi-function meters (MFMs), offer a range of features that facilitate energy management. Notably, in large commercial establishments, such as shopping malls, while there may be only one or two utility meters, there can be multiple MFMs/panel meters installed.



Source: Crisil Intelligence

3.2 Advantages of smart meters over static meters

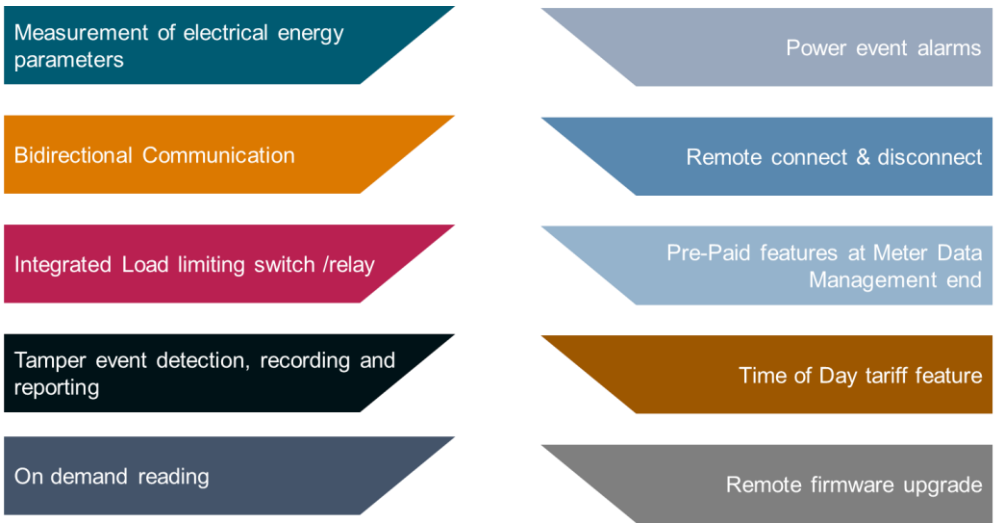
The energy meter market in India is witnessing substantial growth, fuelled by rapid urbanization, rising electricity consumption, increasing demand for energy efficiency, and government efforts to provide universal electricity access and modernize utility infrastructure.

The government under RDSS mandates (as explained in section 2.7.3 of Chapter 2) implementation of prepaid smart meters which requires the users to pay in advance for the usage of electricity. This prepaid system empowers consumers to take control of their electricity consumption, allowing them to monitor and budget their usage more effectively on a monthly basis. In the event that the balance is depleted, the utility sends multiple reminders to the consumer before disconnecting the supply, providing ample opportunity for them to recharge and avoid interruption of service. By promoting prepaid smart metering, the government aims to enhance consumer awareness and responsibility, while also reducing the financial burden of unpaid bills on utilities. In order to promote pre-paid smart metering, States have been advised to provide a rebate of upto 5% to pre-paid consumers. These meters help with efficient energy management and reduce T&D losses, which are critical for improving overall grid efficiency and stability.

Smart meters offer several advantages over traditional meters, including real-time monitoring of energy consumption, less prone to tampering compared to static meters, automatic readings, remote access, and long-term cost savings. These meters also offer the flexibility to switch between prepaid and post-paid billing options, catering to diverse payment preferences and feature a built-in Radio Frequency (“RF”)/cellular replaceable communication modem for seamless connectivity.

These smart meters minimise ownership costs through smart automation and efficient operations, eliminating manual meter reading costs with automated data collection. It delivers better consumption insights to optimize energy usage and improve billing accuracy, accelerate billing cycles with remote reading. It reduces site operational costs and setup time with fail-safe installation and commissioning, enables remote configuration and updates for seamless maintenance. Further, these meters are built to withstand field conditions and ensure long service life.

Some of the basic features of smart meters are:



Advanced Metering Infrastructure (AMI) enabled smart meters are a key component of modern smart grids. These meters offer two-way communication capabilities, enabling remote monitoring and control, which allows utilities to manage tasks, including meter reading, load disconnection/reconnection, and diagnostics without on-site visits. The impact of AMI on the overall utility operations is based on the usage of information and its subsequent course of action. However, the benefits from the AMI system depend on the reliability of the communication system deployed.

Table 8: Key advantages of Smart meter/AMI

Features	Description	Benefit to Utility	Benefit to Consumer
Automated meter reading	Automatic, real-time data transmission directly to the utility company, eliminating the need for a meter reader to physically visit the premises	✓	✓
Real time data	More accurate and real-time data about electricity, gas or water usage. This data can be accessed by both consumers and utility companies, allowing for better management of energy consumption	✓	✓
Remote Disconnect and Reconnect	Utility companies can remotely disconnect and reconnect the service, making it more efficient for billing and maintenance purposes	✓	✗
Time of use pricing	Support time-of-use pricing models, which charge consumers varying rates for electricity depending on the time of day. This encourages consumers to use energy during off-peak hours, reducing stress on the grid	✓	✓
Energy Management	Enables demand response programs by enabling users to monitor their energy consumption in real-time, facilitating the identification of areas for improvement and the implementation of energy-saving strategies	✓	✓
Energy accounting and audit	Facilitate energy accounting and auditing by recording energy consumption at frequent intervals, allowing for detailed analysis, and generating detailed reports. Highlight	✓	✗

Features	Description	Benefit to Utility	Benefit to Consumer
	areas of high consumption, energy loss and pilferage and the effectiveness of energy efficiency measures		
Substation wise granular spatial load forecasting	The granular information of consumers load patterns can be used to improve the load forecast with high accuracy and LDCs can make appropriate decisions in real-time. This can also influence consumer's energy consumption patterns through demand side management	✓	✗
Monitoring of substations and DTs	Enables real time monitoring of all electrical parameters at substation and DT level. Detect issues like voltage fluctuations, harmonics, and other power quality problems that can impact DTs and substations and can help in scheduling the maintenance activities proactively. Utilities can manage peak demand and prevent overloading of DTs and substations.	✓	✗
Environmental impact	Enables consumers to make informed decisions about their energy consumption, leading to reduced energy wastage and optimise overall demand which translates to a corresponding reduction in carbon emission	✓	✓

Source: Crisil Intelligence

The implementation of smart meters through AMI can significantly reduce AT&C losses by improvement in billing and collection efficiency, detecting meter tampering and thereby enhance revenue collection and facilitate demand-side management.

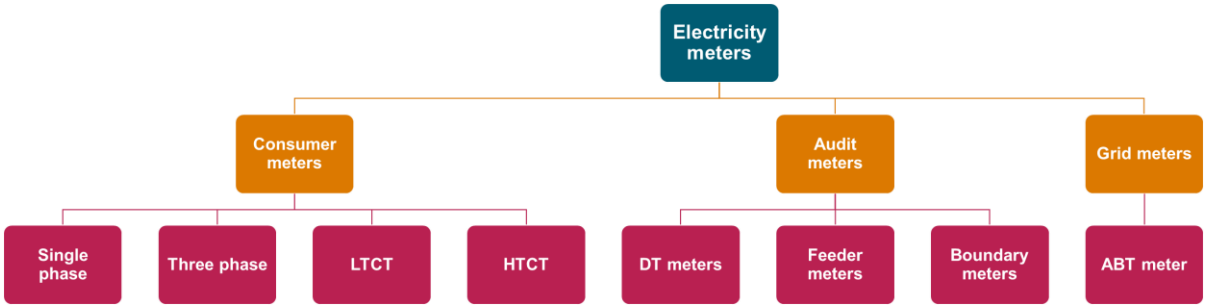
3.3 Overview of different types of electricity meters

The meters can be broadly categorized into the following categories:

- *Consumer meters* - used for accounting and billing of electricity supplied to the consumer but excluding those consumers covered under Interface Meters.

- *Energy accounting/audit meters* - used for accounting of electricity to various segments of electrical systems so as to carry out further analysis to determine the consumption and loss of energy therein over a specified period.
- *Interface/ABT meters* – these are structured based on availability of generating units and having components, viz, capacity charges, energy charges / variable charges and charges for Unscheduled Interchange.
- *Power quality meters* – It is also called power quality analyzer. It monitors various parameters like voltage, current, frequency, harmonics, real and reactive power, power factor to assess the quality of the power and identify potential issues that could affect equipment performance and reliability.

Figure 38: Different types of electricity meters



Source: CEA, Crisil Intelligence

Static energy meters operate without any moving parts, utilizing electronic components and chips for precise measurement. They can measure various types of energy, including active, reactive, and apparent energy, along with other electrical parameters.

Single-phase static meter measures electricity consumption in residential and small commercial use. Three-phase static meters are used in industrial and larger commercial applications. It measures electricity across three phases and one neutral wire, providing a more stable and continuous power supply. It measures various electrical parameters like active and reactive energies, instantaneous parameters and load survey data for accurate billing and electrical analysis. These meters can have local communication facilities such as optical port, infra-red and Bluetooth. These meters have various anti-tamper features and local communication facility using IEC / IS: 15959 protocols.

Smart energy meters are designed with advanced features to enhance energy management and efficiency. They are available in four configurations: single-phase, three-phase, low-tension current transformer (LTCT) and high-tension current transformer (HTCT) operated electric meters. Single-phase and three phase electric meters are usually consumer meters designed to meet the energy needs of most residential, small commercial and industries. LTCT and HTCT are three phase meters with accuracy class of 0.2s/0.5s and are designed for robust peak load management and precise power quality measurement. These meters feature advanced multi-rate/time-of-use and anti-tampering functionalities and are used in HT and LT Consumers, DT and Feeder metering.

LTCT and HTCT consumer smart meter:

These smart meters are suitable for advanced metering infrastructure systems, designed for load management, and anti-theft metering in industrial metering applications. These meters have the capability to measure active,

apparent and reactive energy and thus enable metering as per utility need. They have capability of time-of-day billing which can be configured for various time zones and environments. These meters feature a built-in RF/cellular replaceable communication modem for seamless connectivity. The plug-and-play installation simplifies the setup process, reducing time and effort.

DT smart meter:

DT smart meters enhance the efficiency and reliability of energy distribution systems. These meters provide real-time monitoring of energy flow at distribution transformers, allowing for precise measurement and management of energy distribution. They help in balancing the load across different transformers, optimizing the distribution network, and reducing energy losses.

DT smart meters are usually equipped with advanced fault detection mechanisms, enabling quick identification and reporting of faults for prompt corrective actions. They also feature tamper detection to prevent unauthorized access and ensure data integrity. With robust communication capabilities, these meters can support various protocols for seamless integration with HES and other smart grid components.

Additionally, DT smart meters have internally powered Digital Input ("DI") ports that connect to digital sensors, enabling remote monitoring and control of these sensors. These meters are typically integrated with artificial intelligence for intelligent digital sensors, data integration and analysis which enables real time energy audit of the utilities and establishes key performance parameters like SAIDI and SAIFI. It helps with network management and efficiency. The DI/DO features help with DT monitoring and reduce the DT failure chances. It also reduces overall operation and maintenance costs of the utility. DT smart meters also help to deliver safety to both customer and utilities manpower by providing critical electrical data in real time for any preventive or corrective action in the electrical network.

Feeder and boundary smart meter:

Feeder smart meters provide real-time monitoring, load balancing, fault detection, and detailed data analytics, optimizing energy distribution and reducing losses. Boundary smart meters accurately measure energy flow at distribution zone boundaries, ensuring precise accounting and tamper detection.

Both types of meters support various communication protocols and remote monitoring, offering enhanced accuracy, operational efficiency, data-driven insights, and security. Both have internally powered DI ports to connect to digital sensors which allow remote monitoring and control of these sensors, providing utilities with real-time data and enhancing operational efficiency. It provides utilities with critical electrical data for real time energy audit and monitoring. It helps utilities to have better visualization of the network and identify zones of high losses or anomalies, thus helping them with better planning and efficient operations. These meters are also important for ensuring the safety of utility operations and management staff and using the DI/DO can help in real time monitoring of status for operations and management planning.

Table 9: Basic characteristics of smart meter

Parameters	1-phase meter	3-phase meter	LTCT meter	HTCT meter
Connection type	1-phase 2 wire direct connected	3-phase 4 wire direct-connected	3-phase 4-wire, CT connected	3-phase 4 wire, CT/PT operated

Parameters	1-phase meter	3-phase meter	LTCT meter	HTCT meter
Accuracy	Class-1	Class-1	Class-0.5	Class 0.2S/0.5S
Degree of protection	IP 53	IP 53	IP 53	IP 53
Operating temperature range	-10° to +60°C	-10° to +60°C	-10° to +60°C	-10° to +60°C
Application	Residential metering, Small commercial metering	Residential metering, small and medium scale industries, Commercial metering	Commercial and residential consumers. Also used with distribution transformers for consumer metering and energy audits	Industrial and commercial locations with high voltage and high current loads, Feeder metering

Source: Meter manufacturers datasheets, Crisil Intelligence

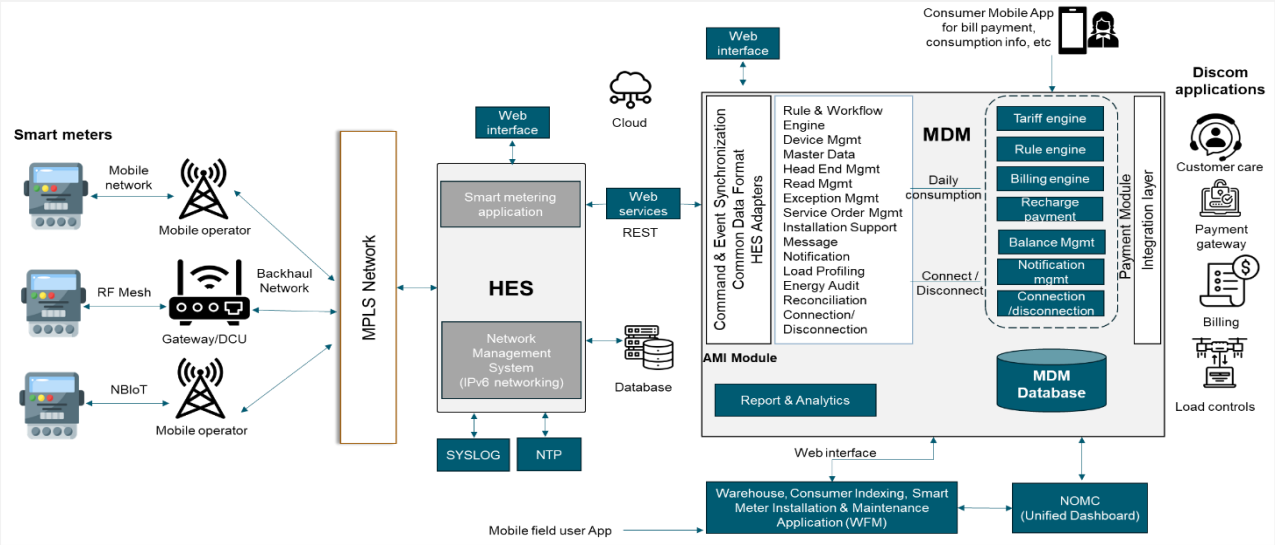
3.4 Overview of AMI system architecture

AMI comprises of the following core components:

- ✓ Smart meters
- ✓ Communication infrastructure
- ✓ Head End System (HES) in secure data center
- ✓ Meter Data Management System (MDM), Customer Portal in secure data centre
- ✓ Web applications and mobile app

These systems are integral to modernizing the grid, improving operational efficiency, and ensuring uninterrupted power supply to consumers.

Figure 39: AMI/smart meter-based system components & architecture



NBIoT: Narrow Band IoT, MPLS: Multi-Protocol Label Switching; SYSLOG: System Logging Protocol; NTP: Network Time Protocol; REST: Representational state transfer; NOMC: Network Operation cum Monitoring Centre

Source: Crisil Intelligence

- **Smart Meter (as per IS 16444)**

Smart meter is an AC static watt hour meter with advanced features, including time-of-use registers, internal connect and disconnect switches, and two-way communication capabilities. It is designed to measure the flow of electricity in both forward (import) and reverse (export) directions, storing and transmitting this data along with other predefined parameters. It is remotely assessed for collecting data/events, programming for select parameters. All smart meters installed under AMISP Program can be used for billing of solar energy produced and then exported by the consumer.

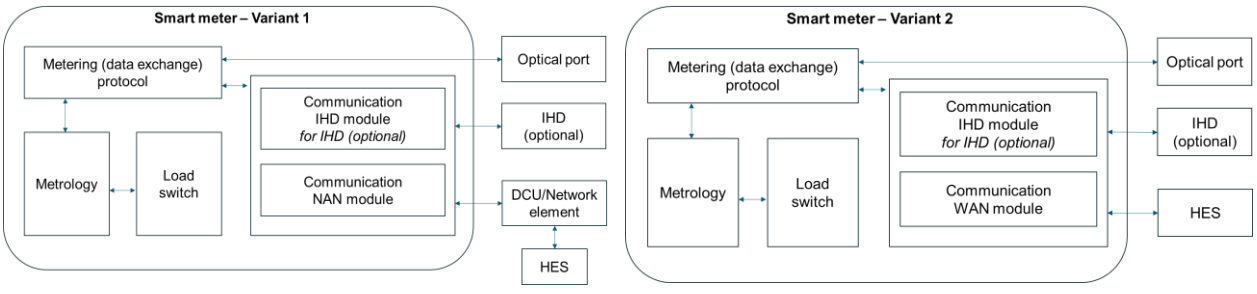
The smart meter comprises of four main parts – Metrology, Load switch, Metering & data exchange protocol and Communication module. Moreover, the smart meter operates on Device Language Message Specification (DLMS) / Companion Specification for Energy Metering (COSEM) protocol which is a standardized communication protocol widely used in smart metering and AMI systems.

DLMS/COSEM is a global standard under IEC 62056 that defines a language for data exchange between devices and/or HES and guides manufacturers, vendors, and consumers to ensure their devices and services meet certain criteria for data exchange, interoperability, efficiency, and security.

DLMS ensures interoperability efficiency, and security in metering applications, including remote reading, control, and value-added services. COSEM is an interface model for manufacturers, vendors, and consumers to develop and use compatible devices and services, facilitating a unified and efficient metering ecosystem.

Smart Meter architecture is categorized into two variants. Based on the technical feasibility buyer may choose the combination of the variants best suited for a given geographical area. The Smart Meter shall have either Neighborhood Area Network (NAN) or Wide Area Network (WAN) module as mandatory communication module for communicating to Data Concentrator Unit (DCU) or Head end system (HES) respectively. If In Home Display (IHD) is chosen, then there could be a suitable additional communication module within the Smart Meter. A Handheld Unit (HHU) is used to communicate locally over the optical port to the smart meter. The two variants are represented below.

Figure 40: Schematic diagram of smart meter



Source: BIS, Crisil Intelligence

As per IS 15959, the smart meter shall support the following features/services:

- Smart meter association requirements
- IHD services

- Push services
- Advanced security profile
- Communication profile
- Firmware upgrade
- Connect/disconnect services
- Parameter list for smart meters

These features are included to support the functional requirements of smart meter that are listed under IS 16444.

- **Communication infrastructure**

Communication Network Interface Cards (NICs) play a crucial role in enabling efficient and reliable data transmission between the meter and utility systems. These NICs integrate with electricity meters, providing two-way wireless communication for remote data acquisition, meter program management, and real-time alerts for issues like meter tampering and outages. Communication is based on the standard IEC and IS: 15959 protocol, ensuring secure and reliable data exchange.

The communication infrastructure is either based on RF / RF mesh network working on 865-868 MHz/ cellular network comprising 4G with 2G fall back, 4G standalone, Narrowband IoT (NB-IoT) with 2G fall back or NB-IoT, Bluetooth Low Energy (BLE) or a combination of these. The Communication network must provide reliable medium for two-way communication between various nodes (Smart Meter, Gateway/Router/Access Point/ Data Concentrator Units) & HES.

Meter data is routed to cellular tower on 4G, 2G, NB-IoT, BLE or in case of RF collected RF mesh and passed on to nearest Gateway/Router/Access Point, DCUs wherever applicable given the communication technology used and transported to HES through 4G Cellular.

Three networks are commonly referred to in the context of the AMI: WAN, NAN and HAN.

- *Home Area Network (HAN) (Optional):* HAN provides connections between the smart meters of the home appliances, other integrated systems such as rooftop photovoltaic (PV) system, distributed sensors, plug-in electric vehicle/ plug-in hybrid electric vehicle, in-home display (IHD), smart thermostat, etc.
- *Neighborhood Area Network (NAN):* NAN provides communication links between several individual smart meters and a data concentrator using 865-868 MHz communication technologies for NAN network and 4G for communication onwards.
- *Wide Area Network (WAN):* WAN performs the task of connecting an AMI end in the local utility network and a data concentrator using 4G, 2G or NB-IOT cellular technologies.

Smart meters feature on-demand WAN/NAN communication for efficient data exchange and network management and generate instant tamper alerts in case of unauthorized access and main fail alerts notify users immediately in the event of a power outage.

Figure 41: AMI communication technologies

Parameters	Last Mile/NAN (in case of RF)	Home Area Network (HAN)	Backhaul/WAN and Backbone
Wireless	6LoWPAN, 865-868 Hz based proprietary RF mesh technology	Wi-Fi, Bluetooth	GSM – 4G/2G fallback NBIoT - 2G fallback

Source: ISGF, Crisil Intelligence

The meters are equipped with replaceable communication NIC, enabling connectivity and easy upgrades. An optical port supports local communication based on standard data collection protocols and the plug-and-play installation simplifies the setup process, reducing time and effort. The system generates instant tamper alerts in case of unauthorized access and main fail alerts notify users immediately in the event of a power outage. Firmware Over the Air (FOTA) upgradation helps to upgrade the meter functionality even after they are installed in the field. Real-Time Clock (RTC) synchronization ensures precise timekeeping for accurate billing and data logging.

- **Software solutions for AMI**

Head-End System (HES) and Meter Data Management (MDM) System are the most important software solutions in an AMI system.

- **Head End system**

The main objective of HES is to acquire meter data automatically, avoiding any human intervention and monitor parameters acquired from meters. HES is responsible for the discovery of all Smart Meters once deployed in the field, the periodic collection of all meter data as well as the processing of all alarms and commands such as connect/disconnect for those meters. The smart meters communicate with the head-end system either on demand or according to a set schedule, effectively measuring, collecting, evaluating, and managing energy use.

HES perform all the requisite functions as per the defined functionalities of AMI. Some of the primary functions could be:

a) Automatic registration of smart meters after installation into the HES along with its metering profile (meter type, hardware & software versions, device IDs, logged in / logged out details etc.).
b) Self-discovery and registration of field level end device nodes (NAN/WAN) like Router/Gateway, Access Point, DCU upon deployment and establishment of communication.
c) Acquisition of meter data on demand and at user selectable periodicity.
d) Two-way communication with meter/ DCU
e) Signals for connect & disconnect of switches present in meters.
f) Audit trail and Event & Alarm Logging
g) Ability to redirect messages including configuration commands from the MDM in order to reach the desired meter
h) Maintain time sync with DCU / meter
i) Store and hold the raw data before it is transferred to the MDM for defined duration (min. 3 days)
j) Handling of Control signals / event messages on priority
k) Critical and non-critical event reporting functionality

l) Device management functionality to get periodic updates from devices on health check, hardware & firmware version, location mapping etc.

HES also facilitates configuration of AMI parameters such as prepaid / postpaid configuration, Net metering, load curtailment limit, clock setting, event setting for connect/disconnect, remote firmware update, threshold limit for monitored parameters, etc.

- **Network management system**

The Network Management System (NMS) functions within the HES to manage TCP/IP communication network and associated devices and monitor the network performance. NMS routinely check the logged in status of the end node / field device and its availability in the network for data exchange. It collects and store monitoring profiles from End Points (NAN/WAN modules) and network devices for performance evaluation and troubleshooting purposes.

- **Meter data management**

The Meter Data Management (MDM) system receives the data from the HES and manages the collected data and also maps the data to the relevant consumer. The MDM system stores, archive, retrieve & analyse meter data and various other MIS along with validation & verification algorithms. It acts as a central data repository with an interactive dashboard. MDM has the capability to import raw or validated data in defined formats and export the processed and validated data to various other systems sources and services in the agreed format. It provides validated data for upstream systems such as billing, analytics, reporting, etc.

- **Enterprise services and user interface**

The data once received from all the smart meters, the utility can perform multiple functions such as billing and collection information, monitor energy usage pattern and detect irregularities, remote connect/disconnect, undertake demand response initiatives, outage detection, etc. The Smart Metering System can also effectively communicate with end-users. As a result, the user interface (a mobile based application) plays a critical role in enabling consumers to receive alerts and notifications related to power availability, critical pricing, and dynamic pricing, allowing them to make informed decisions based on their needs. An Android app provides users with detailed consumption data and other value-added features.

3.5 Review & outlook on Indian smart energy meters market

As of March 2024, there are over 340 million consumers, with over 94% of them are utilising conventional/static meters. As per Electricity (Rights of Consumers), 2020 in December 2020, all new connections are mandated to be equipped with smart prepayment meter. Further, a notification issued by the MoP in August 2021, stipulates that all conventional/static meters must be replaced with smart meters with prepayment feature. The replacement timeline was set as December 2023 for electrical divisions with over 50% consumers in urban areas having AT&C losses above 15%, and for divisions with AT&C losses above 25% in fiscal 2020. For other areas, the deadline was set as March 2025. Additionally, this notification outlined the timeline for feeder and DT metering, which requires the installation of meters equipped with AMR facilities or those covered under AMI. This presents a substantial opportunity for the replacement of over 320 million consumer meters with smart meters, out of which 222 million smart consumer meters (total 228 million including DT and feeder meters) have been sanctioned by the government under the RDSS program.

3.5.1 Regulatory overview of smart energy meters

There are broadly five regulatory bodies which looks after the deployment and compliance standards of smart meters in India.

CEA governs the deployment and rollout of smart meters as part of India's smart grid initiatives. It also develops guidelines and technical specifications for smart energy meters. The Department of Telecommunications certifies smart meters with embedded communication modules under Mandatory Testing and Certification of Telecom Equipment (MTCTE) to ensure telecom compliance. State electricity regulators monitor and regulate smart meter implementation at the state level. Bureau of India Standard (BIS) develops and enforces IS 16444 specifications to ensure quality and interoperability of smart meters.

Figure 42: Governing authorities for smart meters

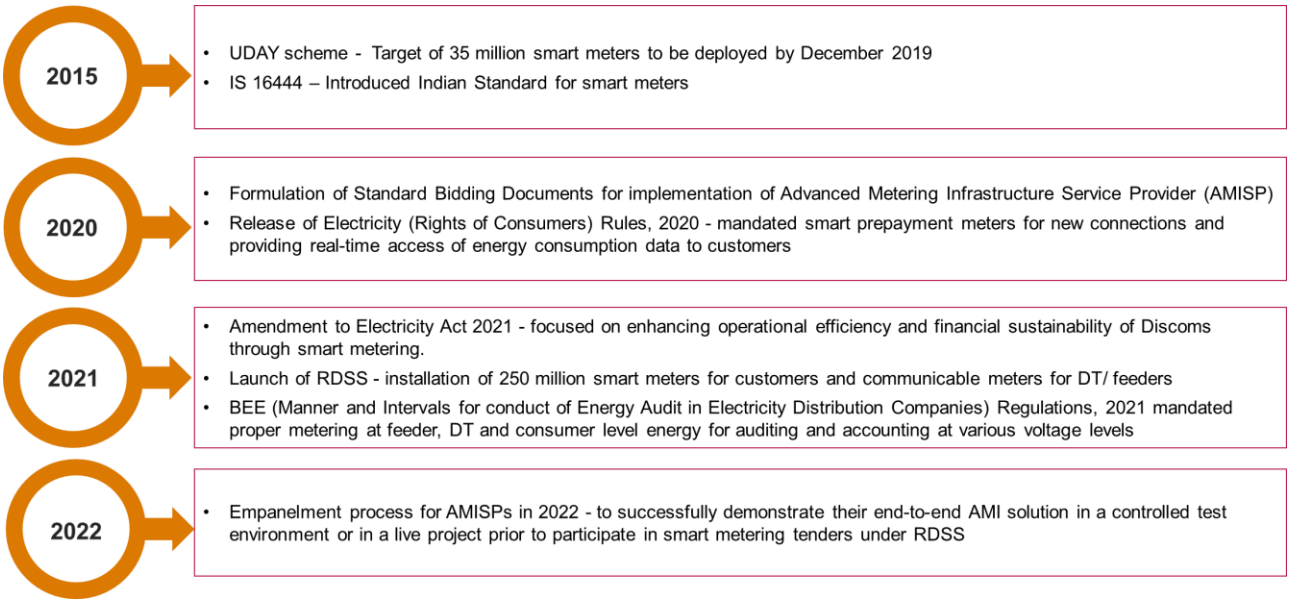
Source: Industry, Crisil Intelligence

3.5.1.1 Regulatory framework

The government of India constituted India Smart Grid Task Force (ISGTF) in 2010, to undertake smart grid pilot projects and develop policies. In 2015, ISGTF was subsumed into National Smart Grid Mission (NSGM), which was established to act as a nodal agency for planning, monitoring, and implementing smart grid policies and program.

The government aims to replace 250 million conventional meters with smart meters by 2022 under the SMNP, which is now part of the RDSS. The National Tariff Policy, 2016, also mandates the installation of smart meters for consumers, with a goal of eventually converting all meters to smart meters. The RDSS also subsumes other schemes, such as the IPDS, DDUGJY, and the Prime Minister's Development Package (PMDP)-2015 for the erstwhile State of Jammu & Kashmir. These schemes will be implemented as per their extant guidelines and under their existing terms and conditions. However, no new projects will be sanctioned under these schemes.

The key milestones in India's journey in the field of smart metering is depicted in the figure below:



3.5.1.2 Meter standards and specifications

The MoP mandated CEA to prepare the functional requirements and technical specifications for indigenous smart meters. CEA released the first edition of the smart meter specifications in June 2013. Subsequently, BIS assigned this task to prepare the standards for smart meters.

3.5.1.3 BIS standards

In August 2015, BIS published the new smart meter standards, IS 16444 and IS 15959 covering single phase and three phase energy meters with net metering facility. These standards outline requirements and tests for smart meters including accuracy, reliability, and communication capabilities. The standards also ensure that smart meters can communicate effectively with the head-end system and provide a framework for data exchange, tariff, and load control. Testing of smart meters in India is done in accordance with these standards to ensure they meet the required specifications and operate efficiently.

Table 10: Summary of applicable meter standards

Standards	Description
IS 16444 Part 1	Specifies the requirements and tests for AC static direct connected Watt Hour Smart Meter Class 1 and 2 such as starting current, accuracy, limits of error, measuring elements, frequency, current and voltage circuit, load control, meter display, data retention, etc.
IS 13779	Specifies AC Static Watt-hour Meter of accuracy class 1& 2 for measuring operating temperature, humidity
IS 15884	Specifies the technical and operational requirements for AC direct connected static prepayment meters for Active Energy (Class 1 and 2) ensuring they function consistently and accurately across different regions and utilities

Standards	Description
IS 15959 Part 1	Data exchange for electricity meter reading, tariff and load Control for proper application/implementation of the provisions. This standard provides guidelines, specifies optional DLMS/COSEM elements and outlines boundary requirements for design of such DLMS/COSEM compliant electricity meters for possible applications in Indian electricity networks
IS 15959 Part 2	Data exchange for electricity meter reading, tariff and load Control for proper application/implementation of the provisions. This standard is applicable for AC static direct connected watthour meter Class 1 and 2 that are designed as per IS 16444. Also, COSEM objects, interface classes, their instances, attributes and methods, DLMS services and communication profile that are to be supported are included to enable data exchange to and from smart meter. This standard also specifies the protocol and communication testing requirements.
IS 9000	Specifies basic environmental testing procedures for electronic & electrical items
IS 12063	Specifies degree of protection provided by enclosures of electrical equipment
IS 14451, Part-2: 1999	Specifies telemetering for consumption and demand. Direct digital transfer of meter values
IS 12346	Specifications for testing equipment for AC Energy meter
IEC62052-11	Specifies general requirements and tests for electricity metering equipment, including type tests for both AC and DC meters
IEC62053-21	Focuses on static watt-hour meters and their type tests, specifically for those measuring AC active energy, with accuracy classes 0.5, 1 and 2.
CBIP-325	Specifies standardization of AC Static energy meters

Source: AMISP Standard bidding document, NSGM, Crisil Intelligence

3.5.1.4 CEA's technical specifications

The CEA published guidelines in 2016 outlining the functional requirements of AMI systems, which include the working principle of HES. The guidelines provide a framework for the development and implementation of AMI systems, emphasizing the importance of a robust and secure communication infrastructure. It also specifies that AMI communication should be based on RF mesh network, PLC, or cellular network, allowing for adaptability to different geographical and infrastructural conditions.

The guideline also outlines specific requirements for smart meters, including the ability to communicate with DCUs, Access Points, or the HES using any of the technologies mentioned in the Indian Standard IS16444 with features such as SIM card compatibility and event logging. It shall support the networking layer protocol IPv4 / IPv6 network addressing OSI architecture model. The Network shall also have adequate cyber security measures.

The technical specifications for single-phase and three-phase whole current smart meters, as per the CEA, include various features such as measurement of electrical energy parameters, integrated load limiting switch/relay, bidirectional communication, and tamper event detection. The meter shall continue recording energy under any tamper condition and would log the event and send alarm at HES after detection of the defined theft features as per IS 15959 Part 2.

3.5.1.5 CEA (Installation and Operation of Meters) Regulations

Applicability of the Regulations

These Regulations are applicable to meters installed and to be installed by all the generating companies and licensees who are engaged in the business of generation, transmission, trading, distribution, supply of electricity and to all categories of consumers. The regulations provide for type, standards, ownership, location, accuracy class, installation, operation, testing and maintenance, access, sealing, safety, meter reading and recording, meter failure or discrepancies, anti-tampering features, quality assurance, calibration and periodical testing of meters, additional meters and adoption of new technologies in respect of following meters for correct accounting, billing and audit of electricity.

As per the regulation, all interface meters, consumer meters and energy accounting and audit meters shall be of static type. The meters not complying with these regulations shall be replaced by the licensee on his own or on request of the consumer. The meters may also be replaced as per the regulations or directions of the Appropriate Commission or pursuant to the reforms programme of the Appropriate Government. Also, all consumers in areas with communication networks shall be supplied with electricity with Smart Meters working in prepayment mode, conforming to relevant IS, within the timelines as specified by the Central Government.

Electricity (Rights of Consumers) Rules, 2020

The introduction of the Electricity (Rights of Consumers) Rules, 2020, along with subsequent amendments, strengthens the rights of electricity consumers and outlines the service delivery responsibilities of distribution utilities. These rules focus on detailed service parameters, including the provision of new connections, consumer metering, billing processes, digital payment options, ensuring a reliable power supply, supporting prosumers, and handling grievances.

Government has also simplified the rules for smart metering. To avoid inconvenience of the consumers, the existing penalties for increase in consumer demand beyond the maximum sanctioned load / demand have been reduced. As per the amendment in metering provision, post installation of a smart meter, no penal charges will be imposed on a consumer based on maximum demand recorded by the smart meter for the period before installation date. Load revision procedure has also been rationalized in a way that maximum demand shall be revised upwards only if sanctioned load has been exceeded at least three times in a financial year. Moreover, smart meters shall be read remotely at least once in a day and the data shall be shared with Consumers in order to enable them to take informed decision about consumption of electricity.

The ToD tariff is applicable for C&I consumers having maximum demand of 10 KW and above, from 1st April, 2024 and for all other consumers except agricultural consumers, latest from 1st April, 2025. The ToD tariff shall be made effective immediately after installation of smart meters, for the consumers with smart meters.

3.5.2 Smart meter implementation models

Smart Meters are a value-added product that are three to four times more expensive than conventional meters. In addition, they come with a variety of after-sales services and hence significant capex is required to implement and operate the infrastructure.

Capex model – Under Discom capex model the Discoms invests upfront in smart meters, aiming to improve billing efficiency and reduce losses. The Discoms retains ownership of the smart meters, which are then used to improve their operations. The Discom expects to recoup its investment through reduced losses, improved billing accuracy, and potentially increased revenue from better collection efficiency.

TOTEX model - Total Expenditure (TOTEX) business model is a combination of both OPEX and CAPEX business models which includes a certain amount of upfront lumpsum payment as well as fixed monthly annuity payments**.** It is a Design Build Finance Own Operate and Transfer (DBFOOT) arrangement (one of public private partnership model) where system integrators (also known as Advanced Metering Infrastructure Service Providers, or AMISPs) will be responsible for all capital expenditures, making discoms free from any financial burden. AMISP would be responsible for supplying, maintaining and operating the metering infrastructure for the purpose of meter-related data and services to Discom.

Some of the key benefits of TOTEX model are:

a) no upfront capex requirement by utilities to reduce their financial burden;
b) innovative payment security mechanism in the form of direct debit facility for AMISP to ensure smooth investment recovery;
c) creation of prepayment infrastructure to ensure customer convenience, etc. among others.

The Discoms are becoming increasingly convinced of the TOTEX model, whereby they will incur no capital expenditures for smart meters and will instead make monthly payments (which are guaranteed) to AMISPs under the ‘pay-as-you-save model’.

The change from capex to PPP/TOTEX implementation model for smart metering projects has been one of the most significant contributions, which has helped expand the Indian smart metering market.

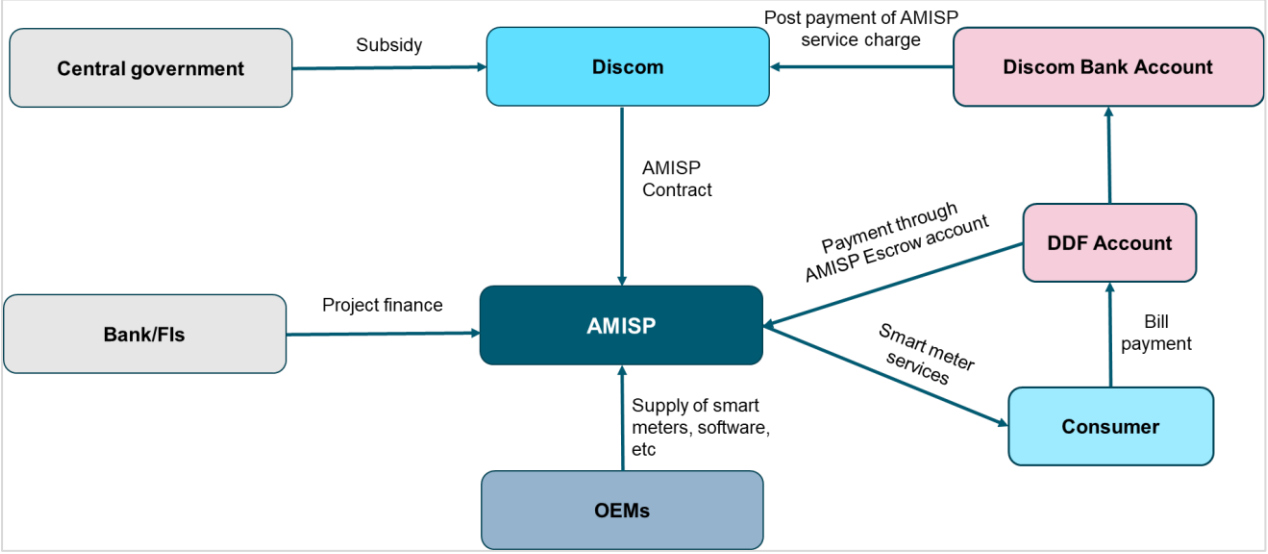
Selection of Bidder under TOTEX model

The Discom will issue an RFP on a DBFOOT model in order to select the eligible bidder. As part of RFP, the eligible bidder shall submit a list of consortium members and subcontractors (if any) along with a valid ISO and CMMI certifications. Once the bidder is selected, the Discom will enter into a contract (“AMISP Contract”) with the selected bidder (AMISP), which will form a SPV to undertake the entire activities as per the scope of work outlined in the RFP. AMISP may also appoint subcontractors to meet their obligations under the Contract for supply of meters and software solutions.

Under the DBFOOT model, the AMISP contract will have a term of approximately 10 years, after which the AMISP will transfer ownership of the entire smart metering system, including hardware, software, licenses, and collected data, to the Discom at no cost. During the contract period, AMISP will be responsible for operating and maintaining the AMI. In return, the Discom will pay the AMISP a monthly service charge, as outlined in the contract terms and conditions.

The deployment of AMI involves a diverse range of stakeholders including government bodies that provide subsidies and oversight for the program, distribution utilities responsible for rolling out the smart meter program, AMISPs that implement and operate the AMI system, lenders/financial institutions that provide capex funding to AMISPs and Smart Meter OEMs. The AMISPs further collaborate with multiple service providers and system integrators to ensure the comprehensive implementation of the AMI system. This collaboration includes communication providers, MDM providers, HES providers, cloud service providers and data analytics platform in the form of web and mobile applications and software. This multi-stakeholder collaboration enables a seamless and efficient deployment of the smart meter program, ensuring a cohesive and effective implementation of the AMI system. The overview of AMISP operating model covering all the key stakeholders is given below.

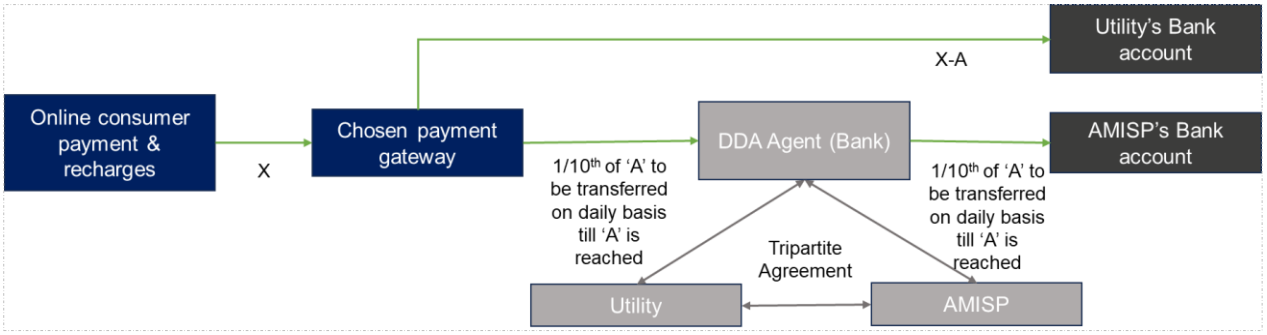
Figure 43: AMISP's Business model



Source: AMISP Standard bidding document, Crisil Intelligence

A key feature of the model is its payment security mechanism through Direct Debit Facility. The Discom is required to setup a direct debit facility within fourteen working days of the Operational Go-Live date. This facility will enable the automatic recovery of the AMISP Monthly Fee from online consumer payments. To achieve this, the Discom will create a separate online payment gateway that is compatible with all payment modes and allows for 100% direct debit of the AMISP Monthly Fee. The direct debit facility will utilize a 'bucket filling' approach, where all consumer recharge bill payments made between the 11th and 10th working day of the following month will be directly credited to AMISP's bank account. This process will continue until the undisputed AMISP Monthly Fee, along with any supplementary invoices, is fully recovered.

Figure 44: Payment flow after Operational Go-live of the AMISP System



X- payments received from consumers; A- AMISP monthly fee;

Source: REC, Crisil Intelligence

Some of the key responsibilities/obligations of AMISP are:

- Operation of the AMI System for the operational period and bearing the necessary charges to maintain the AMI System
- Deployment of smart meters, communication systems, HES and MSM systems;
- Integration with billing systems and existing legacy systems;
- Deployment of standard interfaces to enable integration of future information technology/operational technology applications into the AMI System (including peak load management, SCADA, outage management system and distribution automation);
- Integration of network interface card/communication module with at least three makes of meters in India, to enable the respective meters to seamlessly integrate with the proposed HES and/or mobile device management enabling interoperability of the system;
- Designing, testing and implementing consumer portal and mobile applications covering all consumer categories and category specific features;
- Integration with existing payment infrastructure (to be facilitated by the respective DISCOMs) including different payment channels for pre-paid recharges and post-paid bill payments. Additionally, AMISP shall facilitate the availability of infrastructure for the recharge of Smart Meters through feature phones and physical channels;
- Implementing data privacy as per the specifications specified and the same should be in compliance with the Information Technology (Reasonable Security Practices and Procedures and Sensitive Personal Data or Information) Rules, 2011;
- Develop a consumer engagement plan for smooth implementation of the AMI System. The said plan should include educating consumers about the pre-paid recharge mechanism, benefits of pre-paid meters, and potential usage of Smart Meters data for consumers;
- During operational phase, ensure availability of services and spare parts including for expansion.

3.5.3 Existing consumer, feeder and DT metering status

Consumer metering

As per CEA, there are about 341.8 million consumers in the country as of March 2024, out of which about 322.3 million consumers are metered. About 80% of consumers are domestic, followed by C&I (10%), agriculture (8.13%) and remaining in others category. The number of urban consumers is about 138.1 million (40.42%) and that of rural consumers is 203.6 million (59.58%). In terms of energy consumption, domestic and agriculture consumers consume over 50% of total energy, whereas C&I consume over 40%. The category wise details of consumer wise energy consumption with metering status is given below:

Table 11: Consumer metering status *(figures in million)*

Consumer category	Total energy consumed during FY24 (BU)	Urban	Rural	Total	Total metered
Domestic	352.57	111.46	160.79	272.25	267.32
Commercial	113.51	18.94	11.89	30.83	30.72
Industrial	368.23	2.12	1.87	3.99	3.98
Agriculture	255.11	2.98	24.76	27.75	13.33
Traction	5.20	0.001	0.001	0.002	0.002
Public Water Works	43.42	0.65	1.15	1.80	1.79
Street Lighting		0.43	0.48	0.91	0.90
Miscellaneous & others	16.31	1.58	2.69	4.28	4.25
Total	**1154.35**	**138.16**	**203.63**	**341.81**	**322.29**

Source: CEA, Crisil Intelligence

Feeder metering

As per CEA, there are about 0.25 million 11 kV feeders in the country as of March 2024, out of which 75,544 (30.12%) feeders are Urban feeders and 1,75,268 (69.88%) feeders are Rural feeders including 88,856 (35.42%) Agriculture feeders in the country as of March 2024. The details of feeders are as shown in the table below:

Table 12: Status of Feeder meters

Feeders	Total no. of feeders	No. of metered feeders
66 kV/33 kV/22 kV Feeders	**38,691**	**38,161**
11 kV Feeders		
Urban Feeders (Private Utilities)	12,360	12,221

Feeders	Total no. of feeders	No. of metered feeders
Urban Feeders (Govt. Utilities)	63,184	62,917
Non-Agricultural Rural Feeders	86,412	85,445
Feeders with Agricultural Load >30%	88,856	88,353
Total 11 kV Feeders	**250,812**	**248,936**

Source: CEA, Crisil Intelligence

To ensure comprehensive monitoring of all outgoing distribution feeders, National Feeder Monitoring System (NFMS) is being developed with the objective to establish a centralized IT platform that monitors the reliability and quality of power across the country's distribution feeders. This is being achieved through machine-to-machine integration, both in batch and real-time, with various feeder monitoring systems deployed at the DISCOM level. Overall, the NFMS leverages advanced monitoring, reporting, and data analytics capabilities to enhance the reliability, quality, and operational efficiency of the power distribution system. Its implementation will benefit both Discoms and consumers by ensuring a more robust and effective power supply metering system. Under RDSS, existing non-communicable feeder meters shall be replaced with communicable meters and integrated with AMI. Further, all feeders shall be integrated with the NFMS. Feeder meters have 4 digital inputs, to monitor ON/OFF status of Feeder.

As per the above table, there are only 2,400 feeders pending for meter installation. However, as of March 2025, about 0.20 million feeders have been sanctioned for feeder metering under RDSS, of which over 60% has been installed.

DT metering

As per CEA, there are approximately 15.1 million DTs in the country as of March 2024. Among these, 23.11 lakhs DTs (15.24%) are serving urban areas, while around 128.51 lakhs DTs (84.76%) are serving rural areas. The distribution of DTs between urban and rural areas is as follows**:**

Table 13: Status of DT metering

	Total no. of DTs	No. of metered DTs
Urban	23,11,076	14,50,583
Rural	1,28,51,365	49,03,331
Total	**1,51,62,441**	**63,53,914**

Source: CEA, Crisil Intelligence

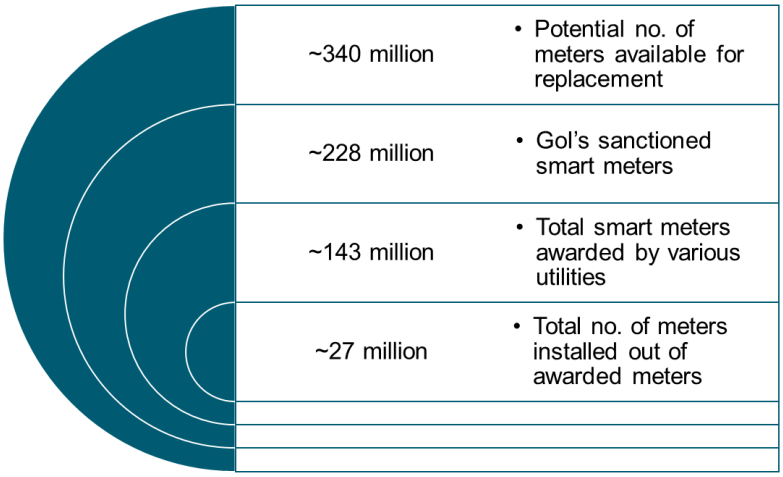
The overall percentage of metering of DTs is low in the country. However, states like Delhi, Kerala, Gujarat, Goa, etc. have exceeded 80% DT metering percentages. On the other hand, states such as Andhra Pradesh, Jammu & Kashmir, Odisha, Punjab, West Bengal etc. have DT metering percentages below 25%. It is crucial for these states to prioritize and dedicate resources to improve their metering infrastructure.

Metering DTs is essential for accurate energy auditing and accounting for the energy flowing from feeders to consumers. As per MoP Notification, all DTs except those supplying only agricultural consumers, HVDS (High Voltage Distribution System) transformers with capacities up to 25 kVA and other DTs with capacities less than 25 kVA, shall be metered with communicable AMI/AMR meters.

As per the above table, about 8.8 million DTs are un-metered as of March 2024. However, as of March 2025, about 5.2 million DT meters have been sanctioned under RDSS, of which 11% has been installed. The potential for the remaining 3.5 million existing DTs which are yet to be metered for which a dedicated scheme needs to be developed by the government.

3.5.4 Status of smart energy meter installation

The figure below illustrates the distinction between sanctioned, awarded, and installed meters. Sanctioned meters refer to the total number of meters for which the government has allocated a budgetary outlay. Awarded meters are those for which the discoms have issued tenders and selected AMISPs to deploy the smart meters. Installed meters are those that have been successfully deployed and are operational, indicating the actual implementation.

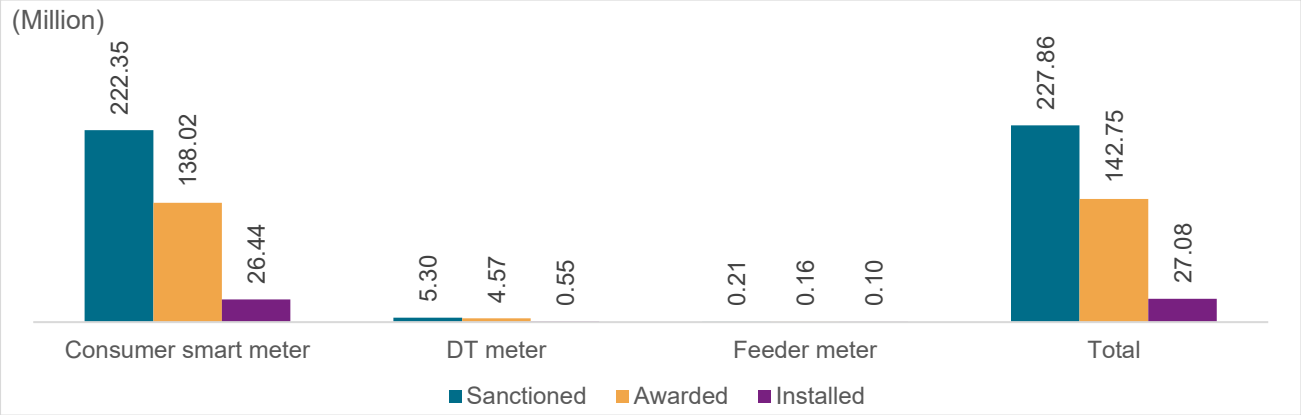


Source: Crisil Intelligence

As of March 31, 2025, approximately 227.86 million smart energy meters (incl. consumer, DT and feeder) have been sanctioned, of which approximately 142.75 million smart energy meters have been awarded and approximately 27 million smart energy meters have been installed, representing 11.9% of the total sanctioned smart energy meters.

The smart consumer meter installation progress stands at 19.2% of the awarded volume of 138 million nationwide. Notably, state distribution utilities have already awarded 62% of the sanctioned meters to various AMISPs. The smart consumer meter segment dominates the sanctioned meter, accounting for 97.6% of the total, while DT and Feeder smart meters make up the remaining portion.

Figure 45: Overall status of smart energy meters



Source: National Smart Grid Mission Portal, Crisil Intelligence

There is significant allotment of smart meters under the "smart consumer meter" category in all the schemes. The DT meter and feeder meter category has the allotment in the few specific schemes like SDP, RDSS, utility owned and PMDP as shown in the below table.

Table 14: Scheme wise allocation of smart meters among the three category *(values in million)*

	Smart consumer meter			DT meter			Feeder meter		
Schemes	**Sanctioned**	**Award**	**Installed**	**Sanctioned**	**Award**	**Installed**	**Sanctioned**	**Award**	**Installed**
DDUGJY	0.038	0.038	0.038	-	-	-	-	-	-
IPDS	0.843	0.843	0.843	-	-	-	-	-	-
Non-RDSS to RDSS	2.97	2.97	2.47	0.052	0.052	0.031	0.00	0.00	0.00
NSGM	0.179	0.179	0.170	-	-	-	-	-	-
PMDP	0.727	0.666	0.649	0.021	0.021	0.013			
RDSS	194.86	111.07	12.89	5.20	4.47	0.48	0.205	0.164	0.100
SDP	0.059	0.059	0.056	0.002	0.002	0.002	0.00	0.00	0.00
Utility Owned	22.68	22.20	9.32	0.02	0.02	0.02	0.00	0.00	0.00
Total	**222.35**	**138.02**	**26.44**	**5.30**	**4.57**	**0.55**	**0.21**	**0.16**	**0.10**

Source: National Smart Grid Mission Portal; Crisil Intelligence

3.5.5 Smart metering implementation in key states

Government of India launched the RDSS. Through the scheme, GoI sanctioned the number of smart meter installation in each state. Below is the status of the smart meter installation. The Scheme aims to reduce the AT&C losses to pan-India levels of 12-15% and ACS-ARR gap to zero by 2024-25.

Under non-RDSS schemes, such as Utility-owned schemes, NSGM, IPDS, and PMDP, a total of 24.5 million smart consumer meters have been sanctioned. As of March 2025, approximately 10.8 million of these meters

have been installed, representing a 45% completion rate. In contrast, the RDSS scheme accounts for the majority of sanctioned meters, with 197.8 million meters approved. Of these, 114 million have been awarded to AMISPs, but installation progress has been slower, with only 11.5% of awarded meters installed as of March 2025.

States such as Uttar Pradesh, Maharashtra, Bihar, Rajasthan have already awarded sanctioned meters to AMISPs, thereby limiting opportunities for smart meter suppliers to capitalize on these markets, particularly if procurement orders have been placed. In contrast, states such as Tamil Nadu, West Bengal, Gujarat, Madhya Pradesh, Kerala, and Punjab present substantial opportunities for both AMISPs and smart meter suppliers, with approximately 83 million smart meters remaining to be awarded in these jurisdictions.

Table 15: Status of smart consumer meter installation in major key states (*in million*)

Sr no	States	Sanctioned	Awarded	Installed	% achieved	Selected AMISPs
1.	Uttar Pradesh	30.98	30.98	2.85	9.2%	GMR, Genus, Intellismart, Polaris L&T (Utility owned scheme)
2.	Tamil Nadu	30.14	0.14	0.13	0.4%	Genus (Utility owned scheme) Not yet awarded under RDSS
3.	Maharashtra	23.56	24.83	1.91	8.1%	Adani, Genus, Montecarlo, NCC
4.	West Bengal	21.21	3.72	0.42	2.0%	Apraava Energy, Iskraemeco India, Polaris, GVPR Engineers
5.	Bihar	17.21	17.21	6.55	38.1%	Adani, EESL, Genus, Intellismart, NCC, Secure Meters
6.	Gujarat	16.51	10.79	1.11	6.7%	Apraava, Intellismart, Iskraemeco
7.	Rajasthan	14.90	14.92	0.61	4.1%	Apraava, Genus
8.	Madhya Pradesh	13.44	5.50	2.16	16.0%	Alfanar Power, Montecarlo, Techno Electric
9.	Kerala	13.29	0.00	0.00	0.0%	Not yet awarded
10.	Punjab	9.83	1.05	1.48	15.1%	Not yet awarded under RDSS
11.	Others	31.28	28.88	9.22	29.5%	
	Total	**222.35**	**138.02**	**26.44**	**11.9%**	

Source: National Smart Grid Mission Portal; Crisil Intelligence

As of March 2025, about 86% of the sanctioned DT meters have been awarded, with ~10% have been installed. Some states such as Assam, Bihar, and Maharashtra have made considerable progress, with Assam leading with ~71% of its meters installed out of 94,547 DT meters sanctioned. It is expected that the deployment of DT meters will be completed in the next 1-2 years. The demand for high value, high margin DT and feeder smart meters is expected to rise as utilities seek better grid monitoring and efficiency solutions.

The key states in terms of sanctioned DT meter quantity are highlighted in the table below**:**

Table 16: Status of smart DT meter installation in major key states (*in million*)

Sr no	States	Sanctioned	Awarded	Installed	% achieved	Selected AMISPs
1.	Uttar Pradesh	1.53	1.53	0.07	4.4%	GMR, Genus, Polaris, Intellismart
2.	Tamil Nadu	0.47	0.00	0.00	0.3%	Genus (Utility owned scheme) Not yet awarded under RDSS
3.	Rajasthan	0.43	0.43	0.00	0.0%	Apraava, Genus

Sr no	States	Sanctioned	Awarded	Installed	% achieved	Selected AMISPs
4.	Madhya Pradesh	0.42	0.43	0.03	6.9%	Alfanar Power, Montecarlo, Techno Electric
5.	Maharashtra	0.41	0.41	0.13	30.5%	Adani, Genus, Montecarlo, NCC
6.	West Bengal	0.31	0.31	0.00	0.0%	Not yet awarded
7.	Gujarat	0.30	0.30	0.08	25.4%	Apraava, Intellismart, Iskraemeco
8.	Andhra Pradesh	0.29	0.29	0.00	1.3%	Adani, Shirdi Sai Electricals
9.	Bihar	0.25	0.24	0.11	44.8%	Adani, Genus, Intellismart, NCC, Secure Meters
10.	Chhattisgarh	0.21	0.27	0.04	17.0%	Genus, Tata Power
11.	Others	0.67	0.35	0.09	14.0%	
	Total	**5.30**	**4.57**	**0.55**	**10.3%**	

Source: National Smart Grid Mission Portal; Crisil Intelligence

The installation of Feeder meters has made significant progress, with over 80% of the sanctioned meters already awarded and nearly 49% installed. Assam (2,782) and Uttar Pradesh (20,874) have completed the installation of all sanctioned meters, while states like Maharashtra and Uttarakhand have achieved installation rates of over 90%. The key states in terms of sanctioned Feeder meter quantity are highlighted in the table below:

Table 17: Status of smart feeder meter installation in major key states (*in thousand*)

Sr no	States	Sanctioned	Awarded	Installed	% achieved	Selected AMISPs
1.	Madhya Pradesh	29.71	28.83	11.91	40.1%	Alfanar Power, Techno Electric
2.	Maharashtra	29.21	29.21	28.88	98.8%	Adani, Genus, NCC, Montecarlo
3.	Rajasthan	27.13	29.68	11.42	42.1%	Idea Infinity, Radius
4.	Tamil Nadu	18.39	0.12	0.12	0.6%	Not yet awarded under RDSS
5.	Andhra Pradesh	17.36	17.36	2.31	13.3%	Adani, Shirdi Sai Electricals
6.	Punjab	12.56	0.00	0.00	0.0%	Not yet awarded
7.	West Bengal	11.87	11.87	2.70	22.8%	Polaris
8.	Chhattisgarh	6.72	8.32	5.54	82.5%	Tata Power, Genus
9.	Bihar	6.43	5.68	5.61	87.3%	Adani, NCC, Secure
10.	Kerala	6.03	0.00	0.00	0.0%	Not yet awarded
11.	Others	40.24	33.75	32.02	79.6%	
	Total	**205.65**	**164.81**	**100.51**	**48.9%**	

Source: National Smart Grid Mission Portal; Crisil Intelligence

A total of over 85 million smart meters are yet to be awarded by the discoms across the states. The table below provides an overview of the total smart energy meters sanctioned but not yet awarded in key states, as of March 31, 2025:

State	No. of smart energy meters sanctioned	No. of smart energy meters yet to be awarded
Tamil Nadu	30,140,849	30,000,000
West Bengal	21,208,759	17,484,486
Kerala	13,290,166	13,289,361
Punjab	9,830,007	8,784,807

State	No. of smart energy meters sanctioned	No. of smart energy meters yet to be awarded
Gujarat	16,510,860	5,715,900
Others	136,878,593	9,831,258
Total	**227,859,234**	**85,105,812**

Source: NSGM, Crisil Intelligence

3.5.6 Key growth drivers for implementation of smart energy meters

Government initiatives:

Under RDSS, the states with relatively high AT&C losses have been classified as *special category states* shall be granted subsidy of Rs. 1,350 or 22.5% of smart consumer meter cost, whichever is lower. All other states shall be granted subsidy of Rs. 900 or 15% of smart consumer meter cost, whichever is lower. To accelerate progress, an additional incentive was offered for installations completed by December 2023 – lower of Rs. 675 or 11.25% of smart consumer meter cost for *special category states* and lower of Rs. 450 or 7.5% for all other states.

Strong implementation pipeline:

A substantial pipeline of smart meter installations is anticipated, with over 85 million meters yet to be awarded. Furthermore, the mandatory installation of smart meters for all new connections, as per regulatory requirements, is expected to drive additional demand. According to the CEA, over 120 million new connections are expected to be added over the next five years, thereby expanding the overall pipeline to over 200 million smart meters.

Introduction of Time-of-Day tariff:

Smart meters can provide real-time energy usage data that would help consumers adjust their consumption patterns to take advantage of lower tariffs during off-peak hours. Discoms can send alerts and notifications to consumers when they are approaching peak hour tariffs, helping them to adjust their usage accordingly.

Urbanisation and rising energy consumption:

The growing demand for energy in India, driven by rapid urbanization and population growth, has created a need for innovative energy management solutions like smart meters. Smart meters provide accurate consumption data, enable effective load management, and help utilities reduce transmission losses, making them an essential tool for managing India's rising energy demand. Moreover, they help address the issue of AT&C losses, improving the overall efficiency of the energy distribution system.

Improvement in billing efficiency and reduction in AT&C losses:

With an average billing efficiency of 86.9% in India for fiscal 2024, a substantial 13% of electricity generated goes unbilled (which is equivalent to about Rs. 800 - 1,000 billion), leading to considerable revenue losses. The implementation of smart metering technology can significantly mitigate this issue by ensuring accurate billing, reducing operational expenses and AT&C losses, and unlocking advanced capabilities such as demand response and grid optimization. Furthermore, smart metering empowers consumers with greater visibility and

control over their energy usage, enabling them to make informed decisions, optimize their consumption, and potentially realize cost savings.

Robust payment mechanisms:

The introduction of a direct debit facility will provide a secure and efficient means of payment collection, enabling AMISPs to receive timely payments from consumers. This, in turn, will mitigate the risk of payment defaults and associated financial losses

Rising decentralised renewable energy sources/storage:

The integration of renewable energy sources into the grid requires dynamic monitoring, load forecasting and real time adjustments. Increasing decentralised RE in the form of rooftop solar projects, microgrids where the consumers also play the role of prosumers. The use of smart meters in such applications become critical for net metering and dynamic pricing. Moreover, DC side smart metering in solar projects and energy storage applications also play crucial role in monitoring and managing the system performance.

3.5.7 Outlook on market size of smart energy meters in India

State discoms have awarded contracts for over 115 million smart meters, translating to a value of approximately Rs. 375 billion over the last five years. About 67% of these awarded quantum was made in 2024 alone. As of March 2025, there remains a substantial pipeline of 85 million smart meters, representing 37% of the total sanctioned meters, that are yet to be awarded by utilities. Furthermore, an additional 28 million smart meters would be required to be sanctioned to meet the target of 250 million smart meters, bringing the total pending smart meters to 113 million. The upcoming awards for these remaining smart meters, expected to be made over the next 2-3 years under the RDSS scheme, are anticipated to unlock a substantial opportunity worth Rs. 360-370 billion by fiscal 2027.

Further, by 2030, the total potential demand for smart consumer meters is expected to reach over 390 million, driven by new installations as mentioned above, over 120 million new connections as per CEA between fiscal 2026-2030 and the replacement of leftover meter along with old smart meters installed between 2017-2020, which would reach the end of their 10-year lifespan between 2027-2030. The demand for DT and feeder smart meters is also expected to rise as utilities seek better grid monitoring and efficiency solutions. Moreover, India has huge potential of small township projects in MES, Railways, Government PSUs like NTPC, HAL, PowerGrid, in addition to many private developers' townships as well. The detailed breakup of smart energy meter market in India by 2030 is given in the table below.

The market for smart consumer meters, DT meters, and feeder meters presents opportunities for growth. The table below summarizes the overall untapped market size of smart meters.

Table 18: Estimated segment wise volume of smart energy meters requirement by 2030

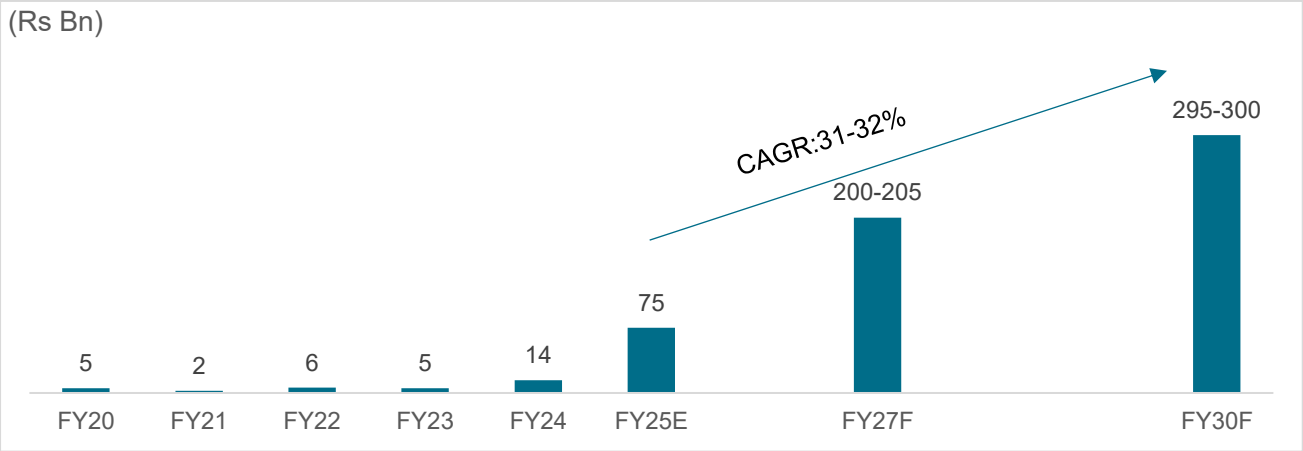
Particulars	Meters in (million)
Consumer metering	
Smart consumer meter target (A)	250.00
Total sanctioned meters (B)	222.35

Particulars	Meters in (million)
Estimated new connections to be added between FY26-30 (C)	120.00
Replacement of leftover meters between FY28-30 (D)	50.00
Total meters to be installed by 2030 (A+C+D)	420.00
Total smart consumer meters installed	26.44
Total estimated no. of meters to be installed by 2030	**393.56**
Feeder metering	
Total sanctioned meters (E)	0.21
Estimated new feeders to be added between FY26-30 (F)	0.64
Total feeder meters to be installed by 2030 (E+F)	0.85
Total feeder meters installed under RDSS	0.10
Total estimated no. of feeder meters to be installed by 2030	**0.75**
DT metering	
Total DT sanctioned meters (G)	5.30
Estimated DT additions between FY26-30 (H)	2.80
No. of existing un-metered DTs (I)	3.50
Total DT meters to be installed by 2030 (G+H+I)	11.60
Total DT meters installed under RDSS	0.55
Total estimated no. of DT meters to be installed by 2030	**11.05**
Total estimated ABT meters required at distribution substation 66/33/22 kV	**0.007**
Total estimated MFM meters required at distribution substation 66/33/22 kV	**0.014**

Note: These values are as on 31st March 2025; Source: NSGM, Crisil Intelligence

Considering the above estimations, the annual smart energy meter market in India was valued at Rs. 75 billion in fiscal 2025 and is projected to attain an annual market size of Rs. 295-300 billion by fiscal 2030, growing at a CAGR of 31-32%. This translates to a cumulative potential market size of Rs. 1,180-1,200 billion over fiscal 2026-30.

Figure 46: Estimated annual market size of smart energy meters



E: Estimated, F: Forecast; Source: NSGM, Crisil Intelligence

3.5.8 Key risk factors and challenges in smart meter adoption

Lack of infrastructure especially in rural areas:

While the necessary infrastructure for implementing smart energy meters is largely in place, the reliability and quality of power and cellular networks remain a significant concern in some of the rural and remote places in India.

Limited track record of DDF:

The use of DDF in the context of meter payments is relatively new and hence there is limited historical data to rely on for forecasting payment patterns. Further, the timeliness of receipt of lumpsum payments remains crucial, as these payments will be utilised for subsequent meter installation cost.

Technical challenges:

The installation and maintenance of smart meters require skilled technicians, which may be lacking in some parts of the country. Investing in training programs to develop a skilled workforce capable of installing, maintaining, and supporting smart meters is essential.

Slow adaptation of smart meters:

The implementation of smart meters has been slower than expected, due to a combination of factors. One of the primary reasons was delay in issuing tenders as utilities navigated the complexities of implementing this new technology and setting up of the necessary infrastructure for DDF mechanisms for payment. Moreover, the technology was also new and AMISPs faced a steep learning curve, requiring around 1-2 years to fully understand the operational and technical challenges associated with the technology. Additionally, the process of collecting and validating consumer data for consumer indexing, as well as the testing and approval process, have also contributed to the delay.

As per MoP, India is now witnessing the average deployment of over 1 lakh smart meters per day in 2025, marking a substantial increase from average 15,000 meters per day installed in 2024. This growth is expected to significantly accelerate the implementation of awarded smart meter projects.

Data privacy and cyber security challenges:

Smart meters have robust cyber safety measures, protocols, and firewalls in place, including encryption and secure communication modules from trusted suppliers. The Software in the Meter has multiple levels of security as per COSEM specifications. When data is received on the HES server, it is protected by various Firewalls and cyber security monitoring is done by Telecom Service provider as per latest international standards. However, the risk of data privacy and cyber security remains a concern when connected to a wireless network.

3.6 Overview of global smart energy metering market

3.6.1 Existing smart meter penetration

The global demand for smart electricity meters has experienced a significant surge in recent years, driven by the increasing focus on efficient energy management, sustainability, and technological innovation. As of 2023, the worldwide installation of smart meters has crossed over 1.5 billion, with a global average of smart meter penetration reaching about 40-43%.

The adoption of smart electricity meters has been particularly pronounced in North America and Europe, with market penetration rates of about 77-80% and 60-63%, respectively, as of 2024. The Asia-Pacific region which has a penetration of about 49%, led by East Asian countries such as China and Japan, with both countries having completed their nationwide rollouts.

The Asia-Pacific region dominates the global metering market, boasting a customer base of over 1.6 billion electricity and gas users, surpassing the combined total of North America and Europe. The region's annual demand for electricity meters is substantial, ranging from 110 to 180 million units, with China alone accounting for approximately half of this demand. As the region's utilities continue to evolve, many are now gearing up to deploy next-generation meters, driven by the emergence of advanced smart meter functionalities and innovative smart energy applications. This impending rollout of second-generation meters is poised to revolutionize the way energy is consumed and managed in the region, enabling greater efficiency, convenience, and sustainability for both utilities and consumers. With its vast market size and growing demand for smart energy solutions, the Asia-Pacific region is set to remain a hub for metering innovation and growth in the future years.

Southeast Asia constitutes the most nascent smart metering market in Asia-Pacific. The main utilities in Indonesia and Thailand are now at the very beginning of their large-scale smart metering implementation plans while the leading utilities in the Philippines have similar ambitions. In Vietnam, the national utility has rolled out basic remote metering technologies for years with a vision to eventually transition to more advanced technologies. The smart meter deployment target has been given in the table below for some of the major countries in the region such as Philippines, Vietnam, Malaysia, Singapore, Thailand, Indonesia.

Table 19: Smart metering plans in key Southeast Asian countries and Middle east region

Major countries	Smart metering plans
Philippines	Manila Electric Company (Meralco) plans to deploy 3.27 million smart meters under its AMI program between 2025 and 2029
Vietnam	Vietnam Electricity (EVN) has been actively replacing older meters with electronic meters and AMR systems. In 2022, there were 24.7 million electronic meters (81% of the total of 30.3 million consumer meters), of which 23.3 million were having remote measuring (AMR) and data collection features. As per Vietnam Smart Grid Development Roadmap 2030, from 2023 onwards, the focus would be on automation of distribution grid and AMI for all customers. However, the country is facing smart metering implementation challenges due to the high cost of smart meters.
Malaysia	The adoption of smart meters began in 2020, and has expanded rapidly across the nation, with around 2.3 million units installed as of 2024. The smart meter initiative aims to install 9.1 million units in Peninsular Malaysia by 2026, with notable increases in adoption expected in regions such as Melaka, Selangor, Kuala Lumpur, and Penang.
Thailand	The Provincial Electricity Authority (PEA) launched a 20-year roadmap in 2017 to develop a national smart grid which also includes smart metering
Singapore	There are over 1.4 million households in Singapore, of which about 0.5 million smart electricity meters have been deployed. The metering of remaining households is expected to be completed by 2026.
Indonesia	PLN, Indonesia's state-owned electricity company has set a target of installing 1.2 million smart meters by 2023, 4 million by 2025 and 10 million by 2030.
Middle East	Saudi Arabia and UAE are investing heavily in smart electricity grids which includes smart meters. Saudi Arabia has automated 32% of its distribution grid and installed over 10 million domestic smart meters. As of 2024, DEWA deployed over 1.2 million smart electricity meters across Dubai. Saudi Arabia has targeted to automate 40% of the distribution networks by 2025, with 32% of that target already achieved. Oman and Kuwait aim to roll out 1.2 million and 0.5 million smart meters, respectively, in 2025

Source: Country reports on smart grid rollout plans, Crisil Intelligence

3.6.2 Country wise standards

Country	Standards	Regulatory Authority
Australia	Australian Energy Market Operator (AEMO) Metering Code	Australian Energy Regulator (AER)
European Union	EN 62056 series for electricity metering data exchange IEC 62053 series for electricity metering equipment and metering accuracy	European Commission
India	IS 16444: Covers technical requirements for smart meters CBIP-325: Provides technical guidelines for meter reliability, durability, and communication protocols MTCTE (Mandatory Testing and Certification of Telecom Equipment)	Bureau of Indian Standards (BIS) Central Electricity Authority (CEA) Department of Telecommunications (DoT) State Electricity Regulatory Commissions (SERCs)
UAE	Cabinet Resolution No. (140) of 2023	Respective Regulation and Supervision Bureau
USA	National Institute of Standards and Technology (NIST) Framework and Roadmap for Smart Grid Interoperability Standards	Federal Energy Regulatory Commission (FERC)
UK	Smart Meter Implementation Programme (SMIP)	Office of Gas and Electricity Markets (Ofgem)

Source: Industry, Respective Regulatory Authority, Crisil Intelligence

Some of the key global standards in smart metering are given in the table below:

Standard body	Reference	Title
IEC	IEC 61968-9	Application integration at electric utilities - System interfaces for distribution management
IEC	IEC/TS 62351	Power systems management and associated information exchange - Data and communications security
IEC	IEC 62052 -11	Electricity metering equipment (AC) - General requirements, particular requirements, tests and test conditions

Standard body	Reference	Title
IEC	IEC 62056 – 21,42,46,47,53,61,62	Electricity metering - Data exchange for meter reading, tariff and load control
IEC	IEC 62058	Electricity metering equipment (AC) - Acceptance inspection
EN	EN 13321 Series	Open data communication in building automation, controls and building management — Home and building electronic system
EN	EN 13757 -1,2,3,4,5	For utility metering using M-bus and other media
EN	EN 14908 series	Information Technology – Control Network Protocol
EN	EN 50065-1	Signaling on low-voltage electrical installations in the frequency range 3kHz to 1485 kHz – General Requirements, frequency bands and electromagnetic disturbances
EN	EN 61334-4-32	Distribution Automation Using Distribution Line Carrier Systems – Data Communications Protocols
IEC	EN 61334-4-511	Distribution Automation Using Distribution Line Carrier Systems – Data Communications Protocols – Systems Management – CIASE Protocol
IEC	IEC 61334-4-512	Distribution Automation Using Distribution Line Carrier Systems – Data Communications Protocols – System Management using profile 61334- 5-1 – Management Information Base
IEC	IEC 62051-1	Electricity Metering – Data Exchange for Meter Reading, Tariff and Control – Glossary of Terms
IEC	IEC 62351 (all parts)	Power Systems Management and Associated Information Exchange – Data and Communications Security
EN	EN 62056-31,42,46,47,53,61,62	Electricity Meter Data Exchange
IEEE	IEEE 1377	Utility Industry Metering Communication Protocol Application Layer
ANSI	ANSI C12.22	Protocol Specification for Interfacing Data Communication Networks

Source: ISGF, Crisil Intelligence

3.6.3 Regional Outlook

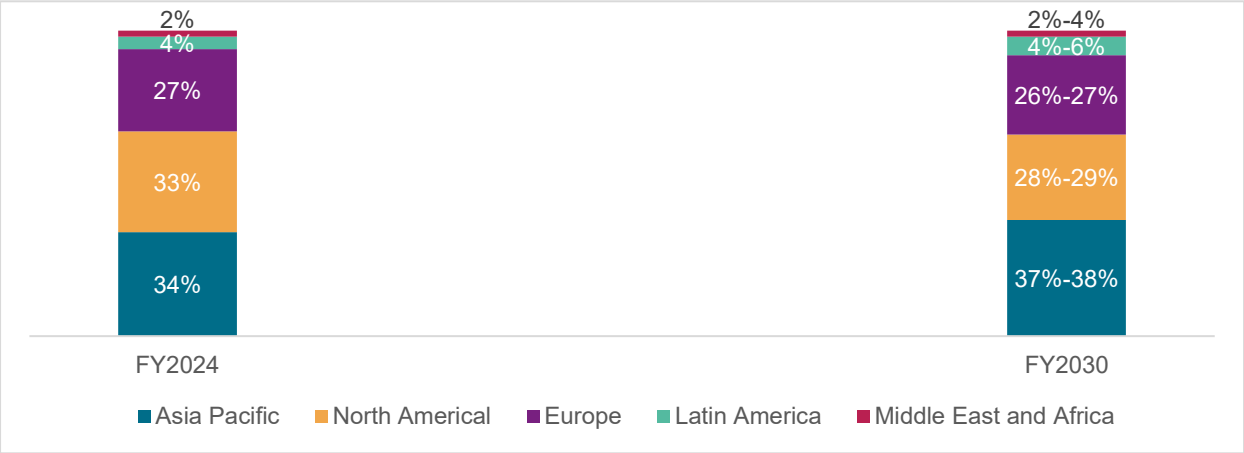
The Asia-Pacific region is expected to dominate the smart meter market, accounting for over 37-38% of the global market share by 2030. China, India, and South Korea are expected to be the key drivers of growth in the region. The market is expected to grow at a CAGR of 14-16%, with a market size of $4-5 billion in 2024 to $11-

12 billion by 2030. The penetration rate of smart electricity meters in the region is expected to grow from 61% in 2023 to 80% in 2029-30.

The North American smart meter market is expected to grow at a CAGR of 10-11% with a market size of $8-9 billion to $14-15 billion by 2030, driven by the increasing adoption of smart grid technologies and the need for energy efficiency. North America is projected to achieve a penetration rate of 94% by 2029-30.

The European smart meter market is expected to grow at a CAGR of 5-6% with a market size of $2-3 billion in 2024 to $4-5 billion by 2030, driven by the EU's smart metering rollout targets and the need for energy efficiency. Europe anticipated to reach 76% by 2027 and 90-92% by 2030.

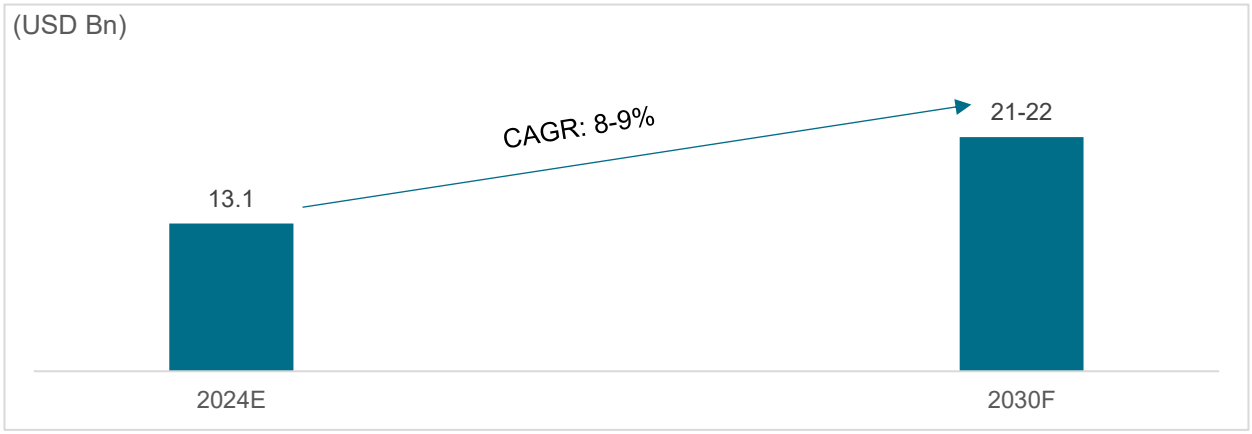
Figure 47: Region wise market assessment (%)



Source: Industry; Crisil Intelligence

The global smart meter market is expected to grow at a rapid pace, driven by increasing demand for energy efficiency, grid modernization, and the need for real-time monitoring and control of energy consumption. The global smart meter market is expected to grow at a CAGR of 8-9% from 2024 to 2030, with the annual market size expected to reach USD 21-22 billion by 2030.

Figure 48: Estimated annual market size for global energy smart meters in 2030



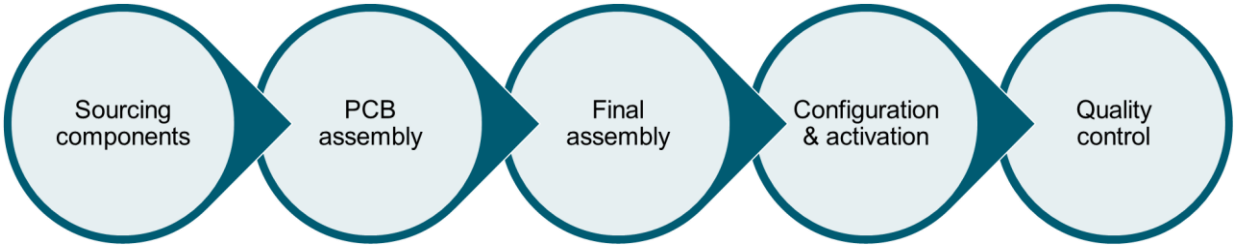
E: Estimated; F: Forecast; Source: Industry; Crisil Intelligence

3.7 Overview of smart meter manufacturing value chain

3.7.1 Manufacturing process

The smart meter has three parts - Structural part (includes bottom case, meter cover, terminal button case, terminal button cover, etc.). Electronic hardware part (includes current and voltage signal sampling, measurement, MCU, control part, data storage, LCD display, communication module, power supply part, etc.) and Software part (to perform series of functions such as energy measurement, data acquisition, data processing, load control, and remote communication).

Manufacturing a smart meter involves bringing together metrology, communications, security, and telemetry into a reliable device suitable for mass deployment. The core of any smart meter is precision measurement of voltage, current, power, and associated parameters.



Components: The raw materials such as polypropylene, PVC granules for meter case and covering, electrical components such as Power convertor, Processor, Modem, Internal Battery, Operator Interface, Cover Tamper Switch, Tact switches, Hall Effect Sensor, Customized circuit board, LED or LCD- which displays the energy consumption in digits, etc. and other materials like screws, springs, battery, battery contacts, connectors, wires, etc.

PCB assembly: The smart meter's electronic circuitry features Printed Circuit Boards (PCBs) with mixed-technology assembly, incorporating Surface Mount Device (SMD) components for both metrology, communication and control functions. These PCBs are designed to support complex wiring requirements, utilizing double-sided or multilayer boards as needed. To ensure reliable power supply and connectivity, the PCBs also include THD devices and connector interfaces. Furthermore, extensive Design for Manufacturability (DFM) considerations are applied to guarantee efficient and cost-effective production of the PCBs, which are a critical component in the functioning of the electronic circuits.

Final assembly: It includes integration of PCB assemblies along with meter case and other components.

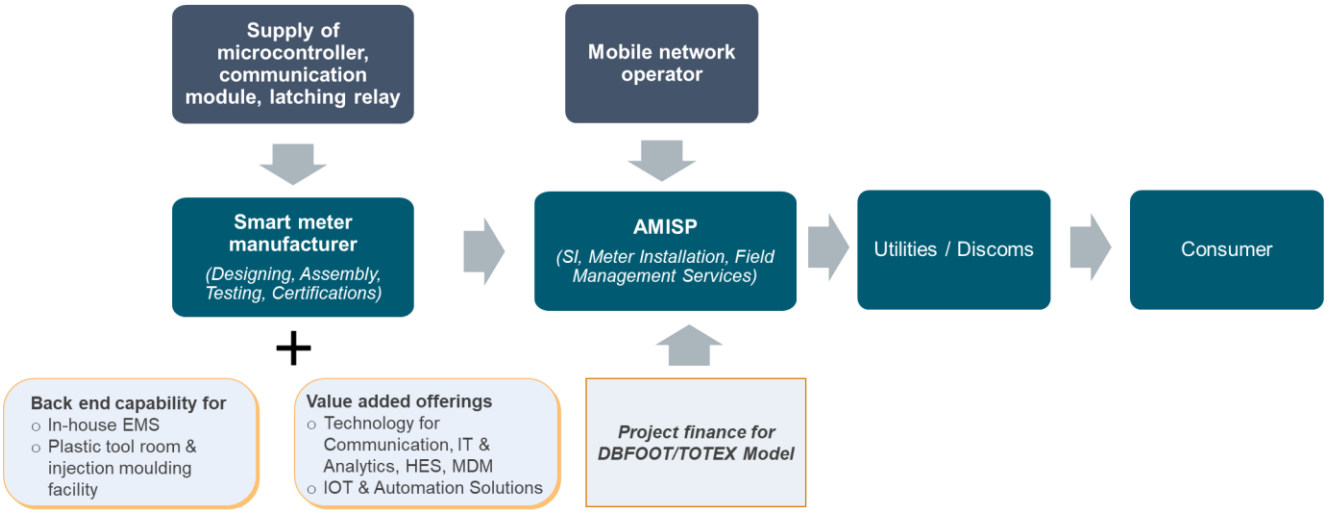
Configuration and activation: It involves cryptographic keys for security, metrology calibration, software/firmware, burn-in testing across operating conditions.

Quality control: Robust quality control and testing is required Incoming component inspection, In-circuit tests during assembly, Power-on functional testing, Metrology calibration and accuracy verification, Burn-in testing over temperature, voltage, Sample destructive testing for robustness.

3.7.2 AMI value chain

The AMI value chain is a comprehensive ecosystem comprising hardware and software components, involving multiple stakeholders and service providers, including EMS providers, system integrators, network operators, Discoms and end-consumers. At the core of the AMI system is the energy metering chipset, which integrates advanced metrology functions along with a processor that includes sufficient embedded memory (ROM, RAM) to handle data processing task. EMS providers typically supply not just smart meter hardware but also a communication module and necessary firmware to enable seamless data transmission. To enable data aggregation and analytics, AMISPs or system integrators enter into a contract with providers of HES, MDM and network operators. The network operators provide connectivity in between data concentrators and HES/MDM. Smart meters are deployed at various levels, including consumer premises, DTs and feeder level. The entire AMI is rolled out within the jurisdiction of Discom, enabling efficient energy monitoring, accurate billing and enhanced grid management.

Figure 49: AMI value chain



Source: Crisil Intelligence

Having a backward integrated capability and value-added offerings provides a significant competitive advantage to a smart meter manufacturer. With in-house capabilities such as EMS, plastic tool room, and injection moulding facility, the company can exercise greater control over the production process, ensuring higher quality, reduced lead times, and lower costs. Additionally, the presence of web applications and software solutions (HES, MDM), analytics tools, and IoT and automation offerings enables the company to provide a comprehensive suite of solutions to its customers. This showcases the company's ability to offer end-to-end solutions, from meter manufacturing to data analytics and automation, enables it to differentiate itself from competitors and establish long-term relationships with customers, ultimately driving business growth and revenue expansion.

Table 20: Key companies in the value chain

Key suppliers/service providers	Description (Product/service offerings)
Electronic components supplier	
Renesas Electronics Corporation	It offers semiconductor solutions. The product offer includes Metering microcontroller unit (MCU), Application MCU,

Key suppliers/service providers	Description (Product/service offerings)
	Communication processors, PLC and Sub-GHz wireless communication solutions for utility meters
NXP Semiconductors	It provides metering MCU, communication processors, gateway, touch sensors
Analog Devices	Metrology ICs, Sensors, Power management products, and communications products
ST Microelectronics	Energy metering ICs, long- and short-range wireless connectivity solutions, 8- and 32-bit microcontrollers, power supply and management devices, sensors, EEPROMs, secure elements and protection devices
Microchip Technology	Metering ICs, PLC modem, Transceivers, EEPROMs
Telit Cinterion	Offers a variety of connectivity solutions for smart meter communication
Quectel	Global supplier of IoT modules (LPWA/4G/3G/2G modules)
Neoway Technology	Provides wireless communication modules (2G/3G/4G/5G/NB-IoT/eMTC) wireless modules, for smart metering applications
Gruner AG	Offers latching relay for smart meters which covers a variety of energy management functions, such as load control, supply control, prepayment, etc.
KG Technologies	Provides latching relays spanning from 5A to 320A
Hongfa	Provides latching relay for smart meters
Guangxi Ramway	Provides latching relay for smart meters
Smart meter manufacturers;	
Allied Engineering Works	The company is engaged in the manufacturing of electric meters such as electronic meters, prepaid meters, smart meters AMI/AMR and manufacturing of wires of various types such as auto-wires, submersible cables, solar cables, building wires upto 1100 V and welding cables. It has three manufacturing units located in Delhi with an annual manufacturing capacity of 7.29 million.
Genus Power Infrastructures	It provides a full range of smart metering products, solutions and services. Along with meter related services, the group also provides domain related software and SaaS (software as a service) to utilities. It has manufacturing facilities in Jaipur, Haridwar and Guwahati with a total capacity of 12 million meters per annum.
HPL Electric and Power	It offers smart meters and conventional meters solutions. Apart from this, it also provides lighting, switchgears, wires and cables. It has a manufacturing capacity of 11 million meters per annum.

Key suppliers/service providers	Description (Product/service offerings)
Kimbal	It offers smart meter solutions, RF Mesh communication infrastructure and Head-end system solutions
Secure Meters	It offers a variety of products and services related to smart grid solutions, smart meters, gas meters, heat measuring devices, energy efficiency, data acquisition system, etc
AMISPs	
Adani Energy Solutions	AESL is one of the leading AMISP with order book of 22.8 million smart meters as of March 2024 received from 9 utilities across 5 states.
Apraava Energy	It has won AMISP projects in 6 states – Assam, Gujarat, West Bengal, Himachal Pradesh, Rajasthan and Madhya Pradesh. The total awarded quantity is 6.86 million. It entered into AMISP business in 2023.
Intellismart	It is a JV of National Investment and Infrastructure Fund (NIIF) and EESL. It has a portfolio of 20 million smart meters in the state of Uttar Pradesh, Assam, Gujarat, and Bihar.
GMR Smart Electricity Distributions	It has received the order for 7.57 million smart meters from UP discoms and installed ~0.44 million smart meters as of Jan 2025 across all project areas.
Polaris Smart Metering	It has a total order for 7.57 million smart meters across Ladakh, Uttar Pradesh, West Bengal and Manipur. As of September 2024, it has installed 0.16 million smart meters. It has a manufacturing capacity of 4 million meters per annum.

Source: Company websites, Annual reports, Crisil Intelligence

3.8 Overview on non-utility energy meters

As per IEA's report on "Energy Efficiency 2024, enhancing energy efficiency at an accelerated pace can yield significant reductions in CO_2 emissions, accounting for over one-third of the total emissions abatement required between 2024 and 2030 to achieve a net-zero emissions trajectory by 2050. This can be achieved through the rapid electrification of energy systems and the implementation of technical efficiency improvements. Notably, between 2010 and 2022, advancements in energy intensity resulted in a cumulative reduction of approximately 7 gigatonnes of CO_2 emissions globally, underscoring the substantial potential of energy efficiency measures to mitigate climate change.

Furthermore, in 2023, governments across the world committed substantial funding to support energy efficiency initiatives, allocating approximately USD 60 billion for efficiency measures in buildings and USD 45 billion for low-emissions vehicles. This brings the total funding earmarked by governments for energy efficiency measures over the past five years to over USD 1 trillion, demonstrating a significant investment in the transition to a more sustainable and low-carbon economy.

Implementing a comprehensive range of energy efficiency measures, including initiatives that promote behavioral change, electrification, fuel switching, digitalization, and material efficiency, can lead to significant

energy savings. As per IEA, by 2030, these efforts can potentially avoid approximately 95 exajoules (EJ) of energy consumption per year, resulting in substantial reductions in energy waste and greenhouse gas emissions.

According to India Energy Scenario 2024, the impact of energy efficiency schemes resulted in total energy savings of 53.60 Mtoe in fiscal 2024, leading to significant cost reductions of Rs. 200 billion.

India's industrial, infrastructure, and building sectors are undergoing a significant transformation to reduce energy consumption. The government has implemented stringent policies and benchmarks, accompanied by penalties for non-compliance, to drive energy efficiency. Additionally, Indian organizations are voluntarily adopting international sustainability standards, such as LEED (Leadership in Energy and Environmental Design) certification. This dual approach, combining regulatory pressure with voluntary adoption of global best practices, is expected to yield substantial energy savings and contribute to a more sustainable future. India has retained its third position on the U.S. Green Building Council's (USGBC) annual list of the top 10 countries and regions for LEED in 2024.

The infrastructure sector, including water supply, irrigation, and wastewater management, relies heavily on energy meters to monitor and manage energy consumption of pumps and motors. Similarly, the transportation sector, comprising highways, railways, metros, ports, and airports, also requires accurate energy metering for lighting, EV charging stations, traction motors, facility management, heavy equipment such as cranes, cargo handling etc.

Additionally, industrial and commercial establishments, office complexes, and residential apartments are significant energy consumers. Across these diverse sectors, the primary goal is to implement effective Energy Management Systems (EMS).

The non-utility sector, which includes infrastructure, industry, facilities, and buildings, is a major consumer of multi-function meters.

Given the substantial electricity consumption in these sectors, sub-metering at a granular level is crucial to identify areas of high energy usage and opportunities for energy efficiency improvements, enabling data-driven decisions to optimize energy consumption.

The widespread adoption of MFM meters with IOT and RTU is underway across various industries, driven by their ability to directly control electrical equipment. These advanced meters are equipped with Industrial Internet of Things (IIOT) and automation capabilities, enabling seamless integration with SCADA systems and EMS. Facility management applications, in particular, rely heavily on these meters, which can be categorized as Panel Meters or Multifunction Meters (MFM) when they feature advanced functionalities. By leveraging these cutting-edge meters, organizations can optimize energy consumption, streamline operations, and improve overall efficiency.

The figure below depicts a typical MFM meter used for monitoring electrical parameters.

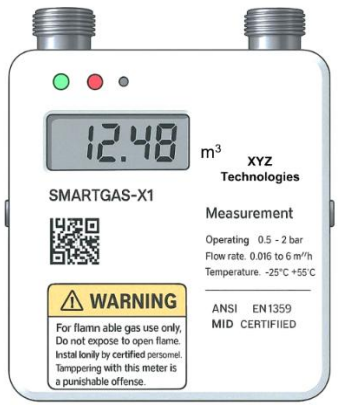
Note: The image depicted above is a generic representation of a MFM meter and is not intended to be a detailed or accurate illustration of any specific product or brand. Source: Industry, Crisil Intelligence

Considering the infrastructure developments in non-utility sector as discussed above, India Digital Panel Meter Market is estimated to increase from Rs. 7-8 billion in fiscal 2025 to Rs. 27-28 billion by fiscal 2030 at a CAGR of 29-30%.

3.9 Market size of gas smart meter – India and global

3.9.1 Overview of gas meters

A gas smart meter is an advanced device that measures the consumption of natural gas in a residential, industrial and commercial setting. It is a digital meter that uses wireless communication technology (cellular/LoRa/LoRAWAN/NBIoT) to transmit usage data to the utility company, eliminating the need for manual meter readings. The gas smart meter is equipped with a range of features, including real-time monitoring, automated meter reading, and remote shut-off capabilities for prepaid consumers. This allows consumers to track their gas usage in real-time, receive accurate bills, and make informed decisions about their energy consumption. Additionally, gas smart meters can detect leaks and anomalies in the gas supply, enabling prompt action to be taken to prevent accidents and reduce waste. A typical representation of smart gas meter is represented below.



Note: The image depicted above is a generic representation of a smart gas meter and is not intended to be a detailed or accurate illustration of any specific product or brand.

Source: Industry, Crisil Intelligence

There are two primary types of smart gas meters – ultrasonic and diaphragm meters. Ultrasonic meters operate on the principle that soundwaves are influenced by the speed and flow direction of the gas through which they pass. A Diaphragm gas meters works by using a diaphragm, which is a flexible membrane, to measure the pressure of the gas passing through it. This causes the diaphragm to move, and the movement is measured and converted into digital signals used to calculate the volume of gas that has passed through the meter.

Parameters	Ultrasonic meter	Diaphragm meter
Accuracy	Class 1 accuracy	Class 1.5 accuracy
Operating temperature	-30 Deg C to 60 Deg C	-25 Deg C to 55 Deg C
Durability	IP 65 - Minimal wear and tear and maintenance free operation	IP-65
Applications	Power plants, city gas stations, gas processing plants, compressors	Primarily used in residential and commercial units
Communication technology	RF, LoRa, GSM, NB-IoT	RF, LoRa, GSM, NB-IoT
Features	• Remote shutoff • Tamper detection • Theft and leaks detection • No moving parts • Improve safety and avoid service outages through pressure monitoring • Half the size and weight of diaphragm meters	It also has features similar to Ultrasonic meters, except: • Less expensive than ultrasonic meters • Useful for low flow rates • Have moving parts • Low accuracy at high flow rates

Source: Manufacturers websites, Crisil Intelligence

The adoption of smart metering solutions in the gas segment has been slower compared to the electricity sector. However, countries such as Italy, UK, and France have been at the forefront of smart gas metering adoption, with a combined installed base of around 47 million smart gas meters, accounting for about 80-85% of the market share.

3.9.2 Government schemes for gas infrastructure

There were about 100 million households in India in 2014 which were deprived of clean LPG fuel and used traditional biomass fuels such as firewood, dried cow-dung, agricultural waste, charcoal, etc. as cooking fuel. The toxic smoke emitted by these fuels contains particulate matter and chemicals that are harmful to eyes and lungs, causing acute and chronic respiratory illness, such as pneumonia and chronic obstructive pulmonary diseases. The smoke also contains carcinogenic elements causing lung cancer. Apart from women, children also suffered from this harmful kitchen smoke.

To address the issues pertaining to traditional cooking, the government launched Pradhan Mantri Ujjwala Yojana (PMUY) scheme to provide clean cooking fuel to the rural and deprived households through LPG gas

connections. Now the progression is the adoption of piped gas, which offers a more convenient and hassle-free experience by eliminating the need for cylinder handling, refilling, and replacement. This shift is not only more cost-efficient, as it reduces transportation costs and enhances safety, but also ensures a reliable and uninterrupted gas supply, alleviating concerns about running out of gas at inconvenient times.

The key initiatives and schemes adopted by the government are as follows:

- Pradhan Mantri Ujjwala Yojana (PMUY): This scheme provides subsidized LPG connections to women from economically weaker households, reducing reliance on traditional fuels like wood and coal. The target was to release 80 million LPG connections to deprived households by 2020. Further, under Ujjwala 2.0, additional allocation of 160 million LPG connections were provided. Thus, the scheme has benefited over 96 million families, improving health outcomes and reducing indoor air pollution. The Government of India has approved release of additional 7.5 million connections under PMUY Scheme, taking overall target under the scheme to 103.5 million, against which connections are getting released now.
- City Gas Distribution (CGD) Network: Implemented under the Petroleum and Natural Gas Regulatory Board (PNGRB), the CGD project aims to expand piped natural gas (PNG) connections in urban and semi-urban areas. The initiative ensures a shift towards cleaner and more efficient fuel sources for households, industries, and transportation. 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.
- Sustainable Alternative Towards Affordable Transportation (SATAT): Launched in 2018, this initiative promotes the production and distribution of compressed biogas (CBG) as an alternative fuel, supporting the expansion of piped biogas connections in rural areas and reducing dependency on fossil fuels. Government has announced phase wise mandatory selling of CBG in CNG (T) and PNG (D) segment of CGD network to promote the production and utilization of CBG. CBG Obligation (CBO) is presently voluntary till FY 2024-2025 and mandatory selling obligation would start from fiscal 2026. CBO shall be kept as 1%, 3% and 4% of total CNG/PNG consumption for fiscal 2026, 2027 and 2028, respectively. From fiscal 2029 onwards CBO will be 5%.

3.9.3 Smart gas meters growth drivers and challenges

Growth drivers

The government has set a target to transition to a gas-based economy by raising the share of natural gas in the energy mix from 6% in 2019 to 15% by 2030. Crisil Intelligence forecasts a robust 6-10% CAGR in natural gas demand in India between fiscal 2026 and 2030. A key driver of this growth will be the expansion of the CGD network to new geographical areas. The demand for piped natural gas (PNG) is expected to increase due to supportive regulatory decisions, expanding gas network coverage, and the identification of 100 industrial clusters with critical polluting levels by the National Green Tribunal.

As the government invests in expanding the natural gas pipeline network, including projects such as the Urja Ganga Gas Pipeline (3,384 km), Indradhanush Gas Grid (1,661 km), Mehsana-Bhatinda pipeline (1,940 km), and Dabhol-Bengaluru pipeline (1,414 km), the availability of natural gas will increase across regions. This, in turn, will lead to a growth in the number of domestic PNG connections, CNG stations, and distribution pipeline

networks, totaling over 8,000 km by 2030. Several government and private entities such as IOCL, HPCL, BPCL, Adani, Torrent Power, are executing CGD projects in various geographies allocated to them.

As the CGD sector expands, the need for efficient and accurate metering of gas consumption will become increasingly important. Smart gas meters, which offer advanced features such as real-time monitoring, leak detection, connect/disconnect, precision in operation will play a crucial role in ensuring the efficient distribution and consumption of natural gas.

Restraints

The cost of smart meters is substantially higher compared to traditional meters, posing a significant financial burden on both consumers and utilities. Further, the rollout and adoption of smart gas meters require clear guidelines and regulatory support from the government.

Many consumers in India are unaware of the benefits of smart meters, which can lead to resistance to their adoption. Educating consumers about the long-term benefits of smart meters, such as accurate billing, reduced energy consumption, and improved safety, is crucial to encourage their acceptance and adoption.

To facilitate the widespread adoption of smart gas meters, it is essential to provide incentives and support to consumers and clear guidelines from the government to ensure a seamless and efficient transition with standardized bidding documents, technical specifications pertaining smart gas meters and related infrastructure.

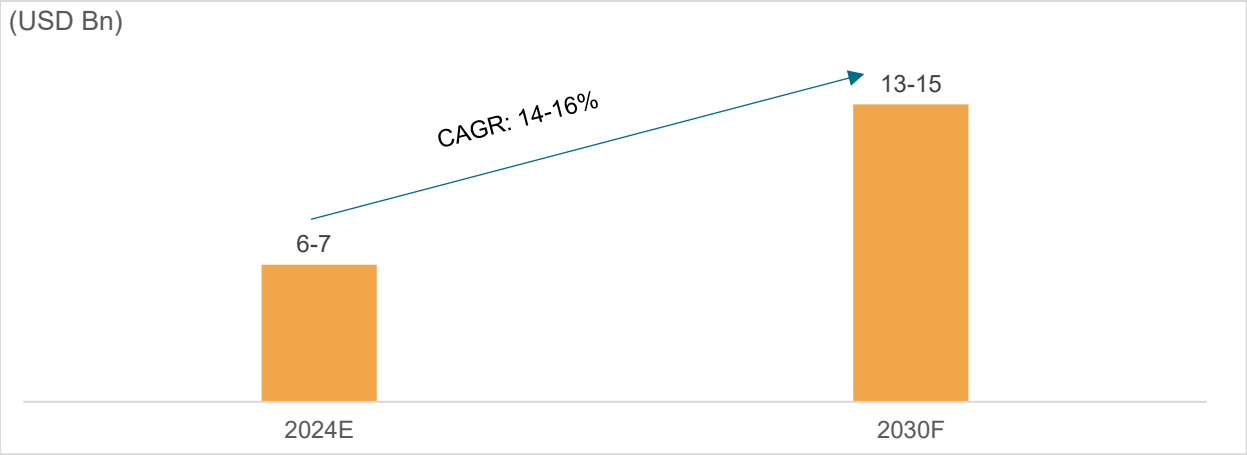
3.9.4 Smart gas meter market outlook

Government of India had envisaged the target of connecting 10 million cumulative PNG household by the end of 2020 and estimated a target of 70 million gas meters by 2030. As of September 2024, India has 13.6 million domestic-PNG connections which is expected to increase to 126.3 million across the country by 2032. PNGRB has authorized 307 geographical areas covering almost 100% of the total geographical area of the country spread over around 733 districts. The smart gas meter market in India is still at a nascent stage but it is projected to grow significantly during the forecast period.

Globally, adoption of smart metering is also growing fast in the European gas distribution market. As of 2024 around 45% of the natural gas customers had been equipped with a smart gas meter which is expected to increase to 60% by 2028. Europe is expected to witness significant growth over the forecast period. Initiatives like the EU's Green Deal and Energy Efficiency Directive promote the widespread adoption of smart metering technologies. Major countries in the region that have called up huge smart gas meter rollouts are Italy, UK, Spain, Luxemburg, and Sweden. In Asia Pacific, countries like China, Japan, and South Korea are at the forefront of this trend, implementing large-scale smart grid projects and modernizing their gas distribution networks. The smart ultrasonic gas meter segment is predicted to foresee significant growth in the coming years. In Asia Pacific, the number of smart gas meters is expected to more than double from 196 million units in 2023 to 420 million units by 2029.

The smart gas metering and CGD market in India and globally is poised for significant expansion, driven by increasing adoption of smart infrastructure and government initiatives. The cumulative market size of Indian smart gas meter is projected to reach Rs. 550-600 billion between fiscal 2026-30 (with an average annual market size of ~Rs. 110-120 billion). While the global annual smart gas meter market was valued at USD 6-7 billion in 2024 and is projected to reach USD 13-15 billion in 2030, with a CAGR of 14-16% from 2024 to 2030.

Figure 50: Estimated annual global smart gas meter market size in 2030

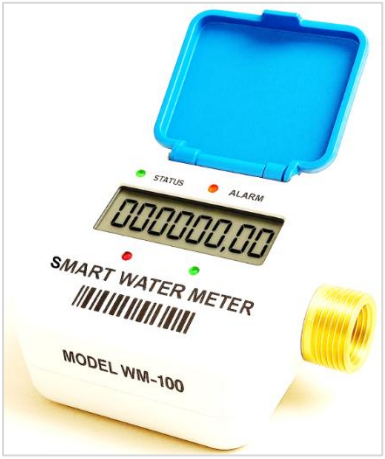


Source: Industry; Crisil Intelligence

3.10 Market size of water smart meter – India and global

3.10.1 Overview of water meters

There are two types of smart water meter for domestic use i.e., ultrasonic and electromagnetic smart meters. Ultrasonic flow meters utilize the properties and behaviour of sound waves passing through moving water. Whereas, in an electromagnetic meter, a magnetic field is created across the pipe. When water, which is an electrical conductor, moves through the magnetic field, a voltage is induced which is detected by electrodes in the body of the meter. The voltage is directly proportional to the flow velocity, which allows the flow rate to be calculated.



Note: The image depicted above is a generic representation of a smart water meter and is not intended to be a detailed or accurate illustration of any specific product or brand. Source: Industry, Crisil Intelligence

One of the key applications of AMI in irrigation and water utilities, where it is used to collect comprehensive flow data. This data can help identify excessive water use patterns, which may indicate leaks or other issues. By

analysing this data, utility companies can notify customers or make necessary repairs, reducing waste and improving overall efficiency.

Parameters	Ultrasonic meter	Electromagnetic meter
Accuracy	Class 2	± 0.5% of flow rate (more accurate than ultrasonic meters)
Operating temperature	-25 Deg C to 55 Deg C	Upto 60 Deg C
Durability	IP68 ensures durability and reliable operation in harsh outdoor environments, protecting the meter from dust, water ingress, and physical damage.	IP68 protection
Applications	Domestic and bulk metering	Mostly used for bulk metering
Communication technology	Cellular / RF / NBIoT / LoRa	Cellular / RF / NBIoT / LoRa
Features	• No moving parts • Water leakage detection • Real-time information • Reverse detection	• No moving parts • High accuracy • Water leakage detection • Real-time information • Reverse detection

Source: Manufacturers websites, Crisil Intelligence

The smart water metering market is still in its early stages of adoption but is poised for significant growth as utilities increasingly upgrade their infrastructure and implement smart water solutions to enhance sustainability and reduce non-revenue water (NRW).

3.10.2 Government schemes for piped water supply

Water is a vital component of life, covering approximately 71% of the Earth's surface. However, despite its abundance, water is a scarce resource due to the fact that a significant portion of it is either saline or inaccessible. About 96.5%, is found in oceans, while the remaining 2.5% is freshwater, with only a mere 0.3% existing in liquid form on the surface. India, with 17% of the world's population, has a disproportionate share of only 4% of the world's freshwater resources.

As per NITI Aayog, about one-third of India’s groundwater reserves are currently overexploited, meaning more is pumped out than is naturally recharged by rainfall. Moreover, almost 70% of India’s water is contaminated. Agriculture accounts for 80% of India’s water demand.

Given the limited availability of freshwater, it is essential to manage this precious resource efficiently. To prevent wastage and ensure sustainable use, it is crucial to have a proper accounting of water through metering. By

installing water meters, we can track consumption, identify areas of leakage and waste, and take corrective measures to optimize water use, ultimately helping to conserve this vital resource for future generations.

Some of the schemes launched by the government to provide water supply rural households and cities:

- Jal Jeevan Mission (JJM) (2019): This flagship initiative aims to provide Functional Household Tap Connections (FHTC) (Har Ghar Nal se Jal Scheme) to every rural home by 2024. The mission emphasizes source sustainability, rainwater harvesting, and reuse of wastewater to ensure long-term water security. Implementation involves community participation through Village Water & Sanitation Committees (VWSCs), ensuring local ownership and management of water resources. As of March 2025, the JJM has provided tap water connections to 122.6 million additional rural households, bringing the total coverage to over 155.1 million households, which accounts for 80.06% of all rural households in India.
- Atal Mission for Rejuvenation and Urban Transformation (AMRUT) (2015): This initiative was launched in June 2015 in selected 500 cities and towns across the country. The Mission focuses on the 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 2.0 scheme, which has been launched in October 2021 for the period of 5 years i.e. from the financial year 2021-22 to the financial year 2025-26, 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. It aims to reduce NRW from the current 40-45% to below 20%.

3.10.3 Smart water meter growth drivers and challenges

The growing water crisis in India, as highlighted by the NITI Aayog's Composite Water Management Index in 2018, has created a pressing need for efficient water management solutions. The report mentioned that India is undergoing the worst water crisis in its history and nearly 600 million people are facing high to extreme water stress. The report predicted that 21 major cities will run out of groundwater by 2025, affecting 100 million people has further accelerated the adoption of smart water management technologies. Further, NRW is also a challenge with almost all water supply utilities in India. It includes physical & commercial losses and free authorized water for which payment is not collected. The average NRW in India is about 38%, which is above the global average range of 30% to 35%, as reported by the World Bank.

The Central Government has taken several measures for conservation and management of ground water including effective implementation of rainwater harvesting in the country. The government launched Jal Shakti Abhiyan (JSA) in 2019 which continued during 2021 also to improve water availability including ground water conditions in the country. Ministry of Housing & Urban Affairs (MoHUA) has formulated Model Building Bye Laws (MBBL), 2016 for the States to adopt measures suitable to local conditions, wherein adequate focus has been given on requirement of rainwater harvesting and water conservation measures etc.

In addition, a number of States have undertaken measures in the field of water conservation/harvesting such as ‘Mukhyamantri Jal Swavlamban Abhiyan’ in Rajasthan, ‘Jalyukt Shivar’ in Maharashtra, ‘Sujalam Sufalam Abhiyan’ in Gujarat, ‘Mission Kakatiya’ in Telangana, Neeru Chettu’ in Andhra Pradesh, Jal Jeevan Hariyali in Bihar, ‘Jal Hi Jeevan’ in Haryana, and Kudimaramath scheme in Tamil Nadu etc.

Several District Water Boards in metro cities such as Bangalore, Chennai, Pune, Mumbai, Delhi are carrying out plans to introduce smart water meters in phased manner through pilot projects. E.g., Bangalore in the first phase plans to install and monitor 2,000 smart water meters for bulk consumers and after successful implementation another 98,000 meters would be installed. Chennai Metropolitan Water Supply and Sewerage Board is planning to install 0.1 million smart water meters in commercial and high-rise buildings. Pimpri Chinchwad Municipal Corporation is planning to replace unauthorized water connections with smart water meters. It has also mandated to install smart water meters in new residential projects. Thane Municipal Corporation have installed over 0.1 million AMR based smart meters.

Growth drivers

The growth of the smart water meter market in India is driven by the government's initiatives to develop water supply infrastructure and ensure universal coverage. The AMRUT 2.0 scheme, which aims to provide universal water supply coverage to 500 Indian cities, is a key driver of this growth. The integration of water metering with water supply projects is expected to ensure equitable water supply, cost recovery, accurate billing, and reduction of non-revenue water losses. As the scheme expands to other towns and cities, the demand for smart water meters is expected to increase, driven by the need for efficient water management and conservation.

The increasing urbanization and population growth in India are also contributing to the rising demand for smart water meters. Traditional water metering systems are unable to keep pace with the growing demand, resulting in water wastage, inaccurate billing, and system inefficiencies. Smart water meters, with their ability to provide real-time data and track usage patterns, are well-positioned to address these challenges. Additionally, the government's focus on improving water management in rural and semi-urban areas, such as through the Jal Jeevan Mission, is expected to create new opportunities for smart water meter manufacturers. The expanding market for water management solutions in these areas is driven by the need for fair distribution, prevention of leakage, and efficient water supply. In 2023, over 192 million rural households had access to piped water supply, indicating an expanding market for water management solutions.

Globally, the smart water meter market is driven by a range of factors, including the increasing demand for water conservation, infrastructure modernization, and digitalization of utilities. The growing attention to water scarcity, technological advancements in IoT, and government policies and regulations are also contributing to the adoption of smart meters. According to UNICEF, the global water crisis is rapidly intensifying. With two-thirds of the world's population facing severe water scarcity for at least one month annually, and over two billion living in countries with inadequate water supplies, the demand for smart water meters is expected to increase. Projections indicate that by 2040, a quarter of the world's children will reside in areas of extreme water stress, further emphasizing the need for efficient and sustainable water management solutions. As a result, the global smart water meter market is expected to continue to grow, driven by the need for innovative solutions to address the world's water challenges.

Restraints

The adoption of smart water meters in India is hindered by several challenges, including the high upfront costs associated with installation and maintenance. The significant cost disparity between traditional and smart water meters, with the latter costing Rs. 5,000 - 10,000 per unit creates a barrier to adoption, particularly in less affluent urban and rural areas. This cost barrier is further exacerbated by the lack of awareness and higher costs in rural areas, where the penetration of smart water meters remains low. According to a survey by the National Sample

Survey Office (NSSO), over 70% of rural households still rely on traditional water meters or unmetered water supply, highlighting the need for increased awareness and education about the benefits of smart water meters.

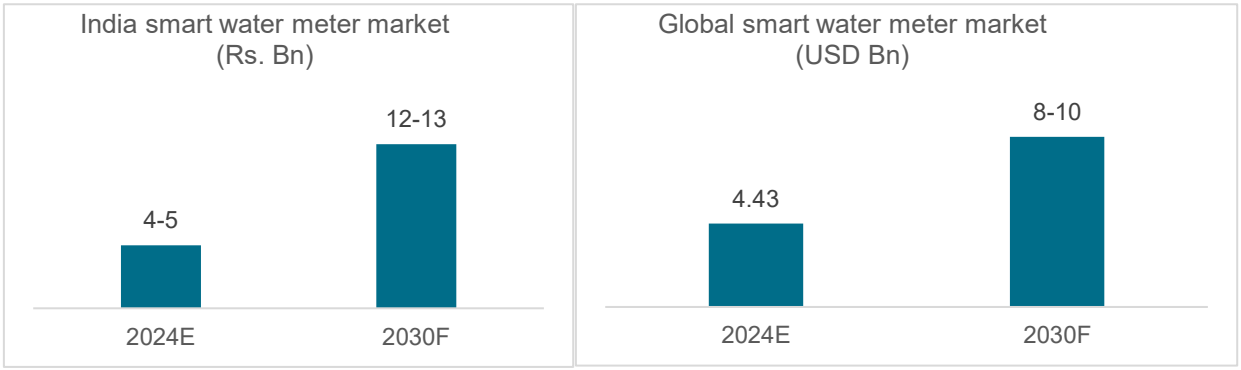
The lack of infrastructure and resistance to adopting new technology in rural areas are additional restraints to the growth of the smart water meter market. The need for consistent power supply to support internet connectivity and meter operation is a significant challenge in areas with unreliable power grids.

3.10.4 Smart water meter market outlook

India is gradually adopting smart water meters, driving by increasing water scarcity and urbanization. As India aims for sustainable water management, smart water meters will be crucial for conserving resources and ensuring fair distribution. Government initiatives such as the Smart Cities Mission, AMRUT 2.0 and Jal Jeevan Mission are expected to accelerate smart water meter adoption with an estimated deployment of 2.0-2.5 million smart water meters between 2025-2030. As a result, over the next five years, the Indian smart water meter market size is projected to reach Rs. 12-13 billion, growing at a CAGR of 17-18% from 2024 to 2030, up from Rs. 4-5 billion in 2024.

On a global scale, the annual smart water meter market was valued at USD 4.4 billion in 2024 and is projected to reach USD 8-10 billion in 2030, with a CAGR of 11-12% from 2024 to 2030.

Figure 51: Estimated market size of smart water meters

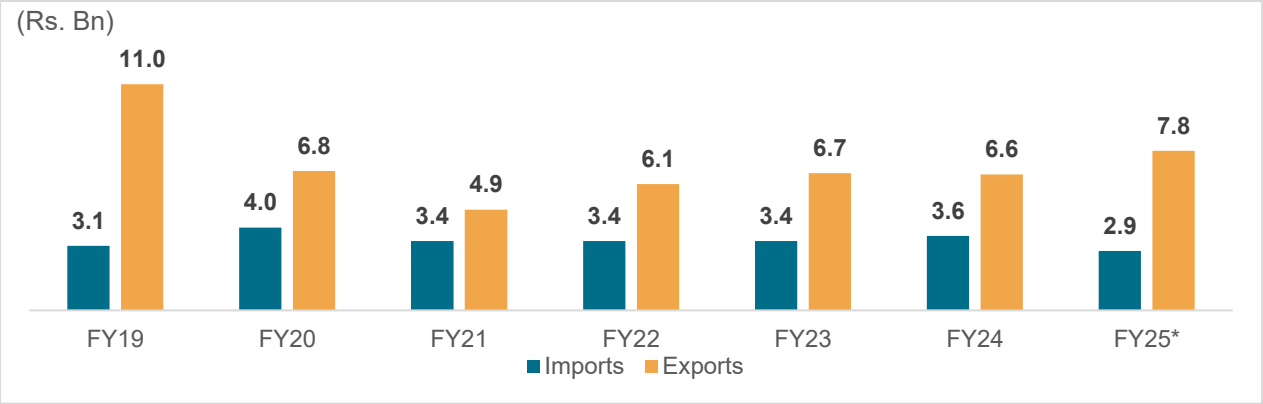


E: Estimated; F: Forecast; Source: Crisil Intelligence

3.11 Import and export of meters in India

India has emerged as a significant player in the global meter market, with a growing number of domestic manufacturers and exporters. India exported meters (incl. associated equipment) worth around Rs. 7.8 billion in 9 months of fiscal 2025. The top 8 countries accounted for 83% of total export value. Countries like UK (33%), Singapore (16%), Mexico (9%) and Australia (8%) were the leading importers for Indian meters. Similarly, India imported meters (incl. associated equipment) worth around Rs. 2.8 billion in 9 months of fiscal 2025. The top 6 countries accounted for 77% of total import value. Countries like China (31%), Germany (15%), USA (10%) and Canada (9%) were the leading exporter to India.

Figure 52: Import export of meters in India



**Apr-Dec 2024, HS Code 9028 (Gas, Lqd/electricity supply/production meters, incl. calibrating meters)*

Source: Department of Commerce; Export Import Data Bank (Ministry of Commerce and Industry), Crisil Intelligence

Currently, India's share in the global export of smart meters is relatively small compared to dominant players such as China, US, and European countries. However, the Indian government has taken proactive measures to boost domestic manufacturing and reduce reliance on imports. The government's mandate for local value addition in smart meter manufacturing has led to a significant reduction in smart meter imports. Furthermore, the imposition of custom duties and stringent regulatory mechanisms has made it challenging for foreign companies to sell smart meters in India through the import route, thereby creating a level playing field for domestic manufacturers. As the domestic industry continues to grow and mature, India is poised to emerge as a significant player in the global smart meter export market, leveraging its competitive advantages and strategic location to cater to the growing demand for smart meters in regions such as Middle East, Africa and Southeast Asian countries.

3.12 Investments in Indian smart meter market

The Smart Meter Industry in India is experiencing remarkable growth, with Indian companies focusing on international collaborations, research, and development to create advanced technologies. They are also expanding their distribution networks and engaging in mergers and partnerships to strengthen their market position. Some of the key deals in the last 1-2 years are listed in the table below:

Deal type	Month	Description
Equity	July 2023	Singapore's sovereign wealth fund GIC announced equity investment of USD 2 billion in a JV with Genus Power Infrastructures Ltd. GIC will hold a majority stake of 74% in the JV
Equity	Feb 2023	I Squared Capital has acquired a controlling stake in Polaris Smart Metering Pvt. Ltd., which owns Gram Power (India) Pvt Ltd, through an investment of $100 million
Joint venture	Feb 2025	EDF India and Actis formed a JV to develop and operate AMISP platform smart metering infrastructure. The total investment in the JV is expected to be around USD 200 million

Deal type	Month	Description
Joint venture	Dec 2023	Adani Energy Solutions Limited (AESL) and Esyasoft Holdings, has formed a 49:51 JV "Adani Esyasoft Smart Solutions Ltd" for implementing smart metering projects in India and other countries
Joint venture	Mar 2023	Indraprastha Gas Limited (IGL) and Genesis Gas Solutions Private Limited have formed a JV "IGL Genesis Technologies Ltd." (IGTL) for setting up smart gas meter manufacturing plant in Noida with an investment of Rs 1.1 billion to produce 1 million meters per annum
Technology acquisition	Feb 2024	IGTL has acquired smart gas meter manufacturing technology from China based Hangzhou Beta Meter for USD 2.4 million

Source: Company press releases, Crisil Intelligence

3.13 Global players in smart meter industry

Key players with global presence:

Itron: Itron is a leading player in the smart meter market, with a strong presence in North America, Europe, Asia-Pacific and Africa. They export smart meters to over 100 countries worldwide. It acquired Actaris Metering System in 2007 which was the leader in electricity, gas and water metering.

Landis+Gyr: Landis+Gyr is another leading player in the smart meter market, with a strong presence in Europe, North America, and Asia-Pacific. They export smart meters to over 50 countries worldwide.

Schneider Electric: Schneider Electric is a global leader in the smart meter market, with a strong presence in Europe, North America, and Asia-Pacific. They export smart meters to over 50 countries worldwide.

Honeywell: Honeywell is a global conglomerate with a strong presence in the smart meter market. They export smart meters to over 100 countries worldwide. Honeywell in 2015 acquired Elster Division of Melrose Industries plc, a leading provider of thermal gas solutions for commercial, industrial, and residential heating systems and gas, water, and electricity meters, including smart meters and software and data analytics solutions.

Badger Meter: It is a leading global provider of water solutions including water meters and is present in over 20 countries worldwide**.**

Hubbell: It is a global player in the smart meter market, with a presence in North America, Europe, Asia, and other regions, including countries like the US, Canada, the UK, France, Italy, China

Competition for Indian Exporters:

China: China is a major competitor for Indian exporters in the smart meter market. Chinese companies such as Kaifa, Dongfang, Laig, Star, Hexing are major players in the global smart meter market.

Europe: European companies such as Siemens, Schneider Electric, and Landis+Gyr are also major competitors for Indian exporters in the smart meter market.

North America: North American companies such as Itron and Honeywell are also major competitors for Indian exporters in the smart meter market.

The global smart meter market is highly competitive, with several players competing for market share. Indian exporters face intense competition from Chinese companies, which have a low-cost production advantage and significant government support. However, Indian exporters have a cost advantage due to lower labor and production costs, and the Indian government provides support to exporters through various schemes such as the Merchandise Exports from India Scheme (MEIS) and the Service Exports from India Scheme (SEIS).

Competition from Chinese players:

India's smart meter industry has emerged as a cost-competitive alternative to China, primarily due to the availability of components and the government's push for domestic manufacturing. India's smart meter industry is not only cost-competitive but also technologically advanced. Unlike China's inward-looking design and architecture, India has adopted an open architecture approach. This means that Indian smart meters are designed to be interoperable and compatible with various systems, making them more adaptable and acceptable globally. For instance, the USA and other international markets prefer open protocols and standards, which India's smart meters adhere to. This adherence to international standards gives Indian smart meters a significant edge in the global market. We intend to leverage these advantages to expand our reach internationally.

4 New technologies and automation

4.1 IoT and automation

4.1.1 Overview of IoT

The Internet of Things (IoT) refers to a sophisticated network of embedded electronic systems, each comprising an embedded controller that facilitates a two-way internet connection via cellular or other radio networks. These IoT devices are interconnected with external sensors and actuators, enabling them to gather and respond to data from their environment. By leveraging information from sensors and the status of actuators, IoT devices can remotely operate and control hardware, devices, or machines, thereby enhancing automation and efficiency.

The IoT device's ability to send and receive information to and from a software solution, typically hosted on the cloud, is a pivotal aspect of its functionality. This software solution serves as a central hub, capable of communicating with multiple IoT devices, sharing information, and issuing commands to perform diverse tasks. The cloud-based platform plays a crucial role in recording and storing the data transmitted by IoT devices, providing valuable insights and analytics that can inform decision-making processes.

Furthermore, the IoT cloud may also integrate Artificial Intelligence (AI) or Machine Learning (ML) engines, which can analyze the collected data, identify patterns, and make predictions, thereby enabling predictive maintenance, optimized performance, and enhanced user experience. The incorporation of AI and ML capabilities allows IoT devices to become increasingly autonomous, adapting to changing conditions and making decisions in real-time. This synergy between IoT devices, cloud-based software solutions, and AI/ML engines has the potential to revolutionize various industries, including manufacturing, power, gas and water utilities, transportation, and smart cities, by fostering greater efficiency, productivity, and innovation.

The IoT has numerous applications across various sectors, and one of its most significant uses is in the management and optimization of critical infrastructure and resources.

4.1.2 Different layers in an IoT ecosystem

In a typical IoT solution, a physical device is equipped with a range of sensors, peripherals, and controllers that enable it to interact with and collect data from the physical world. This device, often referred to as the remote terminal unit (RTU) or "Edge" device, is typically located at the periphery of the network and is responsible for collecting and processing data in real-time. The edge device is equipped with computing capabilities and edge intelligence, which enable it to:

- Process data locally
- Increase autonomy
- Reduce latency
- Decrease the load on the network and cloud

Once the data is processed and prepared by the Edge device, it is transmitted through a network to a specialized system, such as a gateway or a cloud-based platform, where it is collected, stored, and analyzed. This data is

then prepared and rationalized for integration into enterprise IT systems, applications, and analytics, which extract insights and value to support and enable business processes and decisions.

IoT gateways and software play a crucial role in connecting devices, collecting and processing data, and enabling communication between devices and the cloud or other systems. An IoT Gateway serves as a vital link for facilitating communication in the IoT ecosystem, typically enabling interactions between devices (device-to-device) or between devices and the cloud (device-to-cloud). Essentially, it is a hardware component that incorporates application software, which executes crucial functions. At its core, the gateway's primary role is to establish and manage connections between diverse data sources and their intended destinations, thereby ensuring seamless data exchange and communication.

The role of IoT Gateways has undergone significant evolution, transforming them from basic data filtering tools to sophisticated devices that enable advanced visualization and complex analytics. As a result, these intelligent gateways are now playing a pivotal role in driving the rapid growth and expansion of IoT, empowering businesses and organizations to unlock new insights, improve operational efficiency, and create innovative solutions.

Activities performed by a versatile IoT Gateway may include:

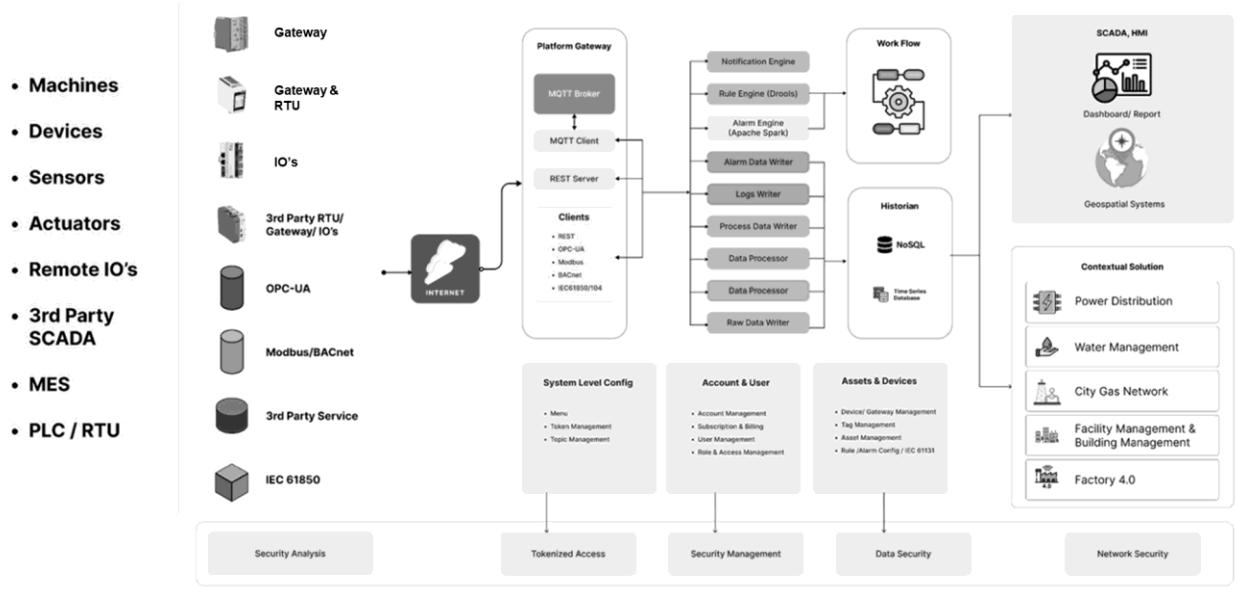
- Data collection, filtering, processing, storage and management
- Protocol conversion
- Device management
- Data visualization and analytics
- Security including management of user access and network security features
- Cloud connectivity and edge computing
- Remote monitoring including alerts and notifications
- Data integration with various systems, applications, and services.
- Firmware updates
- System diagnostics

By performing these activities, a versatile IoT Gateway plays a critical role in enabling IoT solutions, improving operational efficiency, and driving business value across various industries and applications.

4.1.3 IoT automation framework

The left-hand side of the below figure represents the physical domain, comprising various industrial components such as machines, equipment, devices, sensors, and actuators, as well as remote I/Os from other IoT or automation systems, third-party SCADA systems, Manufacturing Execution Systems (MES), and external Programmable Logic Controllers (PLCs) or RTUs. The Gateway RTU can collect data from these systems and others, process it in real-time, and generate a Human-Machine Interface (HMI) that is accessible via HDMI. Additionally, the AI/ML engine can be activated to analyze the data, which is then transmitted to the Cloud and various Contextual Applications via Message Queuing Telemetry Transport (MQTT) protocol.

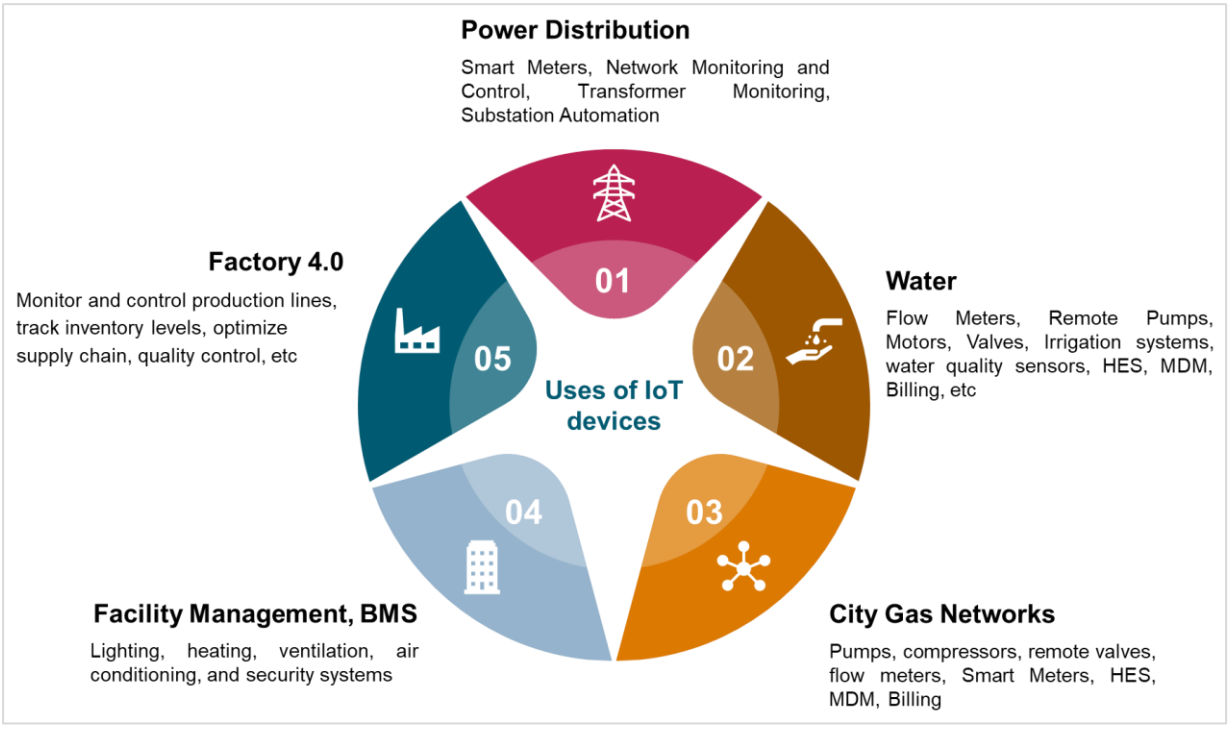
Figure 53: An overview of IoT framework



4.1.4 Key areas for IoT automation

The figure below shows some of the key areas where IoT automation can be used and being used for various applications.

Figure 54: IoT automation contextual applications



Source: Industry, Crisil Intelligence

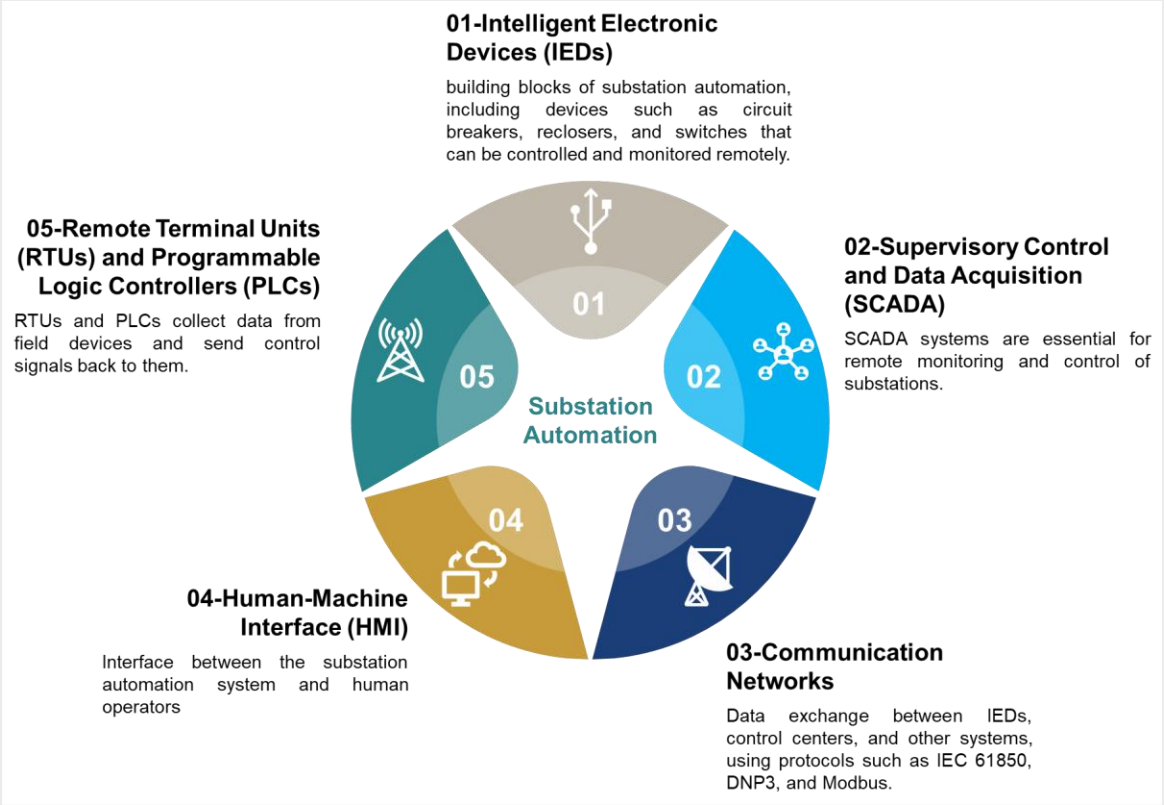
1. **Power Distribution**: The integration of IoT devices in power distribution systems has given rise to smart grids, which enable real-time monitoring and control of energy consumption. This includes the use of smart meters, which provide accurate and timely readings, as well as network monitoring and control systems that can detect and respond to power outages and other disruptions. Additionally, IoT devices are being used to monitor and control transformers, substations, and other critical infrastructure, ensuring efficient and reliable energy distribution.

   i. Distribution substation:

   The substation automation shall help to improve overall availability of the system by Real-time monitoring of substation parameters, such as voltage, current, and temperature, remote control of Intelligent Electronic Devices (IEDs), such as circuit breakers and switches, automatic protection of the substation and connected equipment from faults and anomalies, automatic execution of predefined actions in response to specific events or conditions, analysis of historical and real-time data to optimize substation performance and predict potential issues.

   Substation automation offers benefits such as improved reliability, operational efficiency, safety, data-driven decisions, better maintenance, and cost savings. It integrates functions like SCADA and volt-var control to optimise asset management and reduce human intervention. The rise of IEDs including protective relays, meters, and condition monitors has accelerated the growth of substation automation by enabling smarter, more responsive systems.

Figure 55: Key components of substation automation



Source: Industry, Crisil Intelligence

ii. Feeder automation:

IoT technology enables real-time monitoring of feeders and contactors using sensors and communication networks. Regular monitoring of feeders helps utilities and grid operators to detect faults, improve reliability, optimize energy distribution and enhance safety. Some of the key features of IoT-based feeder monitoring solutions include real time monitoring, predictive analytics, automated fault detection, energy usage monitoring and condition-based monitoring. IoT-based feeder monitoring solutions offer numerous benefits, including improved reliability, increased efficiency, and enhanced safety.

iii. Distribution Transformer Monitoring and Control:

Distribution transformers are prone to failures due to various factors such as overloading, overheating, moisture, and aging. These failures can lead to power outages, equipment damage, and even safety risks. Regular monitoring of transformer health can help utilities and grid operators for unexpected failures, improving grid efficiency. IoT technology enables real-time monitoring of distribution transformers using sensors and communication networks. Temperature, voltage and current, power quality, moisture, vibration etc. can be monitored using IoT. These sensors transmit data to a central platform or cloud-based server, where advanced analytics and machine learning algorithms are applied to detect anomalies, predict maintenance and providing alerts. IoT-based distribution transformer health monitoring offers numerous benefits, including improved reliability, extended lifespan, and increased efficiency.

iv. Fault Isolation System:

To enhance fault location accuracy in distribution networks, an edge computing-based scheme is proposed. Leveraging technologies like edge computing, AI, and mobile internet, power distribution terminals can diagnose faults locally. The system divides the network into segments, each managed by a primary terminal that collects data from nearby terminals. In case of a short-circuit or single-phase ground fault, the main terminal collects alarm signals or waveform data and uses AI algorithms to locate the fault. Field tests with oscillating fault indicators confirm its effectiveness in reducing resource use and improving fault location efficiency.

v. RE and EV-Based Losses:

With the rise of large-scale PV generation and EV charging stations, issues like three-phase imbalance have worsened. An edge computing-based solution in the transformer area can address imbalance, enhance power quality, and reduce network losses.

2. **Water Management**: IoT devices are being used to modernize water management systems, enabling real-time monitoring and control of water distribution networks. This includes the use of smart meters, flow meters, and remote sensors to track water usage, detect leaks, and predict demand. Furthermore, IoT devices are being used to control and monitor remote pumps, motors, valves, and irrigation systems, ensuring efficient and optimized water distribution. Water quality sensors are also being used to monitor water quality parameters, such as pH, turbidity, and chlorine levels, enabling prompt action to be taken in case of any anomalies. Some of the use cases are:

- IoT based flocculation control and drinking water plant automation
- Smart sensors for adequate chlorination in drinking water network
- Pump and motor energy optimisation
- Water leak and theft detection, area identification water audit
- Pressure loss of water network and sizing of boosting station
- Level based, pumping automation
- Equitable water distribution and audit
- Sewage treatment: Soft sensor to ensure sufficient oxygen input to ensure correct balance of BOD and COD
- IT solution for HES and MDM of Water Consumers

3. **City Gas Networks**: IoT devices are being used to optimize the management of city gas networks, including the monitoring and control of pumps, compressors, remote valves, and flow meters. Smart meters are also being used to track gas consumption, enabling accurate billing and demand forecasting. The use of IoT devices in city gas networks enables real-time monitoring and control, reducing the risk of accidents and improving overall safety.
    - Pumping station automation
    - Leak detection, theft and audit
    - Pressure loss and operation of boosting station
    - Equitable distribution
    - Energy Management
    - IT solution for HES and MDM of CGD consumers

4. **Facility Management and Building Management Systems (BMS)**: IoT devices are being used to create smart buildings and facilities, where lighting, heating, ventilation, air conditioning, and security systems can be monitored and controlled remotely. This enables facility managers to optimize energy consumption, reduce waste, and improve the overall comfort and safety of occupants. IoT devices are also being used to monitor and control access control systems, CCTV cameras, and other security systems, enhancing the overall security of facilities.
    - Monitoring, visualisation, control and optimization of HVAC, water and sewage system, lighting, elevator / escalator systems
    - Security, CCTV, access control
    - Fire detection and evacuation system, fire fighting
    - Monitoring visualisation, control and optimisation of power systems from in-house substation, feeders, transformer monitoring, sub metering for Energy Management.
    - Communication systems: Wi-fi, Radio, Switch, Router and Fibre optic and Ethernet management

5. **Factory 4.0**: The integration of IoT devices in manufacturing systems has given rise to the concept of Factory 4.0, where machines and devices are interconnected and can communicate with each other in real-time. This enables predictive maintenance, quality control, and optimized production processes, leading to increased efficiency, productivity, and competitiveness. IoT devices are being used to monitor and control production lines, track inventory levels, and optimize supply chain management, enabling manufacturers to respond quickly to changing market conditions and customer demands.

The list below shows the IoT applications in various sectors:

Sectors	IoT applications
Agriculture	• Precision farming, Livestock monitoring, Crop monitoring, Smart irrigation systems
Smart Buildings, Construction	• Building Management Systems (BMS), Energy management, Lighting control, Security systems, Access control, Smart homes
Smart Cities, Transportation, Traffic Control	• Traffic management, Smart parking, Waste management, Urban planning, Public safety, Smart lighting, Environmental monitoring, Route optimization, Public transportation systems, Intelligent transportation systems (ITS)
Healthcare, Health Responders	• Remote patient monitoring, Telemedicine, Medical device tracking, Hospital management, Emergency response systems, Health analytics
Manufacturing and Supply Chain Management	• Inventory management, Logistics tracking, Freight monitoring, Warehouse management, Cold chain monitoring, Predictive maintenance, Quality control, Industrial automation
Energy including Electricity	• Smart grids, Energy management, Smart meters, Renewable energy monitoring, Energy storage systems
Railways	• Train tracking, Passenger information systems, Freight monitoring, Rail network management, Safety systems
Smart Vehicles, EV Charging, Fleet tracking	• Vehicle-to-everything (V2X) communication, Electric vehicle charging infrastructure, Fleet management, Vehicle diagnostics, Autonomous vehicles, Electric vehicle sharing. Mobility-as-a-service (MaaS)
Security Cameras	• Surveillance systems, Access control, Intrusion detection, Video analytics, Facial recognition
Utilities	• Water management, Gas management, Electricity management, Waste management
Payment	• Mobile payments, Digital wallets, Payment gateways, Transaction analytics

4.1.5 Impact of the Digital India Initiative on IoT Growth

The Indian government's Digital India initiative has been a significant driving force behind the technological advancements leveraged under the initiative such as artificial intelligence, IoT, cognitive analytics are force multipliers in effective provision of and access to education, health, livelihoods, disaster-resilience and other critical dimensions of sustainable development. Its impact is evident in several key areas:

Strengthening Digital Infrastructure: Expansion of broadband and mobile internet connectivity, with a particular focus on rural and semi-urban areas. Ambitious projects like BharatNet aim to provide broadband connectivity to over 250,000 villages, laying the foundation for the widespread deployment of IoT technologies at scale. This digital infrastructure is essential for supporting the growing demand for IoT applications in various sectors, including smart cities, agriculture, healthcare, and manufacturing.

The rapid rollout of 4G and 5G networks across the country providing high-speed, low-latency connectivity is essential for IoT applications. This has enabled the development of a wide range of IoT-based services, including smart city infrastructure, precision agriculture, remote healthcare, and industrial automation.

Smart Cities Mission: The Digital India initiative is closely linked with the Smart Cities Mission, which aims to create sustainable, efficient, and livable cities through the use of IoT technologies. IoT is integral to these projects, providing real-time data and automation that improve service delivery, urban planning, and citizen engagement. For example, IoT sensors are being used to monitor air and water quality, manage energy and utilities, and optimize waste management, leading to improved public health, safety, and overall quality of life.

4.1.6 Market size of IoT

As per Global System for Mobile Communications Association (GSMA) estimates, there were approximately 15-16 billion connected IoT devices globally as of 2023 which are expected to grow by 13-14% CAGR to reach 38-40 billion by 2030. A significant share of these devices uses connectivity based on 3GPP standards, especially in industrial, automotive, and smart city applications. As of 2023, cellular IoT accounts for 20–22% of all connected IoT devices globally. The market is dominated by Asia Pacific, especially China and India, due to large-scale smart meter deployments and connected vehicle adoption.

Cellular IoT Market: The global cellular IoT market, which includes devices and services based on Third Generation Partnership Project (3GPP) standards (e.g., LTE-M, NB-IoT, 5G), was valued at approximately USD 6-7 billion in 2023 and is projected to grow at a CAGR of 25-26% by 2030.

LTE IoT Market: The LTE IoT market (covering LTE-M and NB-IoT, both standardized by 3GPP) was valued at USD 2-3 billion in 2023 and is expected to reach USD 13-14 billion by 2030, growing at a CAGR of 27-28%.

5G IoT Market: The 5G IoT segment was valued at USD 12-13 billion in 2023 and is projected to reach USD 75-80 billion by 2030, with a CAGR of 30-32%.

As a result of Digital India and related government programs, the Indian IoT market is projected to grow rapidly, with estimates ranging from USD 15 -20 billion by 2025 and is expected to reach USD 45-50 billion by 2030. The IoT device base in India as of 2023 estimated to be over 200 million, with applications spanning utilities, healthcare, agriculture, manufacturing, and urban services.

4.1.7 Growth drivers for IoT and Automation

With the advancement in AI technology, companies are now looking to leverage AI at the edge, increasing the demand for real-time data analytics also at the edge.

Digital transformation: Evolving digital transformation is driving the adoption of both IoT and automation technologies.

Increasing demand for connected devices: The growing demand for connected devices used during day-to-day activities as well as smart manufacturing, such as smart home devices, wearables, and industrial sensors, is driving the adoption of IoT and automation.

Advancements in technology: Rapid advances in technologies like 5G, Wi-Fi, and Bluetooth are enabling faster, more reliable, and more secure connectivity, making IoT and automation more viable.

Cost reduction: With advancement in technology as well as widespread adoptions, the cost is reducing rapidly and decreasing cost of IoT devices, sensors, and connectivity is making IoT more accessible to businesses and consumers.

Growing demand for smart homes and cities: The increasing demand for smart homes and cities is driving the adoption of IoT in areas like energy management, transportation, and public safety.

Increased focus on Smart Grids: The increasing adoption of smart grids is driving the use of IoT devices, such as smart meters, sensors, and grid management systems, to optimize energy distribution and consumption.

Increased RE penetration and integration: The growing demand for renewable energy sources, such as solar and wind power, is driving the use of IoT devices to monitor and control energy production, storage, and distribution.

Data-driven decision-making: With improved technology, there is a large volume of data available for analysis. The increasing use of data analytics and business intelligence is driving the adoption of both IoT and automation technologies.

Cybersecurity: The growing concern about cybersecurity is driving the adoption of both IoT and automation technologies, such as secure connectivity and threat detection.

4.1.8 Challenges and limitations of IoT and Automation

Increased threat from cyber-attacks: IoT devices and automated systems are vulnerable to cyber threats and data breaches. Adding more devices provides more vectors to attacks.

Internet dependency: The reliance of IoT and automation on internet connectivity is significant, making redundant systems a necessity. Even brief losses of connectivity can have severe consequences, resulting in substantial costs and significant disruptions to production.

Communication challenged due to interoperability: Different devices and systems may not communicate seamlessly, hindering integration and automation thereby impacting the efficiency of the systems. With complex networks and technologies, the chances of failure increase significantly.

Rules and Regulations: IoT and automation raise concerns about privacy, safety, and liability, requiring regulatory frameworks and standards which are still at nascent stage in many countries.

The integration of IoT technology into industrial automation is revolutionizing the sector, yielding significant advantages such as optimized operational efficiency, reduced costs, and enhanced safety protocols. With applications spanning smart manufacturing, predictive maintenance, and remote monitoring, IoT is poised to shape the future of industrial operations, driving innovation and excellence in various sectors.

5 Overview of wires and cables

5.1 India wires & cables market overview

Wires consist of single conductor and cables are assembly of one or more conductors that are used for the transmission of electricity, data or signals. There are various types and varieties of cables, each designed to perform a specific function. They consist of the conductor metal (majorly copper and aluminium), insulation armoring and sheathing.

Wire & cables are classified as per their functionality or core of construction (like type of conductor metal, type of insulation etc.)

Table 21: Different types of cables

Cable types	Description	Applications
LT Power cable	It is an assembly of two or more conductors with insulation and a protective jacket. The LT power cables industry is used at low voltage (1.1 kV and below), predominantly in sub-transmission and distribution of power. These cables feature construction with solid or stranded copper or Aluminium conductors, PVC/XLPE insulation, with the option of armouring along with inner and outer sheathing. These cables are designed to ensure durability and performance across various applications and are available in multiple sizes and configurations, to suit different needs	Transmission and distribution of electricity in mainly Utility and other commercial and industrial sectors like petrochemicals, mining, steel, non-ferrous, shipbuilding, cement, railway etc.
Solar/DC Cable	It is used for transmission of Direct Current (DC) in solar power generation, other renewable generations, EV applications and other related applications.	Solar power generation, other renewable generations, EV applications and other related applications.
Automotive Wire & Cables	These are specifically designed to be used in automotive applications for wiring harness, battery cables, associated electrical and communications applications. It mostly consists of copper conductors and PVC Insulation. Automotive wires are used in wiring harness which is a bundled set of wires, terminals, and connectors that distribute power and facilitate communication between components including lighting, steering	Automotive wiring harnesses, brake cables, battery cables, trailer cables, fusible link wires, and car speaker wires.

Cable types	Description	Applications
	systems, air conditioning units, dashboard applications, sensors, and more. Additionally, battery cables play a vital role in connecting the vehicle's battery to its electrical system, supplying power to essential components and ensuring overall vehicle performance. These are manufactured using high-quality copper, which ensures electrical conductivity, allowing for efficient power transmission and signal clarity. The wires are insulated with PVC, conforming to industry standards for safety and performance, providing a reliable barrier against electrical hazards and environmental factors such as heat, moisture, and chemicals. These wires are designed to withstand vibrations, temperature fluctuations, and other stresses encountered in automotive environments. This also includes battery cables for automobiles, including motorcycles and other motor vehicles. These cables handle starting, charging, lighting, signal, and instrument panel circuits.	
Specialised cables	This class of cables includes cables that are especially designed for a particular end use/ industry due to particular requirements. These types of cables are usually provided as customized solutions against stringent requirements, including temperature, tensile strength, and chemical resistance. For example, braided cable, Sensor Cable, Anti-capillary cable and others. Braided wires protect cables from electromagnetic interference and increase flex life and mechanical strength. This ensures that cables can withstand the harsh conditions often encountered in automotive environments. The braided design acts as a shield, reducing the impact of external electromagnetic fields on the cable's performance. Sensor cables are designed to be used to connect various automative sensors and have	Multiple specialized applications including, defence, signal and data communication, Railway Signaling Cables, Industrial Automation and Digitalization, safety, power management, etc.

Cable types	Description	Applications
	high abrasion strength, flexibility and mechanical durability.	
Other types of cables	HT Power Cables House wiring Communication wires & cables and others	Multiple applications like high-voltage transmission to fiber optics for 5G networks etc.

Source: Crisil Intelligence

5.2 Key growth drivers for cables

The manufacturing industry and infrastructure development are key drivers of the demand for cables and conductors, with significant growth potential in areas such as power generation, residential and commercial construction. As governments invest in initiatives like power grid expansion, housing development and infrastructure upgrades, the cable market is poised to benefit from these efforts in the coming years. Furthermore, the shift towards renewable energy sources, such as solar and wind power, is creating new opportunities for industry. Some of the key drivers are as follows:

Favourable government power transmission and distribution schemes

The domestic power cables industry is expected to witness moderate growth driven by RDSS, which is aimed at network modernisation and system loss reduction, PGCIL investments in system strengthening, new GEC projects, and state transmission line additions.

Additionally, the power cables industry is expected to draw significant demand from spending on network modernisation and system loss reduction through deployment of armoured cables, aerial bunched cables, and reconductoring. Moreover, underground cabling, renovation and modernisation of existing transmission lines of 66 kV and below would be required for loss reduction over fiscal 2023-28.

With the introduction of tariff based competitive bidding (TBCB) and viability gap funding schemes for intra-state projects, the share of private sector players in the power transmission sector is expected to increase gradually over the long term. With increased awarding of projects under TBCB in the future, private participants are expected to play a key role in driving domestic power demand, thereby positively impacting the demand of cables including transmission and power cables.

Capacity additions in the power generation segment

Robust power capacity additions of 250-260 GW (incl. 27-30 GW energy storage projects) are expected over fiscal 2026-30, as compared with ~86 GW in the previous five years, as India aims to reach 50% of cumulative electric power installed capacity from non-fossil fuel sources. Solar and wind installed capacity in India are expected to grow by 160 GW and 27 GW, respectively from fiscal 2026 to 2030 as per government targets. Such multifold generation expansion plans also require large-scale development in the transmission sector because grid-connected solar and wind plants are usually located in far-flung areas which have limited transmission infrastructure. Extensive transmission and cable infrastructure transmit power for internal usage within the plant and from remote generation sites to consumption centres. This in turn is expected to drive the demand for cables and conductors.

Demand for advanced features and electronic components in modern vehicles

The rapid integration of cutting-edge technologies is revolutionizing the automotive industry, making vehicles safer, more user-friendly, and feature-rich, thereby enhancing their value and usefulness for owners. The proliferation of advanced driver-assistance systems (ADAS) has led to the widespread adoption of cameras, sensors, and other electronic components that improve safety and prevent road accidents.

For instance, cameras are being installed all around the vehicle to detect blind spots, monitor unsighted objects, and facilitate features like 360-degree views, while tire pressure sensors, lane change sensors, collision control sensors, anti-lock braking systems (ABS), and traction control systems are becoming increasingly common.

Furthermore, the growing trend of autonomous vehicles, connected cars, and the Internet of Things (IoT) is driving the demand for advanced automotive cables and wiring systems that can support high-speed data transmission, power distribution, and sensor connectivity. As a result, the demand for automotive wires and cables is expected to surge, driven by the need for reliable, high-performance, and durable connectivity solutions that can withstand the rigors of modern vehicles.

Rising adoption of EVs

The increasing electrification of vehicles, the adoption of advanced safety features, and the growing focus on vehicle-to-everything (V2X) communication are also contributing to the growth of the automotive cables market. The government's ambitious target of achieving 30% EV penetration by 2030 is poised to revolutionize the automotive industry, with projected annual sales of 10-15 million EVs by the end of the decade. This rapid growth in EV adoption, coupled with escalating fuel prices and mounting environmental concerns, is creating ground for the automotive cables market to grow.

As industry continues to evolve, the demand for advanced, reliable, and high-performance automotive cables is expected to increase, driving innovation and investment in the sector.

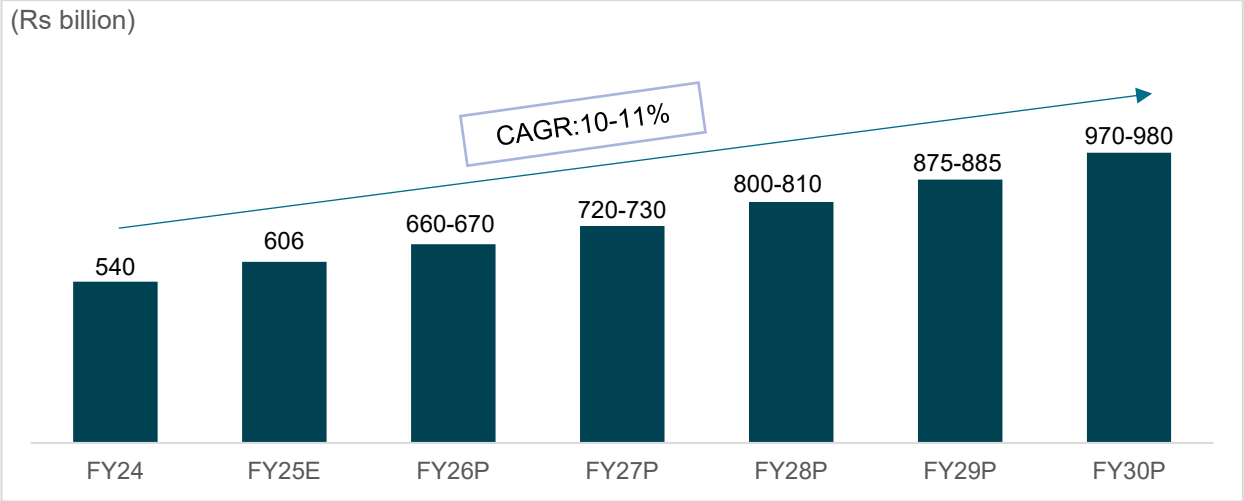
5.3 Existing and estimated market size

The Indian market for LV power cables, automotive cables, and specialized cables was valued at Rs. 540 billion in fiscal 2024. The power and automotive cable segments collectively accounted for more than 52% of the total market value, while railway signaling cables, control cables, and solar DC cables comprised over 38%. The remaining share was attributed to other specialized cables.

The production of LV power cables increased from 0.33 million km in fiscal 2021 to 0.46 million km in fiscal 2024, registering a CAGR of 11.9%. Railway signalling and control cables demonstrated significant growth with CAGR of 55% and 24%, respectively, during the same period.

Moving forward, Crisil Intelligence expects the wires and cables market size for the specified products to grow at a CAGR of ~10-11% between fiscal 2024-30 reaching an estimated value of Rs. 970 - 980 billion by fiscal 2030 due to ongoing infrastructure development projects, metro and rail electrification, rising demand for EVs, among other factors.

Figure 56: India Wires & Cables Market for identified products



Note: E-Estimated; P: Projected;

Source: IEEMA, Crisil Intelligence

5.4 Key challenges in the wires and cable industry

Fluctuation in raw material prices: The industry relies heavily on raw materials like copper, aluminium, steel, and PVC, which are subject to price fluctuations. This price increase significantly affects profit margins within the industry.

Competition and market share: While the market is moderately concentrated, competition is intense. Some of the large key players like Havells India Limited, Polycab India Limited, Finolex Cables Limited have established strong brand presence, extensive product portfolios, and robust distribution networks. These players are actively investing in research and development, enhancing their product offerings, and implementing sustainable practices to consolidate their positions.

Technological advancements: The companies in these industries grapple with the diverse pace of innovations in product development. To keep up with innovations and competitions, companies have to continuously update their technology to compete in the market.

5.5 Key players in the industry

Below is the list of key players operating in the cable and conductor industry in India. Below list is not exhaustive and does not contain all players operating in the sector.

Table 22: Key Manufacturers of wires & cables in India

Manufacturers	Established since	Segment	Products	End Industries
Apar Industries Limited	1958	Industrial and household	Premium products: High transmission low sag conductors, optical ground wire conductors, railway overhead conductors, fiber optic cables, special cables such as tactical cables, under water cables, tether cables, festoon cables. Electrical cable, elastomeric cables like solar, wind, nuclear cables etc., and E-beam cables	Railways, Renewable Energy, Power Transmission, Infrastructure, Oil & Gas, Mining, Defence
Finolex cables Ltd	1967	Household	Housing wires, Power cables, Agricultural cables, Co-axial cables, Speaker cables, Optical fiber cables, LAN cables	Power Transmission, Telecom, Railways, Defence, Agriculture, Data Communication
Havells India Limited	1983	Industrial and household	HT power cable copper and aluminium conductor, LT power cable copper & aluminium conductors, LT control cables, fire survival cables	Power Transmission, Thermal Power plants, Airports
KEI Industries Ltd	1968	Industrial and household	Power cables, communication cables, Instrumentation cables, Control cables, Rubber Cables, Solar cables, Winding wires, Fire Resistant cables, Marine & Offshore cables	Power Transmission, Infrastructure, Oil & Gas, Defence, Manufacturing. Telecom, Consumer Durables, Data Transmission
Polycab India Ltd	1996	Industrial and household	LC Power cable, MV Power cable, Industrial cable, PVC insulated industrial cables, Flexible wires, building wires, Optical Fibre cables, communication and data cables, rubber cables, control cables, instrumentation cables, solar cables	Power Transmission, Infrastructure, Oil & gas, Telecom, Defence, Manufacturing, Consumer Durable, Transport
Siechem Technology	2002	Industrial	Mining cable, Airport lighting cables, Telecommunication Cables, Building Wires, Fire	Power Transmission, Aerospace, Mining, Oil & Gas, Marine &

Manufacturers	Established since	Segment	Products	End Industries
			Resistant Cables, Flexible Cables, Instrumentation Cables, Power Cables, Welding Cables	Offshore, Telecom, Airport, Manufacturing
Universal Cables Ltd	1962	Industrial	EHV cables, medium voltage cables, Low voltage cables Aerial bunched, Power & Control cables, Winding wires, Elastomeric cables and capacitors	Power Transmission & Oil & Gas, Mining, Railways, Defence, Marine, offshore

Source: Crisil Intelligence

6 Competition analysis of companies with similar offerings

India boasts a thriving smart meter manufacturing industry, with several domestic and multinational companies operating in the sector. These players possess the necessary expertise and capabilities to produce a wide range of smart meters catering to diverse applications and end-user segments.

AEW was incorporated in 2011 and initially focused on Static energy meters and Dual source (DRDR) meter until 2020. In 2021 AEW expanded its portfolio and introduced a range of smart energy meter product offerings including single phase, 3-phase, DT, LTCT and HTCT smart energy meters. Additionally, AEW has also been offering comprehensive solutions, including in-house and third-party HES and MDM solutions, to support its smart meter offerings.

- Brief history of Company for smart meter development:
  - 2021: Development of 1-Phase & 3-Phase Smart meters
  - 2021: Development of LTCT Smart Meters
  - 2023: Development of Smart DT Meters
  - 2024: Development of Smart HT Feeder/Boundary Meters

AEW has a strong presence in the manufacturing of energy meters, with three manufacturing facilities in Delhi equipped with advanced technologies such as SMT lines, EMS (PCB Assembly), precision moulding, tool room, sheet metal workshop, etc. for the production of Smart Meters. This integrated backend capability enables the company to produce high-quality smart meters. Furthermore, AEW's expertise extends to service offerings including IoT & automation solutions, AMI- Service Provider and various software solutions for smart metering.

The following table provide details of key players capabilities and offerings in smart metering segment and other business offerings in India:

Table 23: Operational parameters of companies with similar offerings as of 31st March 2025

Parameters	AEW	Genus	HPL Electric	Secure Meter	Kimbal	Polaris	Avon	Capital Power	Bentec
Capabilities and offerings related to smart meters and AMI									
Fully integrated manufacturing facility	✓	✓	✓	✓	NA	NA	✓	✓	✓
IT offerings	✓	✓	✓	✓	✓	✓	✗	✗	✗
Value added offerings – Analytics/IOT	✓	✓	✗	✓	✓	✗	✗	✗	✗
AMISP	✓	✓	✓	✓	✗	✓	✓	✗	✓

Parameters	AEW	Genus	HPL Electric	Secure Meter	Kimbal	Polaris	Avon	Capital Power	Bentec
Types of smart meters being offered									
1 Phase smart electric meter	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 Phase smart electric meter	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 Phase LTCT smart electric meter	✓	✓	✓	✓	✓	✗	NA	✓	✗
3 Phase HTCT smart electric meter	✓	✓	✓	✓	✓	✗	NA	✗	✗
DT meter	✓	✓	✓	✓	✓	✗	✗	✗	✗
Feeder meter	✓	✓	✓	✓	✓	✗	✗	✗	✗
Smart gas meter	✗	✓	✗	✓	✗	✓	✗	✓	✗
Smart water meters	✗	✓	✗	✗	✗	✗	✗	✗	✗
Other meter products	1-ph & 3-ph static meter, dual source meter	1-ph & 3-ph static meter, DT metering, ABT meter, panel meter, Net meter	Panel meter, Net meter, prepaid meter, DT metering	Dual source meter, Panel meter, DT metering, ABT meter	NA	NA	Net meters, Sub-meters, 1-ph & 3-ph MFMs	Domestic, commercial & industrial Gas meter, water meter	1-ph & 3-ph electronic static meter, MFM, Net meter
Other business segments & offerings	Power, automotive, and specialized wires & cables	Grid & Substation Meters, Communication Devices, Facility Management Services, Data loggers	Consumer & industrial segment switchgear, LEDs, solar & telecom cables, SCB, Fans	Heat measuring instruments, thermostats, LVCT, Modem, IHD, etc	Energy management, RTU	NA	EMS tool	NA	Wires & cables, Switchgears, Distribution boards, LED lights

NA: Details not available

Source: Company websites, Investor presentations, Crisil Intelligence

Table 24: Comparative analysis of global players in smart meter

Parameters	Hubbell	Badger	Itron	Landis+Gyr
Headquarter	Shelton Connecticut USA	Milwaukee, Wisconsin, USA	Liberty lake, Washington, USA	Cham, Switzerland

Parameters	Hubbell	Badger	Itron	Landis+Gyr
Key activities	Manufacturer of smart meter under the brand name of Aclara	Manufacturer of smart flow meters and provides its associated solutions.	Manufacturer of electricity, gas and water meters along with services like metering management and communication networks	Manufacturer of electricity, gas and water meters
Other offerings	Electric, gas and water smart meters	Municipal water and C&I solutions, including analytics, all kinds of gas and water monitoring, communication technology etc.	Communication networks, Consumer engagement, Distribution automation, Metering solutions, Grid edge management, Data management and analytics	Dynamic load management, communication networks, Demand side flexibility, Heating ana cooling meters
Global presence	(US and Canada) North America, Latin America (Mexico, Chile, Brazil), (UK, France and Germany) Europe, (Australia, China and India) Asia-Pacific, (south Africa and Nigeria) Africa	Asia, Canada, Europe, Mexico, Middle East	Africa, Central America, Caribbean, East Asia, Europe, Middle East, North America, South America, South Asia, Canada, United States	USA, Europe, Middle East, Africa, Asia Pacific.

Source: Company websites, Crisil Intelligence

- As of March 31, 2025, AEW ranks among the top 5 energy meter solutions providers in India in terms of manufacturing capacity of 7.29 million meters per annum.
- As of March 31, 2025, AEW has supplied 2.92 million smart energy meters to one utility and 13 AMISPs for installation across 6 states, including Andhra Pradesh, Gujarat, Maharashtra, Haryana, Punjab and Uttar Pradesh, representing about 10% of the total smart energy meters installed in India. This contribution underscores AEW's role in AMI adoption in India in line with the government's commitment to promoting it nationwide.
- Of the total smart energy meters supplied, AEW have supplied 0.27 million DT meters as of March 31, 2025, representing over 25% of the total DT meters installed/delivered in India under the RDSS. With the growing demand for high-value, high-margin DT and feeder smart meters, AEW is poised to leverage this rising demand to maintain its market leadership.
- AEW has supplied the highest number of smart meters in Punjab and Uttar Pradesh which were among the top 10 states in India in terms of smart meter installations, as of March 31, 2025.
- AEW's smart meters support standard communication protocols such as IS/IEC 62056 for sharing energy usage data using High-Level Data Link Control (HDLC) and TCP/IP.
- AEW's smart energy meters incorporate advanced communication technologies such as 4G, 2G, NBIoT, BLE, and RF.
- AEW was among the first to offer dual communication capabilities (4G/2G + BLE) in smart energy meters in India, enhancing performance and usability for AMISPs, utilities, and consumers.
- The rapid growth of the smart meter market presents significant opportunities for companies like AEW.
- AEW is expecting to introduce their smart gas and water metering solutions by fiscal 2026, which will make AEW among the first few companies in India to offer such advanced solutions. With the expansion of CGD and water distribution networks and increasing adoption of smart metering, AEW can cater to both Indian and international markets by providing advanced smart gas meters and related infrastructure solutions.
- As per CEA, over 10% of DTs fail due to issues like oil theft, leakage, or overheating.
- The table below sets forth details of AEW's market share in the total smart energy meters installed across some states, as of March 31, 2025:

State	Number of smart energy meters delivered and installed as of March 31, 2025	AEW's share in the total smart energy meters installed/delivered as of March 31, 2025
Uttar Pradesh	2,691,127	44.4%
Maharashtra	3,170,644	5.9%
Punjab	1,480,063	73.5%
Andhra Pradesh	3,126,215	1.6%
Gujarat	2,128,824	13.7%
Haryana	847,467	13.5%

Source: RDSS portal, NSGM, Crisil Intelligence

Financial analysis of domestic and global companies with similar offerings in smart meters

AEW's financial performance has been benchmarked against two Indian listed companies, Genus and HPL, providing similar offerings in smart meter segment and other domestic as well as global players in the smart meter solutions space, to provide a comprehensive view of its industry standing and financial performance.

- AEW is the fastest-growing comprehensive smart energy meter solutions provider in India in terms of revenue growth, achieving a CAGR of 109.76% from Fiscal 2023 to Fiscal 2025.
- AEW's strong financial performance, with profit margin of 19.56%, return on capital employed of 71.47%, and return on equity of 65.69%, the highest among peers listed below in Fiscal 2025.

i. Revenue from operations (Rs. Million), CAGR (FY23-25)

Company	FY25	FY24	FY23	CAGR
Allied Engineering Works Ltd.	7,171.11	3,484.82	1,629.90	109.76%
Genus Power Infrastructures Ltd.	24,420.13	12,005.83	8,083.86	73.81%
HPL Electric & Power Ltd.	17,002.44	14,608.58	12,622.09	16.06%
Secure Meters Ltd.	NA	24,415.04	16,090.94	NC
Sinhal Udyog Pvt. Ltd. (Kimbal)	NA	3,566.77	174.18	NC
Avon Meters Pvt. Ltd.	NA	3,127.25	1,845.38	NC
Capital Power Systems Ltd.	NA	2,098.64	1,776.68	NC
Bentec India Ltd.	NA	4,266.15	2,933.63	NC
Landis+Gyr AG	146,231	160,978.10	135,183.43	4.01%
	CY24	**CY23**	**CY22**	**CAGR**
Hubbell Inc.	471,105.45	443,801.54	388,904.94	10.1%
Badger Meter Inc.	69,182.90	58,116.70	44,453.64	24.8%
Itron Inc	204,298.06	179,542.09	141,131.33	20.3%

NA: Not Available; NC: Not Calculated
Numbers are approximated to nearest integer
Source: Financials reports published in MCA, Company annual reports, SEBI filings, Crisil Intelligence

Note:

1. *Hubbell, Badger Meter, Itron and Landis+Gyr are foreign players. Except Landis+Gyr, the financials for other foreign players are as per the calendar year.*
2. *The figures are converted using average conversion rates for that period;*

   USD: INR rates used for: CY24 – 83.70, CY23 – 82.60, CY22 – 78.60, FY25- 84.56, FY24 – 82.80, FY23 – 80.40, FY22 – 74.50

ii. Gross margin

Company	FY25	FY24	FY23
Allied Engineering Works Ltd.	44.78%	43.54%	31.33%
Genus Power Infrastructures Ltd.	43.00%	40.24%	35.78%
HPL Electric & Power Ltd.	35.03%	34.23%	33.31%
Secure Meters Ltd.	NA	58.18%	66.61%
Sinhal Udyog Pvt. Ltd. (Kimbal)	NA	28.08%	32.20%
Avon Meters Pvt. Ltd.	NA	24.94%	24.56%
Capital Power Systems Ltd.	NA	30.50%	35.29%
Bentec India Ltd.	NA	30.55%	26.24%
Landis+Gyr AG	29.62%	30.62%	28.26%

	CY24	CY23	CY22
Hubbell Inc.	33.83%	35.14%	29.74%
Badger Meter Inc.	39.83%	39.29%	38.89%
Itron Inc	34.39%	32.84%	29.08%

NA: Not Available;
Source: Financials reports published in MCA, Company annual reports, SEBI filings, Crisil Intelligence

Formula used:

Gross Margin: *Gross Profit divided by Revenue from Operations*
Gross Profit: Revenue from operations - Cost of Goods Sold
Cost of Goods Sold: Sum of Cost of materials consumed and Purchases of stock-in-trade and increase/ decrease in inventories.
Note: (Gross Profit calculation excludes direct wages and other direct costs, as a detailed breakdown is not available for all peers. If these costs were included in the formula, the resulting Gross Margin would be lower)

iii. EBITDA margin

Company	FY25	FY24	FY23
Allied Engineering Works Ltd.	28.87%	20.87%	7.27%
Genus Power Infrastructures Ltd.	19.23%	11.27%	9.73%
HPL Electric & Power Ltd.	14.98%	13.15%	12.43%
Secure Meters Ltd.	NA	12.62%	7.38%
Sinhal Udyog Pvt. Ltd. (Kimbal)	NA	1.90%	8.93%
Avon Meters Pvt. Ltd.	NA	5.92%	6.77%
Capital Power Systems Ltd.	NA	9.15%	8.31%
Bentec India Ltd.	NA	8.77%	7.34%
Landis+Gyr AG	3.55%	12.58%	7.92%
	CY24	CY23	CY22
Hubbell Inc.	22.94%	21.77%	17.28%
Badger Meter Inc.	24.04%	21.33%	20.15%
Itron Inc	14.59%	8.81%	3.22%

NA: Not Available
Source: Annual reports, Financials reports published in MCA, SEBI filings, Crisil Intelligence

Formula used:

EBITDA Margin: EBITDA divided by Revenue from Operations

EBITDA: Sum of Profit before tax, depreciation and finance cost - other income

iv. PAT margin

Company	FY25	FY24	FY23
Allied Engineering Works Ltd.	19.56%	13.61%	0.62%
Genus Power Infrastructures Ltd.	12.75%	7.22%	3.58%
HPL Electric & Power Ltd.	5.53%	2.99%	2.40%
Secure Meters Ltd.	NA	5.77%	(0.95%)
Sinhal Udyog Pvt. Ltd. (Kimbal)	NA	3.06%	5.18%

Company	FY25	FY24	FY23
Avon Meters Pvt. Ltd.	NA	3.04%	1.35%
Capital Power Systems Ltd.	NA	3.24%	2.67%
Bentec India Ltd.	NA	5.00%	3.55%
Landis+Gyr AG	(8.64%)	5.59%	12.32%
	CY24	**CY23**	**CY22**
Hubbell Inc.	13.92%	14.26%	10.44%
Badger Meter Inc.	15.12%	13.16%	11.76%
Itron Inc	9.88%	4.52%	(0.53%)

NA: Not available;
Source: Annual reports, Financials reports published in MCA, SEBI filings, Crisil Intelligence

Formula used:

Profit Margin: Profit after tax divided by Revenue from Operations

v. Return on capital employed (ROCE)

Company	FY25	FY24	FY23
Allied Engineering Works Ltd.	71.47%	69.90%	15.00%
Genus Power Infrastructures Ltd.	15.84%	8.69%	5.54%
HPL Electric & Power Ltd.	14.11%	10.94%	8.90%
Secure Meters Ltd.	NA	14.94%	3.21%
Sinhal Udyog Pvt. Ltd. (Kimbal)	NA	3.04%	5.11%
Avon Meters Pvt. Ltd.	NA	15.12%	9.83%
Capital Power Systems Ltd.	NA	11.37%	12.74%
Bentec India Ltd.	NA	19.56%	13.92%
Landis+Gyr AG	(0.54%)	9.83%	3.43%
	CY24	**CY23**	**CY22**
Hubbell Inc.	22.25%	20.28%	18.53%
Badger Meter Inc.	28.84%	24.45%	20.20%
Itron Inc	12.79%	8.82%	(0.63%)

NA: Not available

Source: Annual reports, Financials reports published in MCA, SEBI filings, Crisil Intelligence

Formula used:
Return on Capital Employed: EBIT divided by Capital Employed
EBIT: Sum of Profit before tax and Finance cost
Capital employed: Sum of total equity, current borrowings, non-current borrowings and net deferred tax liabilities/assets
Total equity: Sum of shareholder's equity and non-controlling interest, if any

vi. Return on equity (ROE)

Company	FY25	FY24	FY23
Allied Engineering Works Ltd.	65.69%	64.72%	3.94%
Genus Power Infrastructures Ltd.	16.67%	5.52%	2.96%
HPL Electric & Power Ltd.	10.25%	5.26%	3.80%

Secure Meters Ltd.	NA	12.10%	(1.50%)
Sinhal Udyog Pvt. Ltd. (Kimbal)	NA	16.87%	9.12%
Avon Meters Pvt. Ltd.	NA	11.14%	3.28%
Capital Power Systems Ltd.	NA	9.92%	7.67%
Bentec India Ltd.	NA	19.57%	11.87%
Landis+Gyr AG	(11.34%)	7.0%	13.6%
	CY24	**CY23**	**CY22**
Hubbell Inc.	23.87%	26.51%	21.80%
Badger Meter Inc.	20.61%	17.93%	15.03%
Itron Inc	17.08%	7.38%	(0.80%)

NA: Not available
Source: Annual reports, Financials reports published in MCA, SEBI filings, Crisil Intelligence

Formula used:

Return on Equity: Profit for the period/year divided by Total equity

Total equity: Sum of shareholder's equity and non-controlling interest, if any

7 Challenges and threats for the sector

Challenges

Reliance on imported component: India imports a significant portion of the key components and finished products related to smart meter technology from abroad. Reliance on imported components, especially semiconductors, may impact costs and supply chain reliability

Lack of skilled manpower: Challenges in attracting and retaining skilled personnel in design, software development and field installation, might disrupt business operations. There is a shortage of skilled personnel for AMI deployment, including smart meter installation, data analytics, IoT technologies, and cybersecurity.

Legacy issues: Legacy systems in Discoms often use outdated software and hardware. Integrating AMI with existing billing and grid management systems can be complex and expensive. For seamless transition, these integration challenges need to be overcome.

Communication challenges: There are pockets with low signal strengths or limited internet coverage. Also, to handle data from large number of meters need excellent communication networks which can manage high data volumes,

Threats

Regulatory environment: Any adverse shift in government policies or changes in energy regulations, can significantly impact investment decisions and complicate the deployment of smart metering technologies.

Competition: The smart metering sector is highly competitive, with numerous players vying for market share. Established competitors along with capable new entrants can pose challenges. Intense competition from both well-established companies and new market entrants creates a highly competitive environment

Cost of raw materials: Many of the key components and finished products related to smart meter are imported. If costs for raw materials like semiconductors and other essential raw materials go up materially, overall project budgets might get impacted.

Threats from cyber-attacks: Since Smart meters collect and transmit large amounts of energy consumption data, there are concerns that the data may be leaked, and security may be compromised. Robust data security measures are crucial for consumer trust and acceptance. AMI systems are vulnerable to cyberattacks, which could compromise data privacy and disrupt grid operations. This can impact the progress of installation of smart meters.

Lack of willingness: There has been resistance from the consumers for installation of smart meters. Therefore, some DISCOMs resist adopting smart metering due to concerns about disruptions to their established processes. Consumers may not be aware of the benefits of AMI or may be hesitant to adopt the technology due to privacy concerns. Increasing consumer awareness and acceptance of smart meters are critical for successful market penetration.

Key performance indicators of listed proxies

Table 25: Financial parameters of domestic listed companies with similar offerings

Parameters (Rs. Mn, unless noted otherwise)	AEW			Genus			HPL Electric		
	FY25	FY24	FY23	FY25	FY24	FY23	FY25	FY24	FY23
No. of smart meters sold during the year (million)	2.04	0.76	0.12	NA	NA	NA	NA	NA	NA
Outstanding order book value for metering	18,535.98	19,684.77	1,038.36	301,100.00	210,060.00	41,150.00	34,650.00	17,600.00	12,742.80
Revenue from operations	7,171.11	3,484.82	1,629.90	24,420.13	12,005.83	8,083.86	17,002.44	14,608.58	12,622.09
Y-o-Y growth in revenue from operations	105.78%	113.81%	33.11%	103.40%	48.52%	18.00%	16.39%	15.74%	24.48%
Gross Margin	44.78%	43.54%	31.33%	43.00%	40.24%	35.78%	35.03%	34.23%	33.31%
EBITDA	2,070.09	727.28	118.57	4,696.81	1,352.89	786.50	2,546.52	1,921.53	1,568.68
EBITDA Margin	28.87%	20.87%	7.27%	19.23%	11.27%	9.73%	14.98%	13.15%	12.43%
Profit/loss for the year	1,402.60	474.12	10.17	3113.82	866.65	289.74	939.87	436.25	302.49
PAT Margin	19.56%	13.61%	0.62%	12.75%	7.22%	3.58%	5.53%	2.99%	2.40%
ROCE (%)	71.47%	69.90%	15.00%	15.84%	8.69%	5.54%	14.11%	10.94%	8.90%
ROE (%)	65.69%	64.72%	3.94%	16.67%	5.52%	2.96%	10.25%	5.26%	3.80%
Net Working Capital days	126	85	107	279	319	386	214	236	249

NA: Not Available

Source: Company websites, Annual reports, Crisil Intelligence

Formulae used:

Gross Margin: *Gross Profit divided by Revenue from Operations*

Gross Profit: Revenue from operations - Cost of Goods Sold (Gross Profit calculation excludes direct wages and other direct costs, as a detailed breakdown is not available for all peers. If these costs were included in the formula, the resulting Gross Margin would be lower)

Cost of Goods Sold: Sum of Cost of materials consumed and Purchases of stock-in-trade and increase/ decrease in inventories

EBITDA: Sum of Profit before tax, depreciation and finance cost - other income

EBITDA Margin: EBITDA divided by Revenue from Operations

Profit Margin: Profit after tax divided by Revenue from Operations

Return on Capital Employed: EBIT divided by Capital Employed; EBIT: Sum of Profit before tax and Finance cost

Capital employed: Sum of total equity, current borrowings, non-current borrowings, net of deferred tax liabilities/assets

Return on Equity: Profit for the period/year divided by Total equity

Total equity: Sum of shareholder's equity and non-controlling interest, if any

Net Working Capital: (Current assets-cash and cash equivalents incl. other bank balances)-(Current liabilities-current borrowings)

Net Working Capital Days: Net Working Capital divided by revenue from operations x No. of days during the period/year

Executive summary

India's power sector has made significant progress in terms of installed capacity (475 GW as of March 2025) and renewable energy penetration (~46% of installed capacity), but still faces challenges in the distribution sector, including high losses and debt. To address these issues, the government has launched initiatives such as the Revamped Distribution Sector Scheme (RDSS) to improve the financial health of Discoms and reduce AT&C losses.

Smart metering is a critical component of the RDSS, with the goal of reducing AT&C losses to 12-15% at pan-India levels by improving billing and collection efficiency. Smart Meter penetration in India lags behind the global average of ~43%. As of March 2025, 227.86 million smart energy meters have been sanctioned (including consumer DT and feeder meters), with 142.75 million awarded and about 27 million installed, representing 11.9% of the total sanctioned smart energy meters. The smart consumer meter segment dominates the sanctioned meter, accounting for 97.6% of the total, while DT and Feeder smart meters make up the remaining portion.

As per CEA's draft Distribution perspective plan 2030, the total no. of consumers is expected to reach 520 million by 2030 from the 342 million as of March 2024. Moreover, as per Electricity (Rights of Consumers), 2020 all new connections are mandated to be equipped with a smart prepayment meter. This presents a significant potential for AMI, as smart metering plays a key role in enhancing power sector efficiency. As a result, the smart energy meter market in India is projected to attain a market size of Rs. 1180-1200 billion over fiscal 2026-2030, at a CAGR of 31-32%.

In addition to smart energy meters, India is also adopting smart gas and water meters, driven by government initiatives and increasing demand for efficient resource management. The Indian smart gas meter market is projected to reach Rs. 550-600 billion over fiscal 2026-2030, while the smart water meter market is expected to reach Rs. 12-13 billion during the same period.

Smart meters will revolutionize consumer metering by providing real-time data, remote monitoring and two-way communication capabilities. This empowers consumers to actively participate in demand-side management and make informed decisions about their energy consumption. Smart Meters with communication features are important interventions in reducing distribution losses in the Utilities and in facilitating automatic measurement of energy flows and energy accounting as well as auditing without any human intervention. This intervention will also facilitate switch-over to digital pre-paid system, with recharging facility through mobile phones and enabling of Time-of-Day tariff. The direct impact of this feature will be on reducing the ACS-ARR gap and AT&C losses of the Discoms.

The growth of the smart meter market presents significant opportunities for companies like AEW, which offers a range of products and services, including smart meters, IoT & automation solutions, and software solutions for smart metering. AEW has already supplied 2.92 million smart energy meters across 6 states as of March 2025 and has 3 manufacturing facilities in Delhi with a total manufacturing capacity of 7.29 million meters per annum.

About Crisil Intelligence (formerly Market Intelligence & Analytics)

Crisil Intelligence is a leading provider of research, consulting, risk solutions and advanced data analytics, serving clients across government, private and public enterprises. We leverage our expertise in data-driven insights and strong benchmarking capabilities to help clients navigate complex external ecosystems, identify opportunities and mitigate risks. By combining cutting-edge analytics, machine learning and AI capabilities with deep industry knowledge, we empower our clients to make informed decisions, drive business growth and build resilient capacities.

For more information, visit Intelligence.Crisil.com

About Crisil

Crisil is a global, insights-driven analytics company. Our extraordinary domain expertise and analytical rigour help clients make mission-critical decisions with confidence.

Large and highly respected firms partner with us for the most reliable opinions on risk in India, and for uncovering powerful insights and turning risks into opportunities globally. We are integral to multiplying their opportunities and success.

Headquartered in India, Crisil is majority owned by S&P Global.

Founded in 1987 as India's first credit rating agency, our expertise today extends across businesses: Crisil Ratings, Crisil Intelligence, Crisil Coalition Greenwich and Crisil Integral IQ.

Our globally diverse workforce operates in the Americas, Asia-Pacific, Europe, Australia and the Middle East, setting the standards by which industries are measured.

For more information, visit www.Crisil.com

Connect with us: LinkedIn | Twitter

Disclaimer

Crisil Intelligence, a division of Crisil Limited (Crisil) has taken due care and caution in preparing this report (Report) based on the Information obtained by Crisil from sources which it considers reliable (Data). However, Crisil does not guarantee the accuracy, adequacy or completeness of the Data / Report and is not responsible for any errors or omissions or for the results obtained from the use of Data / Report. This Report is not a recommendation to invest / disinvest in any entity covered in the Report and no part of this Report should be construed as an expert advice or investment advice or any form of investment banking within the meaning of any law or regulation. Crisil especially states that it has no liability whatsoever to the subscribers / users / transmitters/ distributors of this Report. Without limiting the generality of the foregoing, nothing in the Report is to be construed as Crisil providing or intending to provide any services in jurisdictions where Crisil does not have the necessary permission and/or registration to carry out its business activities in this regard. The Client will be responsible for ensuring compliances and consequences of non-compliances for use of the Report or part thereof outside India. Crisil Intelligence operates independently of, and does not have access to information obtained by Crisil Ratings Limited, which may, in their regular operations, obtain information of a confidential nature. The views expressed in this Report are that of Crisil Intelligence and not of Crisil Ratings Limited. No part of this Report may be published/reproduced in any form without Crisil's prior written approval."