

Industry Report on EV Chargers, Telecom Power, Telecom & Data Centre Energy Storage Systems

Exicom Tele-Systems Limited

Sep 2023

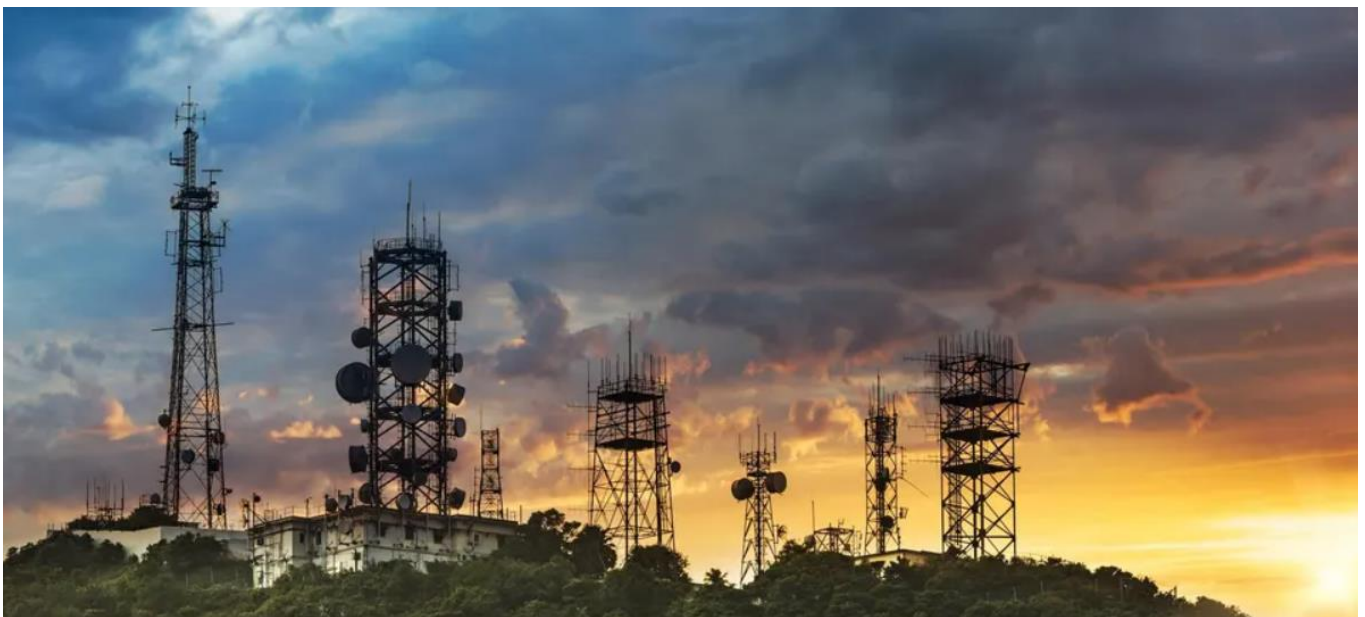


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1. Macro-Economic Scenario – Global and India

1.1 Global economic scenario

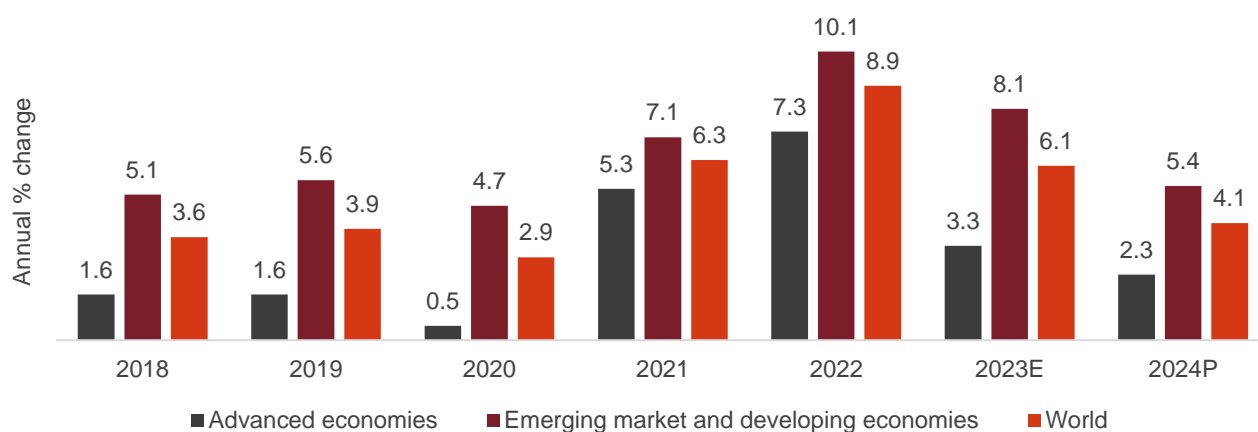
Review and outlook of economic growth and inflation in key countries

The global economy is highly volatile with the cumulative effect of the past three years of adverse shocks of COVID19 pandemic, Russia invasion of Ukraine in early 2022 (“All expressions in the context of ‘year’ should be read as ‘CY’ or ‘Calendar Year’, unless specifically mentioned otherwise”) and the consequent rise in energy and commodity prices. This has forced the major central banks around the world to tighten the economic policies and keep the inflation expectations anchored. After initial outage, some improvement was noted in the global economic indicators in the second half of 2022 and by early 2023, the world economy began showing signs of stabilising. However, increasing commodity prices, geoeconomics fragmentation with Russia’s war in Ukraine and China’s reopening of economic activity seems to be continued into 2023. The global economic growth outlook remains subdued in the medium term due to elevated interest rates, widespread recession, and augmented geopolitical uncertainties.

Global inflation and growth trajectory

Global inflation has been declining since second half of 2022. A fall in the fuel and energy commodity prices particularly for the United States, Euro area and Latin America, has contributed majorly to this decline. To dampen the demand and reduce core inflation, the major central banks around the world have been raising interest rates since 2021 at a faster clip. Monetary policy tightening particularly by major economies has led to sharp increase in borrowings costs, raising concerns about the sustainability of some economies’ debts. As per International Monetary Fund (IMF) the global growth projection in the first half of 2023 has been improved due to more resilient than expected consumer spending in developed economies, recovery in China and a sequel growth momentum in India.

Figure 1: Trend in inflation based on the Consumer Price Index



E: Estimated; P: Projected

Advanced economies – US, Japan, euro area; Emerging market and developing economies – China, India, Russia, Brazil, Mexico, and South Africa

Source: IMF (World Economic Outlook – April 2023 update), CRISIL MI&A

Economic activity in Europe in 2022 was more resilient than expected given the large negative terms of trade fallout from the war and associated economic sanctions. The stinging hike in prices galvanized a reorientation of gas flows, with marked increases in non-Russian pipeline and liquefied natural gas deliveries to Europe, alongside contraction of demand due to mild winter and adjustment by industries to substitute gas and to change production process where feasible. The oil and gas prices began trending downward from their peaks in mid-2022, these actions and channels have diminished the negative effect of the energy crisis in Europe, with better-than-expected levels of consumption and investment in the third quarter of 2022. Decline in food energy prices in the fourth quarter of 2022 (although prices are still high at previous levels) has brought some relief to customer and commodity importers, contributing to a fall in headline inflation. Sustaining lower prices in 2023 will depend on the absence of further negative supply shocks.

In China, COVID19 restrictions were ultimately lifted, multiple large outbreaks led to declines in mobility and economic activity in the fourth quarter of 2022 due to the disease's direct effects on human health and heightened fears of contagion. Supply disruptions also returned to the fore, even if temporarily, leading to a rise in supplier delivery times. The Chinese authorities have responded with a variety of measures, including additional monetary easing, tax relief for firms, new vaccination targets for the elderly, and measures to encourage the completion and delivery of unfinished real estate projects. As COVID19 waves subsided in January 2023, mobility normalized, and high-frequency economic indicators such as retail sales and travel bookings started picking up. With China absorbing about a quarter of exports from Asia and between 5 and 10 percent from other geographic regions, the reopening and growth of its economy will likely generate positive spill overs, with even greater spill overs for countries with stronger trade links and reliance on Chinese tourism.

A return of the world economy to the pace of economic growth that prevailed before the bundle of shocks in 2022 and the recent financial sector turmoil is looking increasingly elusive. More than a year after Russia's invasion of Ukraine and the outbreak of more contagious COVID19 variants, many economies are still absorbing the shocks. The recent tightening in global financial conditions is also hampering the recovery. As a result, many economies are likely to experience slower growth in incomes in 2023, amid rising joblessness. Moreover, even with central banks having driven up interest rates to reduce inflation, the road back to price stability could be long. Over the medium term, the prospects for growth now seem dimmer than in decades.

Fuel and nonfuel commodity prices are expected to decline in 2023, amidst slowing global demand. Crude oil prices are projected to fall by about 24 percent in 2023 and a further 5.8 percent in 2024, while nonfuel commodity prices are expected to remain broadly unchanged. The financial stability risk has increased rapidly since October 2022, the global interest rates stay elevated for longer than expected. The central banks remain focused on returning inflation to targets while deploying tools to maintain financial stability as needed. Governments are on average expected to gradually withdraw fiscal policy support, including, as commodity

prices decline, by scaling back packages designed to shield households and firms from the effects of the fuel and energy price spikes in 2022.

Here's how major economies are tied up:

US inflation softens:

The US economy grew an annualised 1.3% on-quarter in the first quarter of 2023 (revised up from 1.1% in the first estimates), according to the second estimates released by the Bureau of Economic Analysis. The slowdown in on quarter GDP growth was driven by a decline in private inventory investment.

The US job market remained resilient, adding 339,000 non-farm payroll jobs in May 2023, compared with a revised 294,000 jobs in April. On the other hand, the unemployment rate increased to 3.7% from 3.4%.

Inflation in the US moderated to 4% in May 2023 - the lowest rate since May 2021 from 4.9% driven by an on-year decline in energy prices (-11.7%). Core inflation, which excludes food and fuel, softened to 5.3% from 5.5% in April 2023, while food inflation moderated to 6.7% from 7.7%.

The US Fed kept its policy rate unchanged at 5-5.25% at its June 2023 meeting for the first time since March 2022. The Fed funds rate has increased by 500 bps in the current interest-rate cycle. It revised its projection for the median Fed funds rate in 2023 to 5.6% from 5.1%, indicating that it may hike interest rates further in 2023.

European Central Bank (ECB) hikes interest rate:

Persistently high inflation and ongoing geopolitical uncertainties resulted moderate growth in 2023. Among the major European economies, the performance was mixed. The German economy shrank 0.3% whereas the economy of France grew 0.2% in the first quarter of 2023.

The S&P Global's HCOB manufacturing purchasing managers' index (PMI) for the euro area moderated to a 36-month low in May 2023. The manufacturing PMI fell to 44.8 in May from 45.8 in April. A PMI under 50 indicates that the manufacturing activity contracted in May. The HCOB services PMI also moderated in May to 55.1 in May from 56.2 in April, but remained well above the neutral level of 50, suggesting a robust expansion in services activity. However, the pace of expansion was softer compared with April.

Inflation in the eurozone is expected to moderate to 6.1% from 7.0% in 2022, according to a flash estimate released by Eurostat. The softening in inflation is led by a 1.7% on-year fall in energy prices. Food inflation is expected to remain high at 12.5% compared with 13.5% in April 2023. Core inflation (inflation excluding energy, food, alcohol and tobacco) is also expected to soften to 5.3% from 5.6%.

As inflation remains well above its target, the European Central Bank (ECB) hiked interest rates by 25 bps at their June 2023 meeting, taking the deposit facility rate to 3.5%.

UK economy grows on-month:

The UK economy grew 0.2% on-month in April 2023 after a 0.3% contraction in March, driven by the services sector (0.3% vs -0.5%). While the output in consumer-facing services expanded 1.0% in April, it remains below the pre-pandemic levels. Alternatively, the construction sector contracted 0.6%.

Inflation in the UK softened to 8.7% on-year in April 2023 from 10.1% in March, led by a slowdown in energy inflation. Food inflation moderated marginally to 19% from 19.1%. Worryingly, core inflation quickened to 6.8% in April - the highest rate since 1992 - from 6.2% in March. Services inflation is driving the uptick in core inflation, while goods inflation is moderating.

The UK trade deficit contracted for the second consecutive month to £1.52 billion in April 2023 from £2.86 in March. Imports fell 0.6%, whereas exports grew 1.3%, leading to a narrower trade deficit.

Japanese economy expands:

Japan's GDP grew an annualised 2.7% in the first quarter of 2023 (revised up from previous estimate of 1.6%), compared with 0.4% in the fourth quarter of 2022, as pandemic-related restrictions were lifted. The au Jibun Bank Japan Manufacturing PMI stood at 50.6 in May, compared with 49.5 in April, driven by improving output. This is the first time in seven months that manufacturing activity has expanded in Japan. Services activity also expanded in May. The au Jibun Bank Services PMI climbed to 55.9 in May from 55.4 in April.

Manufacturing activity expanded in Japan:

Inflation picked up in Japan to 3.5% in April 2023 from 3.2% in March, led by food inflation. Inflation had moderated to a six-month low in March. Food inflation accelerated to 8.4% from 7.8%, the highest rate since 1976. Core inflation picked up to 3.4% from 3.1%. Prices of electricity fell -9.3% on-year in April. Despite high inflation, the Bank of Japan has maintained its negative borrowing rate.

Japan's trade deficit of Japan narrowed significantly to ¥1,372.5 billion in May 2023 from ¥2,366.1 billion in May 2022, as imports declined 9.9% while exports increased marginally by 0.6%.

Manufacturing activity contracts in China:

Manufacturing activity in China contracted for the second straight month in May 2023. The National Bureau of Statistics (NBS) Manufacturing PMI fell to 48.8 in May 2023, compared with 49.2 in April. Output contracted for the first time since January (49.6), while exports contracted sharply (47.2) as global demand cools. Meanwhile, non-manufacturing activity expanded for the fourth consecutive month, although the pace of expansion was softer than the previous month. The NBS non-manufacturing PMI dropped to 56.4 in April 2023 from 58.2 in March.

Inflation in China inched up marginally to 0.2% in May from 0.1% in April, driven by a pick-up in food inflation. Food inflation accelerated to 1.0% from 0.4%, as inflation in fruits and cooking oils hardened. Core inflation

softened marginally to 0.6% from 0.7%. In response to low inflation and uneven recovery, the People's Bank of China cut its medium-term lending facility rate to 2.65% from 2.75% in June.

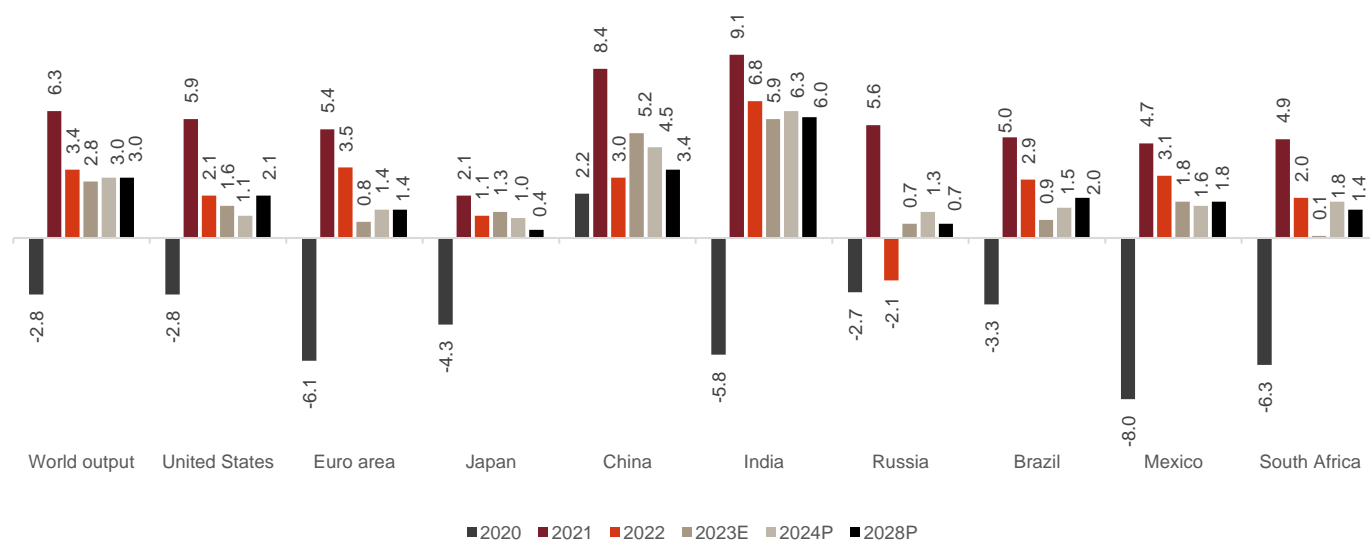
China's trade surplus narrowed to \$65.8 billion in May 2023, from \$78.4 in May 2022. While both imports and exports fell amid softening domestic and global demand, the fall in exports was sharper.

As per the International Monetary fund (IMF), the global economy was projected at 3.4% in 2022 and 2.8% in 2023. The forecast for 2023 is changed from 0.1% lower than predicted in the January 2023 outlook. This forecast for the coming years is well below what was expected before the onset of the adverse shocks since early 2022.

For advanced economies, the growth was projected at 2.7% in 2022 and 1.3% in 2023. About 90 percent of advanced economies are projected to see a decline in growth in 2023. With a sharp slowdown, advanced economies are expected to see higher unemployment. For emerging and developed economies, economic prospects are on average stronger than for advanced economies, but these prospects vary more widely across regions. On average, growth is expected to be in 3.9 percent in 2023 and to rise to 4.2 percent in 2024. In low income developing countries, GDP is expected to grow by 5.1 percent, on average, over 2023-24.

India is expected to remain a growth outperformer over the medium run. CRISIL MI&A expect India's GDP growth to average 6.1% between fiscal 2025 and 2027, compared with 3.1% globally as estimated by IMF. India would also outpace emerging market peers such as China (4.2% growth estimated from 2024-26), Indonesia (5.0%), Turkey (3.2%) and Brazil (1.8%).

Figure 2: IMF GDP projection for key economies



*Euro area includes 19 countries of the European Union

Source: IMF (World Economic Outlook – April 2023 update), CRISIL MI&A

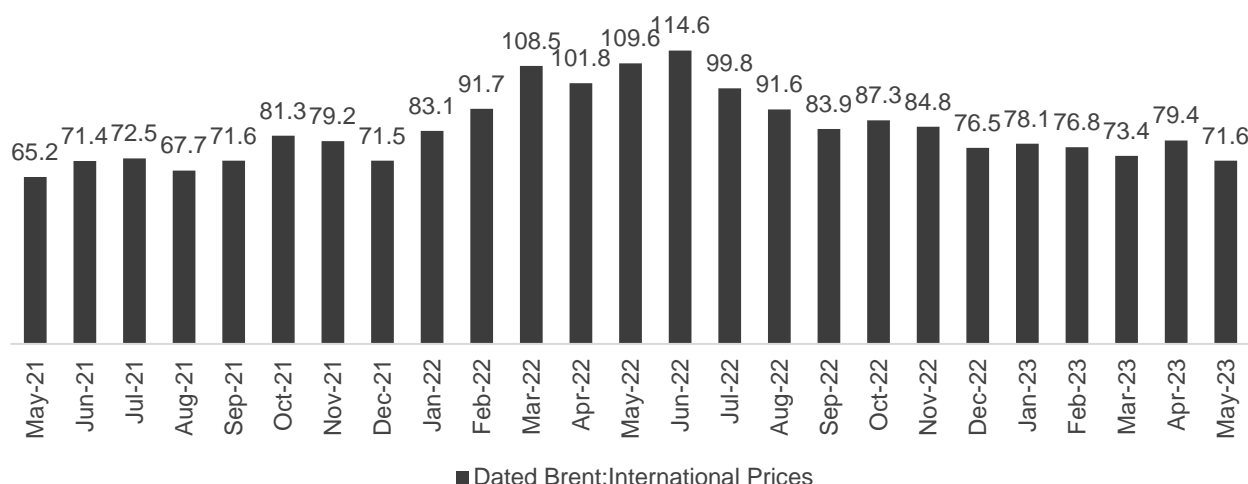
Brent crude falls

Crude oil prices decreased in the first half of 2023 primarily due to sustained prevalence of high inflation coupled with slowdown in demand, which have significantly impacted the prices. A strong dollar along with sharp production cuts resulted in supply pressure pushing crude oil prices downward.

However, the prices remained elevated during 2022 due to demand-supply tightness. Geopolitical tensions between Russia and Ukraine had major impact on energy prices, this along with production outages in Libya and Norway has further put pressure on prices.

The prices averaged \$98-103 per barrel in 2022 compared to \$70.4 per barrel in 2021, which was an increase of 39-46% on year. However, increasing recessionary fears stemming from inflation coupled with interest rate hikes globally have led to significant shadow over consumption and economic growth, pushing prices downward. CRISIL MI&A expects price to remain stabilize in the \$80-85 per barrel range in 2023, in line with decline in prices globally owing to slowdown in oil demand.

Figure 3: Brent crude price trend (USD per barrel)



Note: Dated Brent price is the price of physically delivered crude oil in the North Sea that has specific delivery date

Source: Industry, CRISIL MI&A

Global trade environment

The pace of global trade growth is estimated to taper from 5.1% in 2022 to 2.4% in 2023 owing to slowdown in global demand after two years of accelerated growth from the pandemic recession and shift in the composition of spending from traded goods back towards domestic services.

Rising trade barrier and the linger effects of US dollar appreciation in 2022, made traded product more expensive for several economy. And considering the dollar's dominant role in trading, this will add further pressure on trade growth in 2023.

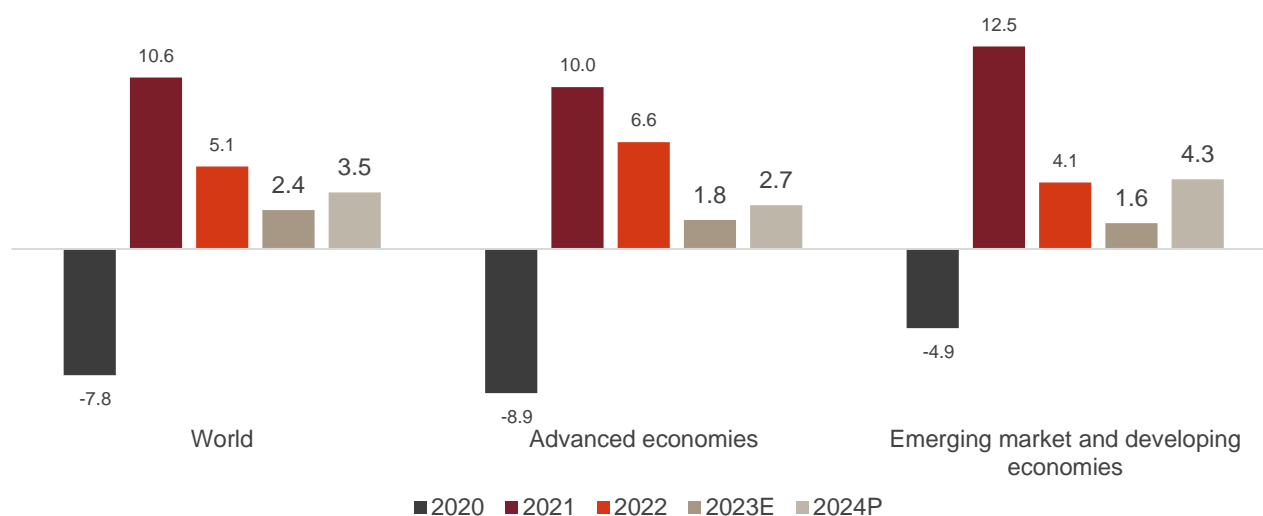
Amid delay in China's recoveries (post COVID19) with substantial share of economies export absorbed by China, a weaker than expected recovery in China would have further significant cross border effects, especially for commodity exporter and tourism dependent economies. The ongoing weakness will have adverse impact on Chinese real estate market which can potentially lead to financial instability.

An escalation of Russia's war in Ukraine now in the second year could prompt renewed energy crisis in Europe and amplify food security in low-income countries. For the winter 2022-23, gas prices were averted, with ample storage at European facilities with higher liquified natural gas imports, lower gas demand amid high prices. A possible increase in food prices from the failed extension of the Black Sea Grain initiative will add further pressure on food importing countries.

Further geoeconomics fragmentation risks not only lowered cross border flows of labour, goods and capital but also reduced international activity on vital global public goods such as climate change mitigation and pandemic resilience. Some countries may benefit from an associated arrangement in global production, but the overall impact on economic wellbeing is expected to be negative with costs particularly high in short term as replacement of disrupted flow will take time.

The Global economy is expected to be resilient in 2023 with tight labour markets in several economies and improved household consumption. Although this would be a challenge against high inflation, lower demand for import and lower commodity prices owing to weakening of activity in most of economies.

Figure 4: IMF estimates of world trade growth (%)



Advanced economies – US, Japan, euro area; Emerging market and developing economies – China, India, Russia, Brazil, Mexico, South Africa

Note: Volumes of exports of goods and services have been considered for the calculations

Source: IMF (World Economic Outlook – April 2023 update), CRISIL MI&A

1.2 Indian economic scenario

Review of real GDP growth over fiscals 2018-2023 and outlook for fiscals 2023-2028

The Indian economy logged 4.1% CAGR over fiscals 2018-2023. This was a sharp deceleration from a robust 6.6% CAGR between fiscals 2017 and 2019, which was driven by rising consumer aspiration, rapid urbanisation, the government's focus on infrastructure investment, and growth of the domestic manufacturing sector. Economic growth was supported by benign crude oil prices, soft interest rates and low current account deficit. The Indian government also undertook key reforms and initiatives, such as implementation of the Goods and Services Tax (GST) and Insolvency and Bankruptcy Code; Make in India and financial inclusion initiatives; and gradual opening of sectors such as retail, e-commerce, defence, railways, and insurance for foreign direct investments (FDIs).

A large part of the lower print between fiscals 2018 and 2023 was because of the economy contracting 5.8% in fiscal 2021 owing to the fallout of Covid-19. Impact of Covid-19 was more pronounced on contact sensitive services as social distancing norms affected services such as entertainment, travel, and tourism, with many industries in the manufacturing sector also facing issues with shortage of raw materials/components as lockdown in various parts of the world upended supply chains.

Over the period, India's economic growth was led by services, followed by the industrial sector. In parts, though, growth was impacted by demonetisation, non-banking financial company (NBFC) crisis, slower global economic growth, and Covid-19.

As lockdowns were gradually lifted, economic activity revived in the second half of fiscal 2021. After a steep contraction in the first half, owing to rising number of Covid-19 cases, GDP moved into positive territory towards the end of fiscal 2021. Subsequently, in fiscal 2022, India's real GDP grew 9.0% from the low base of fiscal 2021.

However, according to the National Statistical Office estimates released on May 31, 2023, GDP growth rose sharply to 6.1% on-year in the fourth quarter (January-March) of fiscal 2023. During the third quarter of the fiscal 2023, GDP had declined to 4.5%. The growth surpassed the number factored in the National Statistics Office's (NSO) second advance estimate of February 2023. Annual growth for fiscal 2023 was revised up to 7.2% (provisional estimate) from 7.0% in the second advance estimate.

GDP grew in the fourth quarter primarily driven by investment and net exports and less of a drag given rising exports and slowing imports. Fixed investment turned in the strongest growth on the demand side while private consumption growth was more subdued on-quarter. Manufacturing and agriculture growth improved on-quarter on the supply side even as services growth remained strong, albeit slowing a tad relative to the previous quarter.

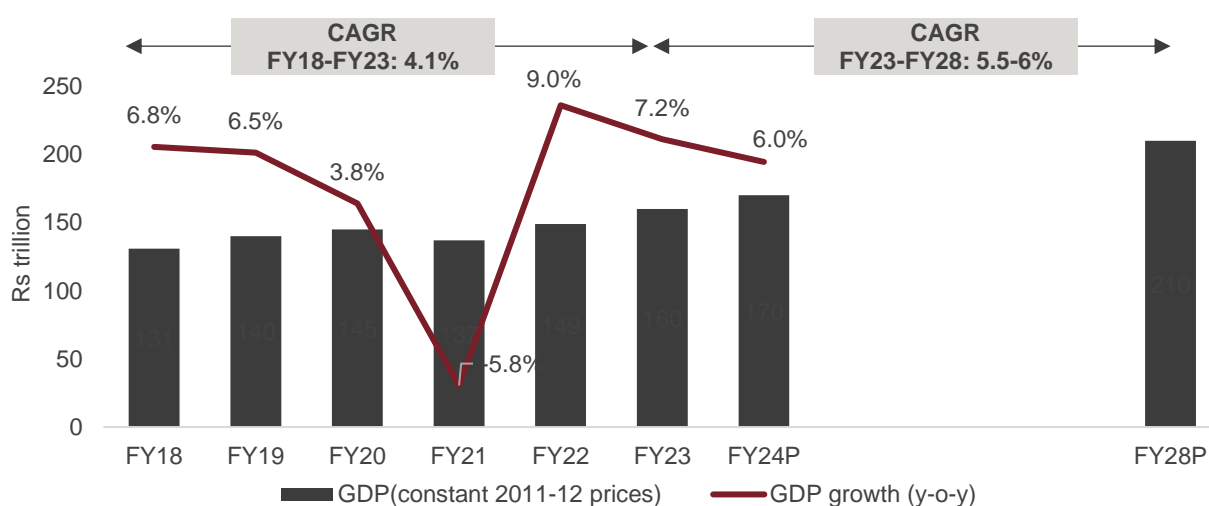
The provisional estimate of 7.2% comes on top of 9.1% expansion in fiscal 2022. This suggests strong growth momentum, which was propelled by domestic demand through the year, both from investment and private consumption. Investment's share rose to an 11-year high of 34% of GDP, while that of private consumption rose to an 18-year high of 58.5% in fiscal 2023.

However, nominal GDP growth tapered to 10.4% on-year in the fourth quarter compared with 11.4% in the third. This was primarily due to the price-effect since the GDP deflator slowed to 4.1% from 6.6%. The deflator is significantly influenced by inflation based on wholesale price index (WPI), which halved to 3.3% from 6.6%. The gap between nominal and real growth is likely to reduce further, with inflation expected to fall this fiscal.

Growth momentum was strong in Fiscal 2023, the current fiscal 2024 will feel the lagged impact of rate hikes of central banks over the past 15 months. External demand is likely to be a bigger hindrance to growth with western advanced economies staring at a sharp slowdown in the coming quarters, whipping up a headwind for exports. While domestic demand will also weaken, hit by rising lending rates, softening inflation and government capex will offer support. Monsoon and El Nino risks remain a swing factor.

Owing to these factors, CRISIL MI&A estimates GDP growth to slow to 6.0% in this fiscal 2024 from 7.2% in the fiscal 2023 with risk to downside.

Figure 5: India's GDP growth trend and outlook



P: Projected; E: Estimated, fiscal 23 – Second advance estimate

Source: National Statistical Office (NSO), CRISIL MI&A estimates

On supply side gross value added (GVA) grew 6.5% in the fourth quarter of 2023 compared with 4.7% in the previous quarter. Agriculture and allied activities surged to 5.5% from 4.7%, the result of a robust rabi output despite unseasonal rains towards the year-end. Manufacturing growth rose sharply after two quarters of decline (4.5% in the fourth versus -1.4% in the third). Resilient domestic demand, easing commodity prices and supply constraints supported production.

All demand segments witnessed growth in the fourth quarter, with support from private consumption, government consumption, fixed investment, and net export. The fourth-quarter growth was primarily driven by a rise in exports and a slowdown in imports to 4.9% from 19.7%. Hence, net exports contributed positively to the GDP growth.

Amongst the demand drivers, Investment recorded the strongest growth, 8.9% vs 8.0% in the third quarter. The increasing investment growth also indicates a gradual pickup in private capex. The private consumption expenditure improved during the quarter. High inflation may have pressure on household consumption, with consumer price index-based inflation remaining elevated at 6.4% in the quarter. However, for fiscal 2023, private consumption growth was a strong 7.5% on top of 11.2% growth attained in fiscal 2022 with pent up demand especially contact -intensive services.

The exports of goods and services also saw robust growth of 11.9% in the quarter versus 11.1% in the previous quarter. Growth in government consumption expenditure slowed sharply to 0.1% from 6.6% as the pandemic spending subsided.

Within the industry basket, growth improved for construction (10.4% vs 8.3%), reflecting a pickup in capital expenditure, particularly by states. There was a modest improvement in mining (4.3% vs 4.1%), while growth slowed for utilities¹ (6.9% vs 8.2%). Overall, industrial GVA grew 6.3% versus 2.3% in the third quarter of 2023. Services maintained the momentum, growing 6.9% versus 6.1%. Growth remained strong for trade, hotels, transport, and communication services (THTC), but slowed a tad to 9.1% in the fourth quarter 2023 from 9.6% in the third. It rose sharply for financial, real estate and professional services (7.1% vs 5.7%), and moved up for public administration and other services (3.1% vs 2.0%) .For fiscal 2023, growth was strongest for THTC services (14% in fiscal 2023 vs 13.8% previous year), followed by construction (10% vs 14.8%), utilities (9% vs 9.9%), public administration and other services (7.2% vs 9.7%), financial, real estate and professional services (7.1% vs 4.7%), agriculture (4% vs 3.5%), and manufacturing (1.3% vs 11.1%) .The solid THTC growth reflected the pending catchup to pre-pandemic levels, while manufacturing was hit by surging commodity prices and supply constraints post the Russia-Ukraine conflict. Manufacturing remained much above its pre-pandemic level relative to THTC.

On demand side segments, the strongest growth was in exports of goods and services (11.9% in the fourth quarter versus 11.1% in the previous quarter). While slowing global trade impacted goods exports, services exports remained strong. Meanwhile, imports slowed sharply to 4.9% from 10.7%. This meant net exports contributed positively to GDP growth in the fourth quarter. Among domestic demand drivers, the strongest growth was in investment (8.9% vs 8.0%). Government capital expenditure remained strong, with states raising capex towards fiscal end. The increasing investment growth also indicates a gradual pickup in private capex. While private consumption expenditure improved, it was more subdued than investment (2.8% vs 2.2%). High inflation may have weighed on household consumption, with consumer price index-linked inflation remaining elevated at 6.4% in the fourth quarter; staying put as against the previous quarter.

However, for fiscal 2023, private consumption growth was strong at 7.5%, on top of 11.2% in fiscal 2022. Investment was vigorous at 11.4% compared with 14.6%. Imports increased more sharply than exports in the

full year, at 17.1% and 13.6%, respectively, illustrating that net exports were a drag on GDP growth. Government consumption spending had slowed sharply to 0.1% from 6.6%, as pandemic spends ebbed.

Table 1: Domestic macroeconomic outlook for fiscal 2024

Macro variables	fiscal 22	fiscal 23	fiscal 24E	Rationale for outlook
GDP (% on-year)	8.7%	7.2%	6.0%	<p>India's real gross domestic product (GDP) growth forecast to 6.0% for fiscal 2024 from 7.2% estimated previously. This is primarily because slowdown in global growth has started to impact India's exports and industrial activity.</p> <p>The domestic demand will also come under pressure owing to hike in interest rates, softening inflation and government capex will offer support in this fiscal. Monsoon and El Niño risks remain a swing factor.</p> <p>Interest rates are higher than their pre-pandemic five-year average (fiscal 2016-2020) this would moderate domestic demand, specifically in interest-sensitive segments such as automobile and housing.</p> <p>Consequently, CRISIL projected GDP growth to slow to 6.0% in fiscal 2024 and 6.2% in fiscal 2025. The risks to the forecast remain tilted downwards.</p>
CPI-linked inflation (% on-year)	5.5%	6.7%	5.0%	<p>Decline in crude oil prices along with the export of other top commodities mainly due to slowdown in global growth. lowered the commodity prices in fiscal 2024, eased inflation during the year.</p> <p>CPI inflation moderated further in the past few months of this fiscal year. The downward growth trajectory is mainly due to the strong base effect that will fade out the headline inflation. Another reason, a fall in global oil and commodity prices, easing supply pressures leading to better availability of inputs and therefore reduced the pressure on prices. Easier food inflation as rabi crop outlook were positive.</p> <p>CRISIL Project CPI inflation remained 5% this fiscal from 6.7% in the last fiscal. Supportive monsoon is key assumption underlying these forecasts. Slowdown in growth and moderated inflation may further cut rates by end of this fiscal.</p>

Macro variables	fiscal 22	fiscal 23	fiscal 24E	Rationale for outlook
10-year government security yield (% , March-end)	6.8%	7.4%	7.0%	<p>Yields on 10-year G-secs yield has trended downward after the monetary policy committee unexpectedly halted the rate hike cycle in its April 2023 review. It continued to decline in May after the inflation print fell further on the back of fall in crude oil prices and rise in FPI debt purchases supported lower yields. Both global and domestic factors contributed towards softening of bond yield.</p> <p>Domestically, yield has fallen almost 50-bps lowest since August 2017 and well below the pre-pandemic five-year average of 95bps.</p> <p>10-year G-sec to averaged 7.4% in March 2023, compared with 6.8% in March 2022.</p> <p>G-sec yields are expected to remain low till end of this fiscal on the back of moderating inflation, lower crude oil prices and as the RBI takes a pause in its rate hike cycle, yield are expected to come down to 7% by March 2024</p>
CAD/GDP (%)	-1.2	-2.5	-2.0	<p>India's exports are expected to face headwinds from the anticipated slowdown in global growth. Several key economies such as US and Euro area both are key export market for India reeling under pressure. Further, deceleration in domestic growth could lead to some softening in imports.</p> <p>However, India's robust growth and falling inflation, and easing trade deficit helped attract foreign investors. A sharp fall in crude oil prices (\$75.7per barrel in May vs \$84.1 in April) also augurs well for the domestic economy. The foreign portfolio investor (FPI) inflows increased to \$5.9 billion(net)in May, the highest in since September 2022. Most of the inflow directed towards equities and inflows are also improved for debt.</p> <p>Narrowing trade deficit had a salutary effect on India's CAD.</p> <p>CRISIL projects India's CAD at ~2% of GDP in the current fiscal, as exports continue to decline at a greater pace than imports.</p>

Macro variables	fiscal 22	fiscal 23	fiscal 24E	Rationale for outlook
Rs/\$ (year-end)	76.2	82.3	83.0	<p>The rupee continues to face headwinds amid global growth slowdown, heightened geopolitical tensions, elevated commodity prices, and aggressive rate hikes by the US Fed, which is continuing to strengthen the dollar as India's Trade deficit widen.</p> <p>However, in calendar year 2023 so far, the rupee has depreciated a mere 0.5% on average against the dollar, remaining on the least depreciated emerging market currencies.</p> <p>The Rupee came under pressure against the US dollar strengthened in the last couple of months of this fiscal, from averaging 82.3 against dollar in April, INR-USD exchange rate fell 0.4% on month to 82.3 against dollar in May. The rupee has remained resilient this year.</p> <p>CRISIL expects the rupee to average 83 against the dollar in March 2024 compared with 82.3 in March 2023. A surge in Foreign Portfolio Investment (FPI) flows restricted the currency from falling further down.</p>

E: Estimated, P: Projected

Source: Reserve Bank of India (RBI), NSO, CRISIL MI&A

While growth was robust in fiscal 2023, a slowdown is inevitable in fiscal 2024, driven by rising borrowing costs. While central banks aggressively raised policy rates over the past 15 months, their transmission to broader lending rates is taking place with a lag. Rates are expected to peak in the fiscal, hitting both global and domestic demand. External demand will weaken more with major advanced economies facing the highest interest rates in over a decade. S&P Global expects United States GDP growth to slow to 0.7% in 2023 from 2.1% in 2022; Eurozone will brake to 0.3% from 3.5%. These economies account for 33% of goods exports. Hence, exports will curb the growth in this fiscal. While the rise in domestic interest rates is relatively lower than in advanced economies, bank lending rates have reached the pre-pandemic five-year average. This is expected to moderate domestic demand, especially in interest-sensitive segments such as automobiles and housing.

However, falling commodity prices and slowing inflation augurs well for domestic demand this fiscal. We expect further support from the government's continuing infrastructure spending. The key swing factor is monsoon, which has a significant bearing on rural demand. While the India Metrological Department has

forecast a normal monsoon, regional and temporal distribution will have a bearing on agricultural output. Downside risks from an expected El Niño remain.

Because of these factors, CRISIL MI&A projects GDP to grow 6% this fiscal, compared with 7.2% in fiscal 2023. Nominal growth will see a sharper slowdown to 10.6% from 16.1%, with falling inflation (particularly for WPI) narrowing the gap between real and nominal GDP.

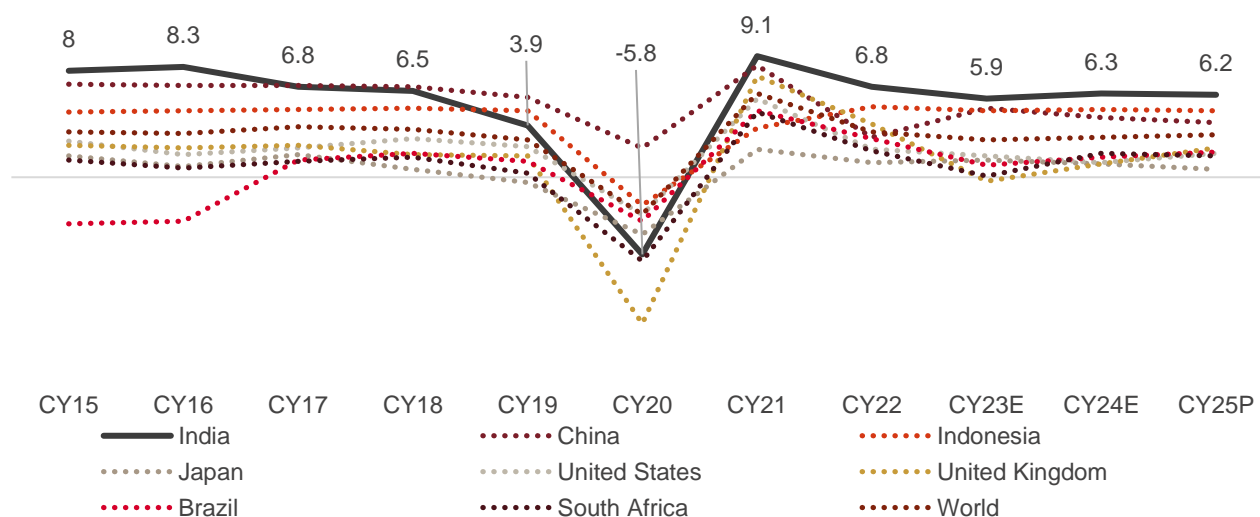
India to remain a growth outperformer globally

Despite the slowdown in near term, India is expected to remain a growth outperformer over the medium run. CRISIL MI&A expects GDP growth to average 6.1% between fiscal 2025 and 2027, compared with 3.1% globally as estimated by IMF.

Drivers for India's economic growth

- Stronger domestic demand is expected to drive India's growth premium over peers in the medium term.
- Investment prospects are optimistic, given the government's capex push, progress of Production-Linked Incentive (PLI) scheme, healthier corporate balance sheets, and a well-capitalised banking sector with low non-performing assets (NPAs)
- India is also likely to benefit from its diversification of supply-chain for incoming FDI flows. As global supply chains get reconfigured with focus shifting from efficiency towards resilience and friend shoring.
- Private consumption (~57% of GDP) will play a supportive role in raising GDP growth in the medium term.

Figure 6: India is one of the fastest growing emerging economies (GDP growth, % on Year)



E: Estimated; P: Projected

Note: GDP growth is based on constant prices

Source: IMF (World Economic Outlook – April 2023 update), CRISIL MI&A

Factors that will shape growth in fiscal 2024 and 2025

Moderate household demand supported by service catch up and government capex:

Strong industrial growth led by manufacturing sector, the index of Industrial production accelerated to 4.2% on year in April 2023 from 1.7 in March majorly led by growth in manufacturing sector, which was supported by domestic oriented sectors, however certain export -oriented sector capped the gain. While manufacturing sector growth led by infrastructure and construction goods and consumer non-durables. However slow activity for primary, intermediate, and capital goods. Consumer non-durables comprising essential items such as food products — saw the sharpest rebound in growth relative to the previous month. Easing inflation in the past few months seems to be improving demand from poorer segments. Rural inflation fell more swiftly in the past few months, which helped increase real wages for their workforce. This, coupled with robust rabi production, seems to be hinting at improved rural demand.

Infrastructure and construction goods growth rose in April after a three-month slowdown, reflecting a pickup in government capital expenditure with the start of the fiscal 2024. At 12.8%, it was the strongest contributor to IIP growth in April.

Industrial performance seems to be encouraged from easing inflationary pressures in the past few months. Falling commodity prices eased input cost pressures for producers, and softening retail inflation has boosted consumers' purchasing power. S&P's Purchasing Managers Index for manufacturing rose further to 58.7 in May 2023 from 57.2 in April, recording the strongest expansion since October 2020. This suggests healthy manufacturing performance in May as well.

Slowing external demand will inevitably also be a drag on domestic growth, considering major advanced economies are expected to slow down following the sharp rise in interest rates. While the rise in domestic interest rates is relatively lesser than in advanced economies, lending rates in India too, are now higher than their pre-pandemic five-year average. This is expected to moderate domestic demand, especially in interest-sensitive segments such as automobiles and housing.

Global and domestic growth cycle:

The GDP growth has been resilient so far, with sharp uptick to 6.1% in the last quarter of fiscal 2023. However, recovery remained uneven, with private consumption being more subdued than other demand segments in the second half. Urban demand and services have been leading the recovery so far. Meanwhile, investment remains robust and net exports have become less of a drag on growth. Robust rabi production augurs well for rural prospects. Services and investments are expected to remain robust. However, weakening external demand and geopolitical risks are key downside risks to growth outlook.

The growth in key advanced economies was mixed, with the economy of the Euro area contracting on quarter, while US growth slowed down to an annualized 1.3% compared with 2.6% in the previous quarter. Japan's GDP growth accelerated to 2.7% in the first quarter compared to 0.4% in the last quarter 2022. China is showing an uneven recovery. Manufacturing activity contracted in China for the second consecutive month while inflation remained low in May due to sluggish demand.

The central bank lowered down the policy rate, the US policy rate decline by 1.6% point in 2023 and 1.8 % point in 2024 relative to the baseline. The global average of policy rate declines by 2.1 and 2.3% over the same period. However even after rate cuts in 2024 S&P global expect Fed rate to be at 4% until late 2024. The high interest rates in major advance economies can significantly alter capital flow and asset prices, as stated by the IMF in its financial stability report of April 2023.

Monetary policy tightening and weakening growth momentum in advanced economies have already started to impact India in the form of slowdown in exports and volatility in foreign portfolio investment (FPI) inflows. India's core export which includes crude oil and gems, and jewellery exports shrank lower 4.0%, as healthy performance in core categories such as electronics, iron ore and select agriculture commodities. The impact of weakening global demand is visible in most other core export categories.

Exports are expected to face headwinds from the anticipated slowdown in global growth, largely premised on lower growth in advanced economies such as the US and the euro area both are key export markets for India. Further, deceleration in domestic growth could lead to some softening in imports.

Financial condition stabilises, broader economy to face elevated rates

The RBI is expected to further extend pause on rate hike, as it evaluates inflation trajectory and growth momentum. While inflation has fallen in the past four months, progress of monsoon and impact of El Nino will be monitorable. The impact of past rate hikes on growth will be the most prominent in fiscal 2024. As growth slows, CRISIL MI&A expects the RBI to initiate rate cuts in the last quarter of this fiscal.

While the pause on rate hikes has augured well for financial markets, elevated bank lending rates could tighten financial conditions for some segments of the economy. Rates will rise further in real terms as inflation moderates. Even as the repo rate remained unchanged in May 2023, the 'real repo rate' (i.e., repo rate adjusted for CPI inflation) increased to 2.2%, the highest since August 2019. It is worth noting that tight financial conditions contributed to growth slowdown in fiscal 2020. On the global front, the US Fed paused rate hikes in June, but remains on the edge as the economy continues to witness tight labour market conditions.

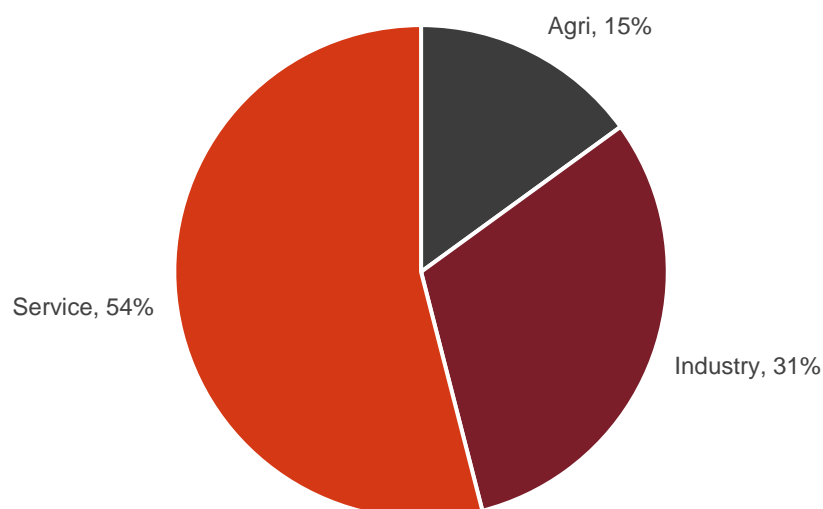
S&P Global expects the Fed rate to remain at peak levels in the calendar year 2023. While the risk of tight and volatile global financial conditions persists, India's vulnerability to these shocks is expected to be lowered this year. India's current account deficit (CAD) anticipated to be declined in fiscal 2024 on the back of lower crude oil prices. This, coupled with the RBI's adequate forex reserves and the country's good growth prospects, should cushion the impact of a global spillover on overall macros.

Government policies to boost manufacturing in India

India's economic output is mainly driven by the high-productivity services sector which contributes 54% of the economic output. Industry accounts for a distant second at 31%, of which, manufacturing accounted for nearly 60%. Growth in the manufacturing sector can not only increase jobs in the sector but also reduce forex outgo

on imported goods. Hence, the government has introduced several incentives in the past decade to boost the manufacturing sector in India.

Figure 7: Sectoral GDP share (fiscal 23)



Source: CRISIL MI&A

Construction capex to rise 13-16% in this fiscal on a high base of fiscal 2023

Growth momentum in capex for fiscal 2024 continued from fiscal 2023 with major focus on construction by infrastructure segment given the rising investment and focus by central and state government capex coupled with schemes such as NIP, NMP and Gati shakti initiatives on a rising pace. Although fiscal 2022 had seen challenges due to second wave of coronavirus and other minor challenges like irregular monsoon in certain states, it showed sharp estimated rise of 35-40% to Rs 9.1-9.3 lakh crore over a low base of fiscal 21.

The construction sector is projected to grow at 13-16% in fiscal 2024 with major contribution by infrastructure segment given the rising investments and focus by central and state government capex. Construction capex is projected to rise 15-17% per year in fiscal 2023 led by infrastructure segment to Rs. 10.5 to 10.7 lakh crore. The rise is in keeping with the Govt's focus on infrastructure as visible in rising central and state budget allocations to capex in order to meet the infra build out outlined in the NIP.

CRISIL Research estimates healthy growth of construction investments in fiscal 22 due to the effect of low base in fiscal 21 where construction activities were highly impacted by lockdowns due to the outbreak of Covid-19 Pandemic.

Infrastructure to drive construction sector growth in the medium-to-long term

The share of infrastructure projects is expected to grow faster in the next five years compared to the past five years, as the government focuses on infrastructure under the NIP, National Monetisation Pipeline (NMP) and

Gati Shakti initiatives. The Central government's focus on roads, urban infrastructure and railways will boost infrastructure investments.

Table 2: Infrastructure & industrial investment growth review and outlook

Sector	fiscal 18- fiscal 22 CAGR	fiscal 22E (Rs trillion)	fiscal 23E (Rs trillion)	fiscal 24P y-o-y growth	fiscal 23-27P to fiscal 18-22E ratio
Infrastructure (A)	12%	5.7-5.9	6.9-7.1	18-20%	1.9x
Roads	13%	2.7-2.8	3.1-3.3	20-25%	1.9x
Power	5%	0.2-0.3	0.3-0.4	10-12%	1.5x
Railways	17%	0.8-0.9	1.1-1.2	12-14%	2.1x
Urban Infra	17%	0.8-0.9	1.0-1.1	31-33%	2.4x
Irrigation	2%	0.7-0.8	0.8-0.9	7-9%	1.5x
Other Infra	5%	0.2-0.3	0.2-0.3	14-16%	1.6x
Industrial (B)	8%	0.7-0.8	0.7-0.8	6-8%	1.2x

Note: E-Estimated, P- Projected

Source: CRISIL MI&A

Of the total capex, the Centre is expected to contribute just one-third, with state capex accounting for the rest. However, actual state capex is lagging budgeted estimates. Private companies are primed and getting ready for scaling up investments but remain cautious in the current uncertain environment. Private consumption remains the weak link owing to reduced direct fiscal policy support. Roads and Railways dominated by public funds to lead growth in infrastructure.

The total budgetary allocation on capital expenditure in infrastructure for fiscal 2023-24 saw a 14% rise over the revised estimates for fiscal 2022-23 to Rs 9.5 lakh crore with roads and railways being the biggest beneficiaries. Of this, Rs 5.4 lakh crore will be through budgetary support, with the remainder from internal and extra budgetary resources and grants in aid for capital creation. The share of infrastructure projects is expected to increase to 65-70% in the next five years as against 55-60% in the past five years, as Infrastructure investments are seen growing faster than the other two segments due to the Government's focus on Infrastructure under the NIP, NMP and the Gati Shakti initiative. The Central government's focus on roads, urban infrastructure and railways will boost infrastructure investments.

Production Linked Incentive (PLI) scheme – A boost to Industrial investments in the short to medium term

The PLI scheme's prime objective is to make manufacturing in India globally competitive by removing sectoral disabilities, creating economies of scale, and ensuring efficiency. It is designed to create a complete component ecosystem in India and make the country an integral part of the global supply chain. Furthermore, the government hopes to reduce India's dependence on raw material imported from China. The scheme is expected to boost economic growth over the medium term and create more employment opportunities, as many of the sectors covered under the scheme are labour-intensive. It will be implemented over fiscals 2022 to 2029.

The PLI scheme is a time-bound incentive scheme by the Government of India which rewards companies in the 5-15% range of their annual revenue based on the companies meeting pre-decided targets for incremental production and/or exports and capex over a base year. The stronger-than-expected pick-up in demand and larger companies gaining share from smaller companies has also led to revival of capex in fiscal 2022. The rise in this fiscal was on account of the expansion plans underway by India Inc.

Construction spends across Industrial investments in fiscal 2024 are seen rising 6-8% driven by expansion in oil and gas and metals segment. The growth is on a low base of fiscal 23 where the sector face slight bump due to geopolitical issues in fiscal 21 and fiscal 22. However, The Production Linked Incentives (PLI) scheme is expected to provide the necessary boost to the sector.

The stronger than expected pickup in demand and larger companies gaining share from smaller companies also led to revival of capex in fiscal 22. Based on an analysis of eight key sectors, CRISIL Research estimates construction investment in the industrial segment at Rs -4.0-4.1 lakh crore between fiscals 2023 and 2027, rising 1.3 times over spends seen in fiscals 2018 to 2022. The rise in investments is projected due to inclusion of PLI scheme in the capex investments of industrial sector. While the PLI scheme entails 13 sectors, we have only considered 3 capex intensive sectors viz. Auto.

Table 3: Budgeted incentives for each sector under the PLI scheme

Sector	Segment	Budgeted (Rs bn) *	
Automobile	Advance chemistry cell (ACC) battery	181.0	751.4
	Automobiles and auto components	570.4	
Electronics	Mobile manufacturing and specified electronic components	409.5	545.15
	Electronic/technology products/IT hardware	73.25	
	White goods (ACE and LED)	62.4	
Pharma and medical equipment	Critical key starting materials/drug intermediaries and active pharmaceutical ingredients	69.4	253.6
	Manufacturing of medical devices	34.2	
	Pharmaceutical drugs	150.0	
Telecom	Telecom and networking products	122.0	122.0

Sector	Segment	Budgeted (Rs bn) *	
Food	Food products	109.0	109.0
Textile	Textile products: man-made fibre (MMF) and technical textiles	106.8	106.8
Steel	Speciality steel	63.2	63.2
Energy	High-efficiency solar PV modules	240.0	240
Aviation	Drones and drone components	1.2	1.2
Total			2,192

*Approved financial outlay over a five-year period

ACE: Appliance and consumer electronics; LED: Light-emitting diode

Source: Government websites, CRISIL MI&A

Make in India

The 'Make in India' initiative was launched in September 2014, to give a push to manufacturing in India and encourage FDI in manufacturing and services. The objective of the initiative was to increase the share of manufacturing in GDP to 25% by 2020 by boosting investment, fostering innovation, and intellectual property, and building best-in-class infrastructure for manufacturing across sectors, including, but not limited to, automobile, auto components, aviation, biotechnology, chemicals, construction, defence manufacturing, electrical machinery, electronic systems, food processing, mining, oil and gas, pharmaceuticals, renewable energy, thermal power, hospitality and wellness.

To achieve this objective, a dedicated Investor Facilitation Cell (IFC) was set up to assist investors in seeking regulatory approvals, hand-holding services through the pre-investment phase, execution, and after-care support. Key facts and figures, policies and initiatives and relevant contact details were made available through print and online media. The Indian embassies and consulates proactively disseminated information on the potential for investment in the identified sectors in foreign countries while domestically, regulations and policies were modified to make it easier to invest in India.

Indeed, FDI inflows have received a leg up, as India jumped to the eighth position in the list of the world's largest FDI recipients in 2020 compared with the twelfth position in 2018, according to the World Investment Report 2022. FDI to India almost doubled to \$83.6 billion in fiscal 2022 from \$45.15 billion in fiscal 2015. India is on track to attract \$100 billion FDI this fiscal according to the Ministry of Commerce and Industry.

However, the share of manufacturing in GDP has not attained the intended levels of 25%. Hence, additional policies were announced, and targets rolled forward initially to 2022 and then to 2025. Domestically, there were multiple steps taken to improve, to make sectors more attractive and ease investment processes. Some of the major steps taken included announcement of the NIP and reduction in corporate tax; various sectors such as defence manufacturing, railways, space, and single brand retail have been opened for FDI. Measures to boost domestic manufacturing were also taken through Public Procurement Orders (PPO), Phased

Manufacturing Programme (PMP) and Production Linked Incentive (PLI) schemes, etc. Many states also launched their own initiatives on similar lines to boost manufacturing in their respective states.

Decoupling of global supply chains

As traditional supply chains are threatened by large scale global events, a rising trend in protectionism and wage inflation, there is a greater need for rethinking supply chain models to remain competitive. In the wake of global disruptions such as Covid, geopolitical crises, environmental disruptions, etc., significant decoupling of supply chains is happening to bring key supply links closer home, particularly the ones situated in China.

To establish collective supply chains that would improve their resilience in the long term, 18 economies, including India, the US and the EU unveiled a roadmap in July 2022 which included steps to counter supply chain dependencies and vulnerabilities. This was done as a part of the ongoing supply chain derisking strategy of global companies/multinationals, wherein global companies are diversifying their businesses away from their reliance on a single large supplier, to alternative destinations. Beijing's Zero-Covid policy and the attendant disruptions to global supply chains, container shortage and higher lead times have served as an impetus to this strategy. This reorientation has benefitted other Asian economies in southeast Asia and India. India can take advantage of the same as the enormous quantum of Chinese exports coupled with India's cost advantage in manufacturing, would serve as a highly lucrative opportunity for Indian manufacturers. Realising this opportunity, the government has introduced many reforms and incentive schemes to increase domestic manufacturing and attract global manufacturing firms to India.

Atmanirbhar Bharat

Atmanirbhar Bharat Abhiyan or the self-reliant India campaign was launched in May 2020 amid the Covid-19 pandemic, with a special and comprehensive economic package of Rs 20 trillion, equivalent to 10% of the country's GDP.

The scheme was launched with the primary intent of fighting the pandemic and making the country self-reliant based on five pillars: economy, infrastructure, technology-driven system, demography, and demand. The stimulus package announced by the government under the scheme consisted of five tranches, intended to boost businesses, including Micro, Small and Medium Enterprises (MSMEs), help the poor (including farmers), boost agriculture, expand the horizons of industrial growth, and bring in governance reforms in the business, health, and education sectors.

The mission emphasises the importance of encouraging local products and aims to reduce import dependence through substitution. It also aims to enhance compliance and quality requirements to meet international standards and gain global market share.

The government has also rolled out other reforms — namely, supply chain reforms for agriculture, rational tax systems, simple and clear laws, capable human resources, and a strong financial system.

Contraction in per capita Income

Per capita income (per capita NNI) is estimated to have grown 2.3% in fiscal 2020, compared with 5.2% in fiscal 2019. In fiscal 2021, per capita income declined 9.7% owing to GDP contraction amid the pandemic's impact. On the lower base of fiscal 2021, per capita income rose 7.5% in fiscal 2022.

However, per capita income is forecast to be declined in line with GDP projection. According to the International Monetary Fund's estimates, India's per capita income (at current prices) is expected to increase at a 7.4% CAGR over calendar years 2023-28 as compared to earlier estimate 10.5% CAGR over calendar years 2022-27.

Near term Outlook on Agriculture, Industrial and services GDP

Service sector is major growth driver

In fiscal 2020, the services sector accounted for 55.3% of India's GDP, compared with 52.4% in fiscal 2015. However, its share dipped to 53.6% in fiscal 2021 owing to the pandemic. Fiscal 2022 saw marginal improvement in the share of the services sector with gradual normalisation of market operations.

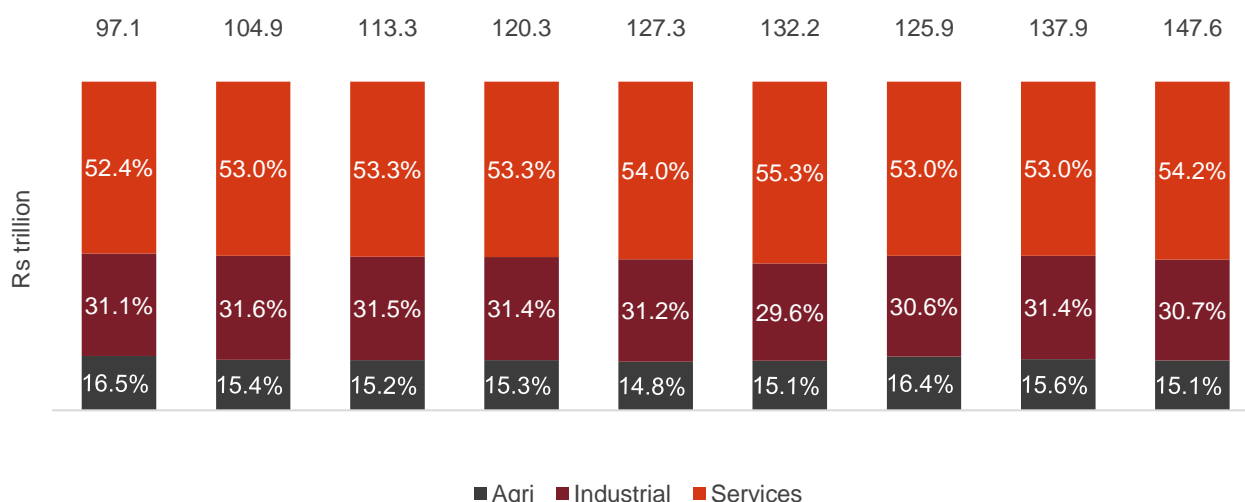
The industrial sector, which is the second-largest contributor, maintained its share in GDP, as it logged a 7.1% CAGR over fiscals 2015-19. Industrial contribution declined in fiscal 2020 with the slowdown in economic development. Before overall economic activity slowed down in fiscal 2020, India's industrial sector output growth was supported by the Make in India initiative, rising domestic consumption and GST implementation. The initiatives improved India's position on the World Bank's Ease of Doing Business index to 63 in fiscal 2019 from 142 in fiscal 2014.

The pandemic and subsequent lockdown exacerbated the economic slowdown in fiscal 2021. The services segment was the worst affected and declined 7.8% on-year, followed by industrial, which declined 3.3% on-year. Agriculture was the only sector that grew 3.3% on-year and restricted the fall in GDP.

In fiscal 2021, the agriculture sector's share in Gross Value Added (GVA) at constant prices expanded, while the share of the services and industrial sectors contracted.

Agriculture GVA continued to grow at a steady 4.0% in fiscal 2023. Faster GDP growth in fiscal 2023 saw the share of agriculture increased during the fiscal. The share of the industrial sector in GDP grew 4% in fiscal 2023, strongly by utility services with a respectable 8%, higher than above all other industrial sectors. Mining grew by 5% while manufacturing and construction added marginal growth momentum from a high base of fiscal 2022. The high base of fiscal 2022 led to moderate growth of the industrial sector in fiscal 2023. The services sector grew by 9% in fiscal 2023. Trade, hotel, transport, and communication THTC saw strong growth to 14% in fiscal 2023 compared to previous fiscal.

Figure 8: Share of sectors in GVA at constant prices



Source: RBI, CRISIL MI&A

During fiscal 2023, the Agri sector is expected to continue its growth momentum of ~4% y-o-y, thereby contributing to 15.1% of the GVA. The services sector is expected to provide thrust to the economy with 7.2% growth and a share of 54.2% while the industry sector remains at 30.7% share in fiscal 2023, helping it maintain its contribution.

CRISIL expects the contribution of services to increase and the Agri sector to lose some ground during the year due to higher growth in the services sector.

Review and outlook on inflation

CPI inflation high on base effect

Inflation, as measured by the Consumer Price Index (CPI), moderated sharply to 4.3% on-year in May, from 4.7% in April. The downward trajectory is mainly because of fall in global oil and commodity prices. The global energy index fell an average 31.1% on-year in the last four months, while the metals index is down 17% on average. Also, the easing supply chain pressures lead to better availability of inputs and therefore reduced pressure on prices. As input cost pressures abate, though retail prices are higher than a year ago, month-on-month the increase is lesser, easier food inflation as the rabi crop enters the market, sequentially food inflation fell 0.2% on a seasonally adjusted on month basis, compared to 0.1% rise in the preceding month. Overall inflation is moderate, for instance food inflation has been easing for the past few months and with the latest reading at 2.9%. Encouragingly, there is also an easing of sequential momentum. Much of this is being led by fruits and vegetables, edible oils, however pricey cereals and milk continue to exert pressure on overall inflation.

The biggest takeaway from the May 2023 CPI print was the persistent stickiness in core inflation, which stood at 5.1% in May, and same as April, Inflation in some essential categories remained broadly unchanged- health (6.2% vs 6.3%), transport and communication (1.1% vs 1.2%), housing (4.8% vs 4.9%)

Inflation in clothing and footwear moderated to 6.6% from 7.5%. On the other hand, inflation in personal care and effects accelerated sharply to 9.9% from 9.0% in the previous month as inflation in gold (18.2% vs 13.8%) and silver (13.0% vs 4.7%) accelerated.

Fuel inflation settled at 4.6% in May vs 5.5% previous month. The lowest rate since March 2021. A large part of this fall was due to a high base and moderating global crude oil prices. The price of Brent crude oil decreased from \$84.1/bbl to \$75.7/bbl.

Food inflation fell to 2.9% in May from 3.8% in April driven by vegetables (-8.2% inflation), edible oils (-16%) however Pulses saw an increase in inflation to 6.6% from 5.3%. Though inflation in cereals cooled, it remains in double digits at 12.7%. The easing in cereals inflation was led by cooling inflation in wheat (from non-PDS sources) (12.6% vs 15.4%). As inflation in wheat remains in double-digits, the government signaled that it would continue to ban exports of wheat. The government has also imposed stocking limits on wheat and some pulses till the next crop arrivals in March 2024 and October 2023, respectively for these crops.

WPI-linked inflation falls on-year

Inflation based on the Wholesale Price Index (WPI) eased sharply again in May to -3.5 from -0.9% in April (and 1.4% in March). This is the twelfth consecutive month of moderation in WPI inflation. WPI inflation is easing largely on base effect, and some sequential easing of some food groups. WPI pressures eased for manufactured product such as foods, textiles, and chemicals however inflation is hardened in electrical material and pharmaceuticals.

Fuel and power WPI inflation also slipped into the deflation zone to -9.2% from 0.9%. Inflation in coal moderated (2.5% vs 3.2%), while prices of mineral oils fell by 16.2% on-year. Inflation in electricity moderated sharply to 9.7% from 20%

Inflation outlook

CPI inflation may moderate in the coming months as base effect comes into play. Going ahead, food inflation falls led by edible oil, vegetables, and some softness in cereals. However elevated inflation rate in milk, cereals, species, and recent uptick in pulses remains a monitorable. In the months to come, rainfall conditions will play a key role in shaping food inflation.

Amongst the food category, inflation in milk has been elevated over the last year driven by higher procurement cost. Demand of milk remains high while stocks of dairy products are lower than the previous year prompting the government to consider importing milk and/or milk products. The easing in cereals inflation was led by cooling inflation in wheat. As inflation in wheat remains in double-digits, the government signaled

that it would continue to ban exports of wheat. The government has also imposed stocking limits on wheat and some pulses till the next crop arrivals in March 2024 and October 2023, respectively for these crops.

Some relief on fuel inflation can be expected if the recent decline in Brent crude oil prices is sustained (which would bring down domestic fuel prices at the pump).

Considering these factors, CRISIL M&I Projects CPI inflation forecast at 5% for this fiscal, from 6.7% in fiscal 2023. A supportive monsoon is a key assumption underlying this forecast. In this scenario, CRISIL expects the Monetary Policy Committee (MPC) to maintain a pause as it continues to watch the impact of past rate hikes. As growth slowdown seeps in and inflation moderates, we expect it to cut rates by the end of this fiscal.

The Indian Meteorological Department has predicted overall normal rains this year. However, timeliness and regional distribution are very critical for crop production, price signaling and hence inflation expectations. With rabi harvest entering the market, some respite for cereal and pulses prices could be felt in the next 2-3 months. However, any distortion in rains could bring a reversal of gains in categories experiencing low/easing inflation (vegetables and edible oils), or worse, keep inflation elevated in cereals. However, some recently announced policy measures (imposing stock limits on wheat and pulses, and possible imports of milk or milk products) could cap some of the upside to food inflation.

2. Telecom Industry – Global and India

2.1 Global telecom industry

The global telecom industry is a significant and rapidly growing market. The adoption of smartphones, increasing data usage, and the deployment of 5G networks have transformed the way people communicate and access information globally. The proliferation of IoT devices has been another significant driver in the telecom industry. IoT connects various devices and enables data exchange over the internet, leading to increased demand for connectivity and network infrastructure.

The industry is dominated by major telecom operators and service providers such as AT&T, Verizon, China Mobile, Vodafone, Deutsche Telekom, and NTT. Additionally, technology companies like Huawei, Ericsson, Cisco, and Nokia are key players in providing network infrastructure and equipment.

Table 4: Major telecom operators by countries

Country	Major Telecom Operators	Key Features
United States	AT&T, Verizon, T-Mobile, Sprint	Large market, advanced infrastructure, technological innovation
China	China Mobile, China Telecom, China Unicom	World's largest market, significant growth, advanced technologies
India	Reliance Jio, Bharti Airtel, Vodafone Idea	Fast-growing market, large subscriber base, push for digital connectivity
Japan	NTT Docomo, KDDI, SoftBank	Technologically advanced, early adopter of mobile innovations
Germany	Deutsche Telekom, Vodafone Germany, Telefonica Germany	Mature market, focus on high-speed broadband and 5G deployment
United Kingdom	BT Group, Vodafone UK, O2	Mature and competitive market, emphasis on connectivity
Brazil	Vivo, Claro, TIM Brazil	Largest market in Latin America, growing mobile and internet penetration
South Korea	SK Telecom, KT Corporation, LG Uplus	Highly advanced market, focus on high-speed broadband and 5G

Source: CRISIL MI&A

These are just a few examples of major telecom markets around the world. Other significant markets include France, Italy, Canada, Australia, Russia, and many more. Each market has its unique characteristics, regulatory framework, and competitive landscape.

The convergence of services is another notable trend in the telecom industry. Traditional telecom operators are expanding their offerings beyond voice and data services, incorporating content streaming, video-on-

demand, and other value-added services. Adoption of cloud computing, software-defined networking (SDN), network virtualization, and artificial intelligence (AI) technologies.

The rollout of 5G networks is expected to drive significant growth and innovation in the telecom sector. 5G technology promises faster data speeds, low latency, and the ability to connect a massive number of devices simultaneously, enabling new applications and services.

And the adoption of edge computing is expected to increase in the telecom industry. Edge computing brings computing resources closer to the network edge, reducing latency and improving performance for real-time applications such as autonomous vehicles, smart cities, and augmented reality (AR)/virtual reality (VR).

Efforts are underway to extend internet connectivity to underserved areas globally, with initiatives like satellite internet, high-altitude balloons, and other innovative solutions. Bridging the digital divide remains a focus for governments and telecom operators.

Overall, the global telecom industry is poised for growth and innovation driven by advancements in technology, the proliferation of connected devices, and evolving customer needs. The successful adaptation to these trends and challenges will determine the future success of telecom companies worldwide.

2.2 Indian telecom industry

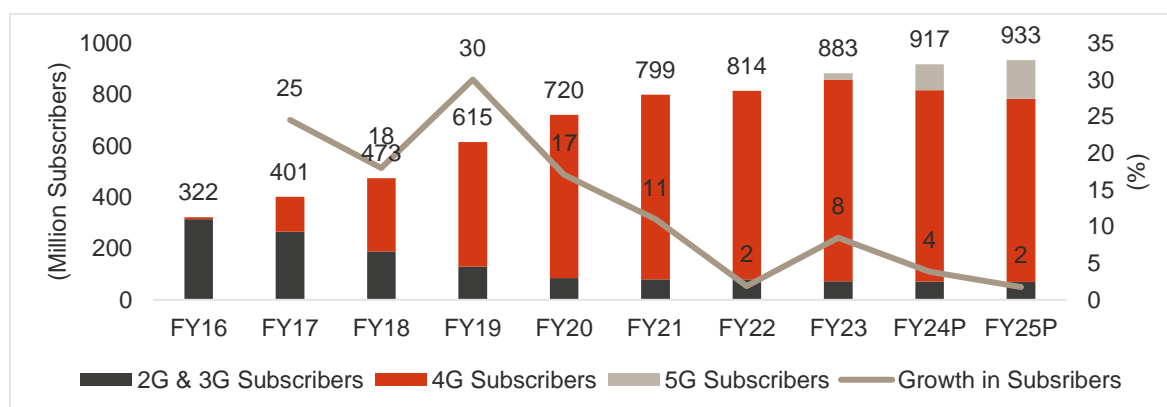
The Indian telecom industry has witnessed significant growth and transformation over the past few decades. It has emerged as one of the largest and fastest-growing telecom markets in the world. The liberalization of the industry led to the entry of private players and the introduction of new technologies and services. The industry is highly competitive, with several major players vying for market share. The major telecom operators in India include Bharti Airtel, Reliance Jio, Vodafone Idea (now Vi), and BSNL. Competition has led to innovative pricing strategies, affordable tariffs, and improved services.

The industry witnessed a surge in mobile subscribers, as mobile phones became affordable and accessible to a wide range of consumers. The growth of the internet and data services has been a key driver of the industry. The launch of 4G services and affordable smartphones led to a surge in data consumption and digital services, with users accessing various digital services such as streaming, social media, e-commerce, and online content. It has become one of the largest data markets globally, with increasing internet penetration and the rise of digital platforms. The recent rollout of 5G technology in Oct 2022, is expected to enable faster internet speeds, enhanced connectivity, and support for emerging technologies like the Internet of Things (IoT) and smart cities and bring the next wave of growth in the industry.

Market Overview:

The industry is characterized by its vast customer base and a high level of mobile penetration. As of fiscal 2022, India had over 1,142 million mobile subscribers, making it the second-largest mobile market in the world, according to data from the Department of Telecommunications (DOT). Mobile services constitute a major portion of the Indian telecom market. The mobile segment has witnessed remarkable growth, driven by increasing affordability, expanding network coverage, and the rise of data services. The mobile subscriber base has been growing steadily, with a focus on providing affordable voice and data services to a diverse customer base.

Figure 9: Trend in telecom data services subscribers



Source: Company reports. TRAI, CRISIL MI&A Research

The industry witnessed a surge in internet users over the past few years — internet penetration as a percentage of total population was ~62% in fiscal 2022, compared with less than 20% in fiscal 2015, as per DOT. Of the total ~920 million internet subscribers in fiscal 2023, ~883 million are wireless subscribers and the balance is wired. The dominance of wireless internet subscribers in India is unlike other developed markets such as the US and European countries, which have a judicious mix of wireless and wired broadband users. Wired broadband subscriber penetration as a percentage of households in developed markets averages at 30-40% compared with a mere 9% in India as wireless data tariffs have been relatively cheaper here. The subdued growth in wired internet demand in the past was on account of the concentration of services in large cities and major urban areas. Additionally, 4G mobile broadband prices have been much lower than those of wired broadband. Hence, most of the internet consumption is taking place via mobile phones.

Telecom industry infrastructure in India:

The telecom industry infrastructure in India has witnessed significant growth and development over the years.

- **Telecommunication networks:** India has a robust telecommunications network comprising both wired and wireless technologies. The wired network includes extensive landline connections, primarily based on copper and fiber-optic cables. The wireless network consists of mobile networks covering a large portion of the country, offering voice and data services.
- **Mobile Network Operators:** India has multiple mobile network operators providing cellular services across the country. Some of the major operators include Bharti Airtel, Reliance Jio, Vodafone Idea, and BSNL. These operators have established a wide network of base stations and towers to enable mobile connectivity in both urban and rural areas.
- **Internet Connectivity:** India has witnessed significant growth in internet connectivity. Broadband services are provided through various technologies such as Digital Subscriber Line (DSL), cable, fiber-optic, and wireless networks. The government has also initiated projects like BharatNet to expand internet connectivity to rural areas.
- **International Connectivity:** India is well connected to the global internet backbone through multiple submarine cable systems. These undersea cables provide high-speed international connectivity for data and voice communications, ensuring seamless global connectivity.
- **Data Centres:** With the rise of digital services, there has been an increase in the establishment of data centres across the country. These data centres house servers and network equipment, providing storage, processing, and hosting capabilities to support various online applications and services.
- **Regulatory Bodies:** The telecom industry in India is regulated by TRAI and the Department of Telecommunications (DoT). These regulatory bodies oversee licensing, spectrum allocation, quality of service, and other aspects of the telecom sector.
- **Government Initiatives:** The Indian government has taken several initiatives to promote telecom infrastructure development. Initiatives like the National Optical Fiber Network (NOFN) and the National Broadband Mission (NBM) focus on expanding broadband connectivity to rural and remote areas.

The telecom infrastructure in India continues to evolve, driven by technological advancements, increasing demand for data services, and government initiatives to bridge the digital divide and provide connectivity to all citizens.

Government initiatives for the development of the industry:

The Indian government has taken several initiatives to foster the development and growth of the telecom industry. These initiatives aim to improve connectivity, expand infrastructure, promote digital inclusion, and support the overall growth of the sector. Here are some key government initiatives in India:

1. **BharatNet:** It is a government project aiming to provide high-speed broadband connectivity to all villages in India. The project involves the laying of optical fiber cables to connect rural areas, enabling the delivery of various digital services. It aims to bridge the digital divide and empower rural communities with internet connectivity.
2. **National Broadband Mission (NBM):** The National Broadband Mission was launched in 2020 with the goal of providing universal broadband access to all citizens. It aims to enhance the quality and availability of broadband services, especially in rural and remote areas. The mission sets targets to achieve broadband connectivity for all, including through leveraging innovative technologies.
3. **Production-Linked Incentive (PLI) Scheme:** The Union Cabinet approved Rs. 12,195 crores production-linked incentive (PLI) scheme for telecom & networking products under the Department of Telecom to boost the telecom industry.
4. **PM GatiShakti National Master Plan:** The development of a robust telecom infrastructure in the country is a key thrust area of the PM GatiShakti National Master Plan, a Rs 100 trillion pan-India infrastructure plan.
5. **National Digital Communications Policy (NDCP):** The NDGP 2018 provides a comprehensive policy framework for the development of the telecom sector in India. It focuses on various aspects such as broadband connectivity, spectrum management, attracting investments, promoting innovation, and enhancing consumer protection.
6. In 2022, the government approved a revival package of BSNL amounting to Rs. 1.64 Lakh crore. Revival measures include infusion of fresh capital for upgrading BSNL services, allocation of spectrum, de-stressing its balance sheet and augmenting its fiber network by merging Bharat Broadband Nigam Ltd. (BBNL) with BSNL, as well as the settlement of adjusted gross revenue (AGR) dues.
7. Saturation of 4G mobile services in uncovered villages across the country will provide 4G mobile services in 24,680 uncovered villages in remote and difficult areas. The project has a provision to include additional villages on account of rehabilitation, new-settlements, withdrawal of services by existing operators etc. The project is being executed by BSNL using Atmanirbhar Bharat's 4G technology stack and is funded through Universal Service Obligation Fund.
8. **Draft Telecommunications Bill:** The Indian Government introduced a draft telecommunications bill in September 2022 that would help in the growth of the telecom industry.

These initiatives, along with regulatory measures by TRAI and DoT, aim to create an enabling environment for the telecom industry's growth, improve connectivity, and support digital transformation in India.

Table 5: Some key regulatory policies and their impact assessment

Regulation	Release month	Measure / Development	Impact
5G Auction prices	Apr-22	Department of telecommunications(DOT) accepted the price cuts recommended by TRAI for 2022 auction	Low
Apex court slashes Incumbents plea	Jul-21	Apex Court Rejects Incumbents plea of recalculating AGR dues due to arithmetic errors	High
Spectrum auctions	Mar-21	Department of Telecommunications(DOT) initiated the formal proces of auctions that is scheduled to be held in March-2021. The auctions would include spectrum across all bands except 5G spectrum	High
Scrappage of IUC charges	Jan-21	TRAI scraps IUC charges for all operators from January 1st 2021	Medium
Moratorium on Sprectrum Payments	Nov-19	The Government of India as a form of relief package announced a moratorium of 2 years i.e fiscal 2020 and fiscal 2021 on deferred spectrum payments	Medium
Apex court order on AGR definition	Oct-19	The honourable supreme court gave a ruling in favour of Department of Telecommunication with regards to definition of Adjusted Gross revenues(AGR). As a result of this Telecom operators are liable to pay dues of last 14 years as per the order including interest, penalty and interest on penalty	Very high
National Digital Communications Policy, 2018	Sep-18	Facilitate development of communication infrastructure and services to achieve inclusive socio-economic growth in the country	Medium
The Telecommunication tariff (63rd Amendment) Order, 2018	Feb-18	In case of tariff being found predatory, the service provider will be charged an amount not exceeding Rs 50 lakh per tariff plan for each service area, by way of financial disincentive. But, the service provider must be holding the market share (either subscriber base or gross revenue) of atleast 30% in a service area	Low
Relaxation of spectrum Cap	Jan-18	Increased the spectrum holding cap from 25% to 35% in a circle and removed the intra-band cap of 50% holding in a circle Imposed 50% cap on the combined spectrum holdings in the sub-1GHz band (700 MHz, 800 MHz, and 900 MHz bands) per circle as compared with individual band cap earlier.	Medium
Deferred payment period and Interest rate	Jan-18	The deferred payment period for spectrum has been increased from 10 years to 16 years	Medium
Interconnect Usage Charges	Sep-17	TRAI has cut the IUC from 14 paise/min to 6 paise/min w.e.f. Oct 1,2017 Starting Jan 1, 2020 the IUC will be lowered	High

Source: CRISIL MI&A

Recent developments in the industry:

New DoT regulations to impact regulatory capex:

- **Price cuts & new bands**
 - Spectrum price cut of 36% for coveted 5G band of 3300-3670 MHz on 20 years basis.
 - 700 MHz, 2300 MHz & 2500 MHz witness largest price cut of 40%, 53% & 41% respectively.
 - 600 MHz and 24.5-28.5 GHz frequency introduced for auction.
- **New payment terms**
 - Condition of 50% upfront payment for 5G band removed.
 - Incumbents can either pay part payments and remaining over the course of period after a moratorium adjusted to the percent of part payment to full payment or Incumbents can pay the amount over 20 years of equal instalments.

While the price cut remains a positive step, prices cut of 36% remains low as against demand of >90% by incumbents for the 5G band. However, abundant supply of spectrum is expected to result total principle outflow of Rs 1.5 trillion as for 5G band. Introduction of new frequency band a positive. Overall, we expect muted participation due to high spectrum prices. 700 MHz band is expected to be sold first time to offer 5G services. The new payment term is a positive as it will relieve the incumbent players of Rs 590-620 billion upfront payment on 5G as per CRISIL MI&A estimates.

Telecom relief measures ensures industry remains a 3+1 player market in near term:

- **Liquidity reforms**
 - Up to four years moratorium on (adjusted gross revenue) AGR.
 - Up to four years moratorium on deferred spectrum liabilities.
 - Option of converting certain government debt to equity.
 - Dues pending as of date - Vodafone Idea – Rs 64,052; Bharti Airtel – Rs 25,796
- **Structural reforms**
 - Non-telecom revenue to be excluded from the definition of AGR on prospective basis.
 - Favourable changes brought into bank guarantee requirements for players.
 - Tenure of spectrum in future auctions to be increased from 20 years to 30.
 - Revoked penalty and interest on penalty.
 - In future auctions, telcos will be allowed to surrender airwaves after 10 years.
 - To attract investments, 100% foreign direct investment (FDI) under automatic route permitted in the sector.

The government's steps addressing liquidity issues have come as a huge relief for the players as they are facing hefty regulatory pay-outs from fiscal 2023. Four-year moratorium on AGR and spectrum dues will ease cash-flows to the tune of ~Rs 22,000-25,000 crore annually for Vodafone Idea and ~Rs.35,000 crore for the entire industry, as per CRISIL MI&A estimates. This will give companies wiggle room to make active investments in 5G. Structural reforms announced will shield the sector from any major stress in the future, too.

Drivers and challenges affecting the Indian telecom industry:

India has witnessed a significant increase in mobile penetration, driven by the availability of affordable smartphones and low-cost data plans. This has led to a larger customer base for telecom operators and increased demand for mobile services. With the increasing popularity of mobile apps, streaming services, social media, and e-commerce, there is a growing demand for data services. Consumers are increasingly relying on mobile data for various activities, leading to higher revenue generation for telecom operators.

The Indian government's push for digitization, initiatives like BharatNet, and increasing adoption of digital services by individuals and businesses are driving the demand for telecom services. This includes the need for high-speed internet, cloud services, IoT connectivity, and enterprise solutions. Telecom operators are focusing on expanding their networks to rural areas, where there is significant untapped potential. BharatNet aim to connect rural areas with high-speed broadband, presenting opportunities for telecom operators to extend their services and reach new customers. Telecom operators are investing in expanding their data

networks, upgrading to advanced technologies like 4G and preparing for the rollout of 5G. This expansion enables faster data speeds, improved network coverage, and capacity to handle the increasing data demands of consumers and businesses.

The Indian telecom market is highly competitive, with multiple players vying for market share. The Indian power electronics manufacturing industry is characterized by strong competition among increasingly quality-conscious manufacturers. Intense competition often leads to price wars, reducing profitability for operators and putting pressure on revenue growth. Changes in regulations, licensing fees, spectrum allocation, and other policies can create uncertainties and affect the business models and profitability of telecom operators.

Telecom operators face significant capital expenditure in infrastructure development, network expansion, and technology upgrades. Balancing these investments with affordable pricing plans while maintaining financial viability is a challenge, especially in a highly price-sensitive market. India's diverse geography and vast population present infrastructure challenges for telecom operators. Building and maintaining a robust network infrastructure, especially in remote and rural areas, can be complex and costly. The rapid pace of technological advancements, such as the transition to 5G, requires significant investments and infrastructure upgrades.

CRISIL MI&A expects the number of internet subscribers to reach 910-915 million by fiscal 2024, resulting in ~65% internet penetration and by fiscal 2026, with a complete transition of 2G and 3G data services to 4G and 5G, ~70% internet penetration. This can be attributed to increased demand for data, competitive pricing of 4G services, early conversion to 5G, and availability of affordable handsets. We expect broadband internet subscriber base to log a 4-6% compound annual growth rate over fiscals 2023-2026. This will swell the broadband internet subscriber base in India to ~1,000 million by fiscal 2026.

After an estimated 7% growth in fiscal 2022, the industry's revenue is expected to witness a healthy growth at 10-13% in fiscal 2023 to touch Rs 2,290-2,400 billion on account of the full impact of the tariff hike taken in fiscal 2022. In fiscal 2024, the industry is expected a stable growth of 10-13% growth to touch Rs 2,600-2,700 billion on account of the full impact of expected tariff hikes taken in the second half of fiscal 2023. Additionally, migration of marginal top line 4G customers to 5G is also expected to drive marginal revenue in fiscal 2024. CRISIL MI&A expects growth rate of 14-16% over a period of fiscal 2023-2026, with the industry crossing the ~Rs 3,600 billion mark by fiscal 26 driven by tariff hikes and customer upgrading.

With 3-4 times higher BTS requirement and ~34% more fiberisation required, major capex to be driven by network capex this and next fiscal. Regulatory capex to remain low owing to low instalment outflow. We expect telcos capex to rise in the current fiscal to touch Rs 1,150-1,300 billion largely driven by network capex. After spending Rs 1.5 trillion on the 5G auction spectrum, the telcos are expected to invest heavily in network to rollout pan-India 5G by fiscal 2024. Fiscal 2024 too will largely witness network capex along with an instalment of regulatory capex to the tune of Rs 1,000-1,100 on account of rollout obligations, investments in expanding 4G sites, and strengthening fibre footprint. and quality enhancement of services. Among the top 3 private players, the weaker player remains significantly under-invested of all and hence is also expected to allocate most of its capex to boost its network.

2.3 Indian telecom tower industry

The telecom tower industry in India plays a crucial role in supporting the country's rapidly growing telecom sector. Telecom towers provide the necessary infrastructure for wireless communication networks, including mobile networks and internet connectivity. Telecom towers are erected to accommodate the equipment necessary for wireless communication. These towers consist of a steel structure that supports antennas, transceivers, and other equipment. Tower companies lease out space on these structures to telecom operators for installing their equipment. Telecom tower infrastructure is primarily divided into active infrastructure, passive infrastructure and backhaul. Wireless networks comprise three components:

- Active infrastructure
- Passive infrastructure
- Backhaul

Active infrastructure

It consists of electronics that power wireless networks such as radio antennas; base transceiver stations (BTS)/ cell sites; and cables – all these equipment's form the front end of the telecom network. A BTS is a link between a mobile device and telecom operator network acting as a transmitter and receiver of signals, used to propagate mobile waves carrying data and voice to help efficient communication among individuals.

Passive infrastructure

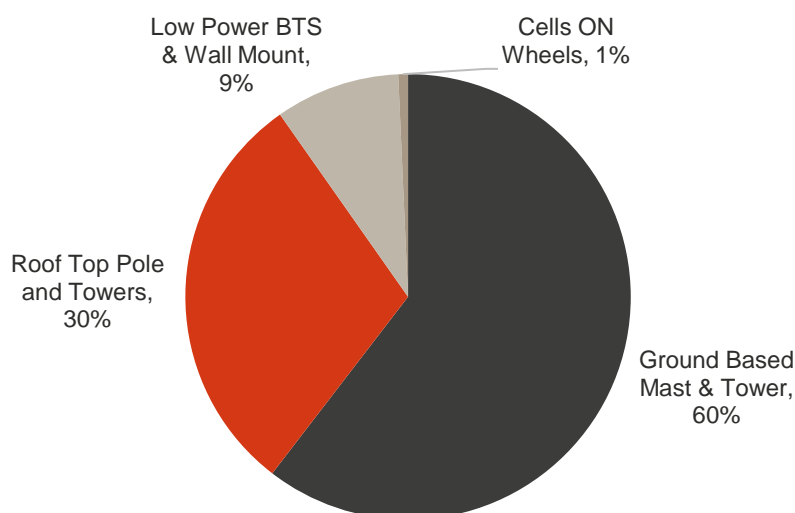
Telecom tower companies set up an entire range of passive infrastructure to be used by telecom operators to offer services to their subscribers. Companies either build the towers themselves or outsource their construction. Additionally, they also procure equipment such as power regulation systems; battery back-ups; diesel generator (DG) sets; Outdoor cabinets to house electronics, and air-conditioners from different suppliers.

Passive infrastructure does not play any role in carrying wireless signals, but it is a vital part of the network as it ensures the operability of active components and availability of 24x7 power to ensure high uptime for the network. Though passive infrastructure is independent of the type of communication technology being used, the extent of its installation is determined by the number of operators mounting their base stations at a particular site.

The rapid growth in subscriber base – which grew over 30x from less than 40 million to nearly 1.2 billion in two decades has necessitated an equally strong growth in telecom towers. The total telecom tower base in India stood at nearly 754,000 while the number of Base Transceiver Station (BTS) was nearly 2.4 million. Ground based mast & tower dominates the Indian telecom tower sector, accounting for nearly 60% of total installed tower base. Roof top pole & tower is the second largest segment, accounting for

nearly 30% of the total. The remaining 10% is made up of cell on wheels (COW), Low Power BTS (LPBTS) and wall mount towers.

Figure 10: Telecom tower type mix in India



Source: DOT, CRISIL MI&A Research

Backhaul

Backhaul is a process of transferring data, using a viable medium (optic cables or airwaves), from one point to another. This data is generally transferred to the main station after which it is distributed to a particular location(s) and these connections cumulatively are known as backhaul.

Telecom Tower Market Review

In India, there are specialized tower companies that own and manage the telecom tower infrastructure. These companies lease out tower space to multiple telecom operators, allowing them to share the infrastructure and reduce costs. Some prominent tower companies in India include Indus Towers (Incl Bharti Infratel), Summit Digital, American Tower Corporation (ATC), and Ascend telecom. Tower sharing is a common practice in the Indian telecom industry. Telecom operators enter into agreements with tower companies to lease tower space and share the infrastructure with other operators. This sharing helps reduce capital expenditure, operational costs, and environmental impact, as multiple operators can utilize the same tower infrastructure. Tower companies generate revenue through lease rentals charged to telecom operators for using tower space. The rental charges are typically based on a per-tenant basis, i.e., per operator per tower. The revenue models may also include additional charges for services such as power backup, security, and maintenance.

The telecom tower industry in India continues to evolve as the demand for mobile and internet services grows. The deployment of advanced technologies like 5G, increased tower density in rural areas, and the adoption of sustainable practices will shape the future of the industry. With a large and diverse population, India requires

a significant number of telecom towers to ensure widespread coverage and connectivity. The density of telecom towers varies across urban, suburban, and rural areas, with higher tower density in urban regions compared to rural areas. Efforts are being made to increase tower density in underserved and remote areas to bridge the digital divide.

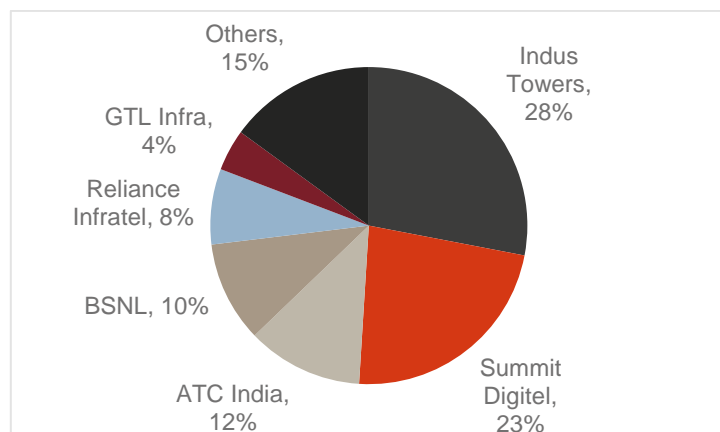
Post major consolidation, top 3 tower cos to account for over 70% of market:

With telecom service providers looking to exit the infrastructure space, tower companies like American Tower Corp are investing to increase the size of their tower portfolio to compete in the industry. The merger of Bharti Infratel and Indus Towers, which was officially completed in December 2020, led to the formation of the largest tower company in India (with a tower market share of ~32%) and the second-largest tower company in the world (second to China Tower).

Currently, Indus Towers, Summit Digital infrastructure (previously known as Reliance jio infratel), and American Tower Corp (ATC), are the key players in the Indian telecom towers space. Together they commanded ~65% share of the country's estimated ~7.5 lakh towers in fiscal 2023. India's other players, Tower Vision and Ascend Telecom Infrastructure have a comparatively small portfolio of ~15,000 towers together. In the medium term, 3-4 large players are expected to operate along with smaller players and telcos having captive towers.

Consolidation in the tower space will help the industry to move towards a more mature structure with fewer players influencing operations. Smaller players with a portfolio of 2,000-2,500 towers are expected to be subsumed by major players as they look to position themselves better. Following consolidation, the top three tower players will account for almost 80% of total towers.

Figure 11: Indus Towers and Summit Digital lead in the market share (as of fiscal 2022)



Note: The market share of players has been estimated based on the number of towers as reported by the respective tower comp

Source: Industry, Company reports, CRISIL MI&A

Market Outlook

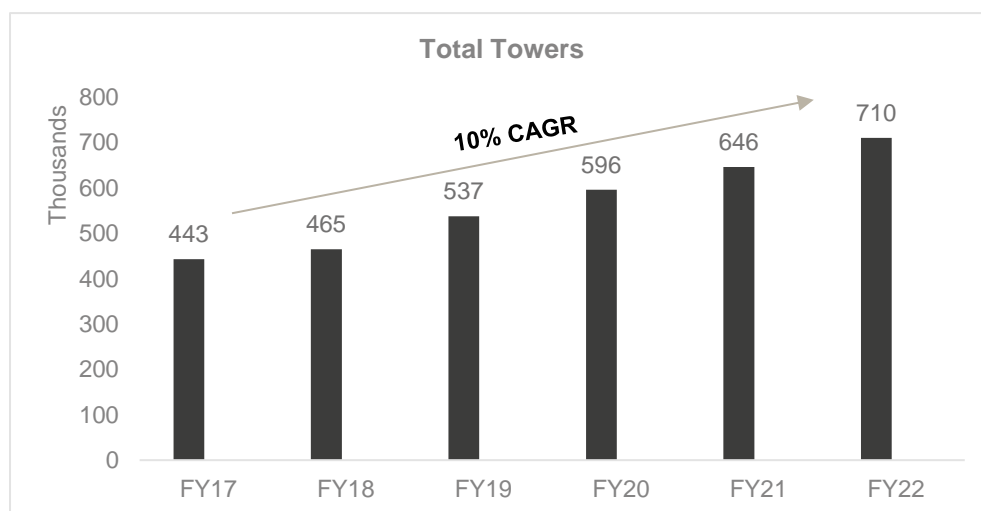
India continued to see a meteoric rise in internet penetration, as it continued its journey to become one of the fastest growing digital communication markets in the world. The scale of data consumption in India is unparalleled when compared to global growth, which is flattening.

As per DOT report, the data traffic in the country grew by 30 times in the past 5 years which is amongst highest globally with 97.9% of the data usage coming from 4G in 2021. The data traffic grew by 31% in 2021 on y-o-y basis due to rise in 4G data consumption. The number of 4G subscribers reached over 700 million with 100 million new additions during the year. Moreover, there are over 2 million 5G devices already in use across the country. Data usage is set to surge further because of the higher number of connected devices, immersive applications experience (AR/VR), smart home, IoT and enterprise use-cases, factory and public safety use cases and surging data consumption per unit.

This strong growth in telecom data usage puts pressure on telecom infrastructure. Capacity expansion and equipment modernization is essential to provide customers with a seamless telecom service. To support such a strong user base, and their ever-increasing telecommunication needs there is a need for an equally strong telecommunication infrastructure backbone.

The no of telecom towers being deployed have grown at a healthy clip of 10% CAGR over the last 5 years, primarily led by Reliance Jio with the overall industry adding over 2.5 lakh towers, which is more than half of fiscal 17 tower population. The additions were largely on account of the 4G roll out in the country.

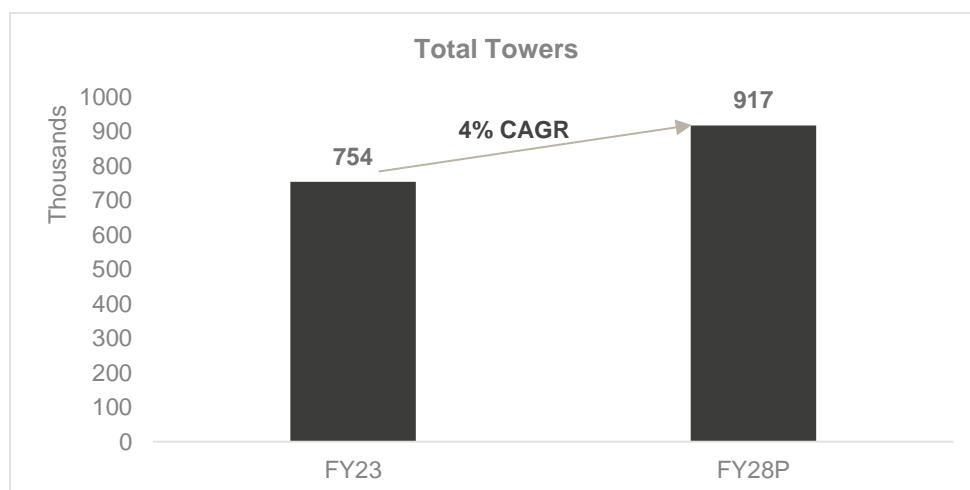
Figure 12: Tower infrastructure review (No of towers)



Source: CRISIL MI&A

However, going forward, the new tower additions are expected to grow modestly at a CAGR of 4.0% from 7.5 lakh in fiscal 2023 to 9.0-9.2 lakhs by fiscal 2028. And most of the capex will happen towards upgradation of the towers for 5G, as almost ~80% of fiscal 24 tower population is expected to be upgraded by fiscal 28.

Figure 13: Tower infrastructure outlook (No of towers)



Source: CRISIL MI&A

2G and 3G BTS to decline; 4G BTS additions to help overall growth:

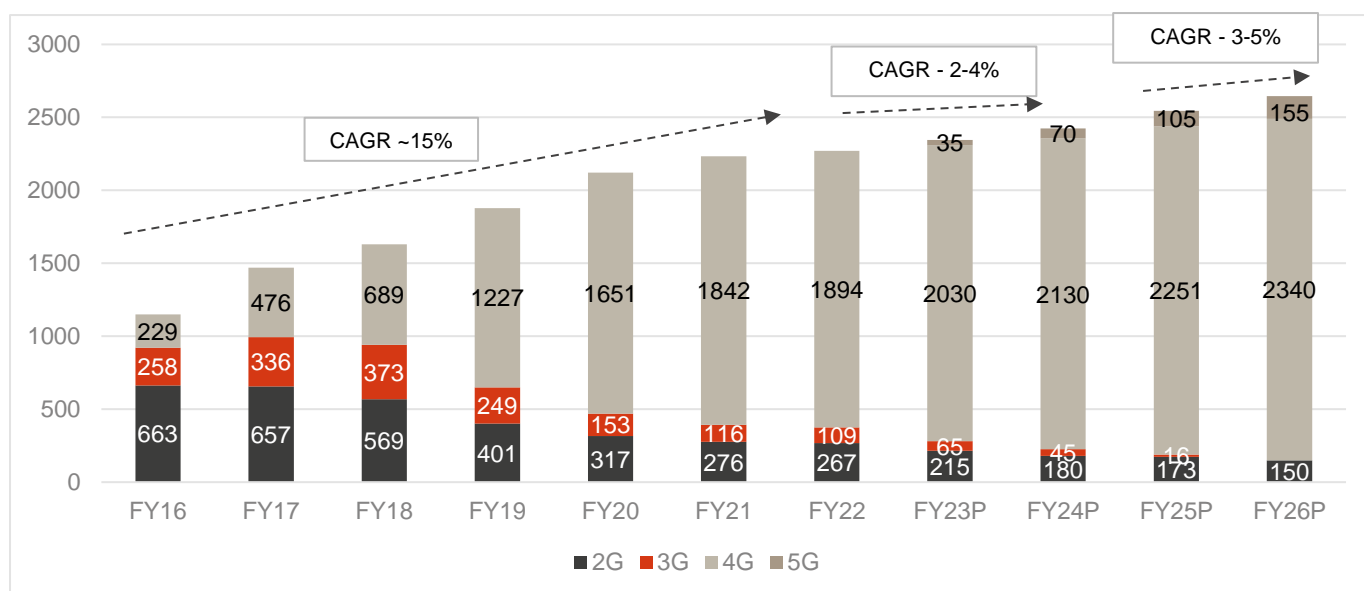
The overall BTS number is expected to grow at 3-5% CAGR between fiscal 2023 and 2026, much lower than the ~7% CAGR during fiscal 2017 and fiscal 2022.

The slowdown can be explained by the following two factors –

- The past growth of ~7% was a result of massive expansion across technologies (2G, 3G, and 4G), as operators were primarily focusing on gaining incremental subscriber market share. With 4G introduction, the spike in data usage/traffic and a significant reduction in data tariffs, incremental BTSs were added by tower companies.
- In fiscal 2022, a ~3% on-year reduction was observed in the number of 2G BTSs and a 6% on-year reduction in 3G BTSs as telecom players were pushing subscribers to switch to 4G. This de-growth continued the back of 13% and 24% degrowth in 2G and 3G base stations in fiscal 2021.

For fiscal 2024, we expect this trend to continue, as telecom service providers encourage subscribers to migrate from 2G and 3G to 4G. In line with this, we project a reduction in 2G and 3G BTSs between fiscals 2023 and 2026, alongside an increase in 4G and 5G BTSs, which is expected to clock ~6-8% CAGR between fiscal 2023 and 2026. Growth in 4G and 5G BTSs is expected to offset the reduction in 2G and 3G BTSs and non-standalone additions, and help overall BTS numbers grow, albeit at a slow pace.

Figure 14: 4G BTSs to lead additions; 5G additions to be moderate



E: Estimated P: Projected

The number on top of each bar denotes '000 BTSs

Single RAN BTSs are counted as two different technologies

Source: Department of Telecom, CRISIL MI&A

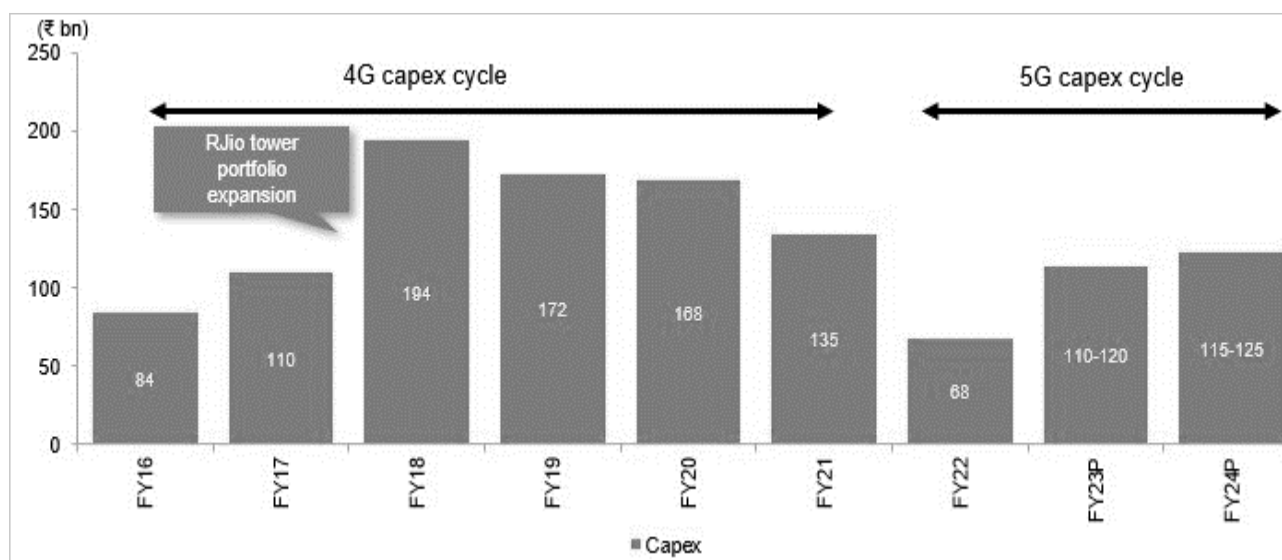
The growth will primarily be driven by the upgradations of the existing tower infrastructure and secondly due to the new tower additions supporting 5G roll out in the country. While Reliance Jio has committed a total investment of Rs 2,000 bn for an ambitious 5G roll-out plan over the next 3-5 years, Airtel is expected to make an investment to the tune of Rs 300-500 bn for the tower's upgradation, enabling the existing infrastructure to be 5G ready. BSNL is likely to put up 20,000 towers under the Bharatnet project. Vodafone Idea may go slow in the 5G adaptation, owing to its weak financial position.

Capex to increase owing to 5G deployment

The telecom towers industry witnessed exponential growth in construction and upgradation capital expenditure (capex) over fiscal 2016-2021 owing to massive network expansion and the 4G rollout. During this period, over ~11,00,000 base transceiver stations (BTS) were cumulatively added to roll out 3G and 4G services. By contrast, only ~1,78,000 BTSs are expected to be added over fiscal periods from 2022 to 2024. This is because telecom companies (telcos) are currently focusing on replacing 2G and 3G tenancies with 4G tenancies to bring their subscriber base under the umbrella of 4G services, thus limiting construction capex growth in fiscal 2023 and 2024 on that front.

While players will likely use alternate technologies such as small cells and MIMO (multiple-input and multiple-output) to augment capacity, the need for speedy 5G deployment will result in both the upgradation of existing 4G towers and installation of incremental towers and BTS. Hence, CRISIL MI&A expects a cumulative capex of ~Rs 300-310 billion over the fiscal 2022-2024.

Figure 15: Capex to increase gradually on account of 5G deployment and 4G upgradations



Note: Our forecast is based on the expansion of operators, estimated mix of ground-based towers (GBTs) and rooftop towers (RTTs), capex required to build a tower, and incremental capex needed to maintain it. But it does not include the capex incurred by telcos to build their captive towers.

Source: CRISIL MI&A

BSNL revival package and a nation wide 4G implementation a boost to the industry

Another booster to the industry is the second revival package of BSNL amounting to Rs. 1.64 Lakh Cr, announced in 2022. The revival measures include infusion of fresh capital for upgrading BSNL services, allocation of spectrum, de-stressing its balance sheet and augmenting its fiber network by merging Bharat Broadband Nigam Ltd. (BBNL) with BSNL, as well as the settlement of adjusted gross revenue (AGR) dues. And in Jun 2023, the third revival package with the total outlay of Rs. 89,047 crore is also announced for the allotment of 4G/5G Spectrum to BSNL, providing further fillip to the telecom industry.

BSNL is also rolling out pan India 4G network and is expected to upgrade 1 lakh tower sites (Including 8k-9k new sites) via upgradation of both communication infrastructure and power infrastructure at these sites.

Aspirational District Scheme has been planned for provisioning of 4G based Mobile Service in 502 uncovered villages of four states -Uttar Pradesh, Bihar, Madhya Pradesh & Rajasthan. Till October 2022, 132 villages have been covered by installing 106 Mobile towers under this project. The Government has further accorded approval to provide 4G Mobile service in 7287 uncovered villages of Aspirational Districts of 5 States namely Andhra Pradesh, Chhattisgarh, Jharkhand, Maharashtra, and Odisha.

Another project for saturation of 4G mobile services in uncovered villages across the country has been approved. The project will provide 4G mobile services in 24,680 uncovered villages in remote and difficult areas. The project has a provision to include additional villages on account of rehabilitation, new-settlements, withdrawal of services by existing operators etc. In addition, 6,279 villages having only 2G/3G connectivity

shall be upgraded to 4G. The project is being executed by BSNL using Atmanirbhar Bharat's 4G technology stack and is funded through Universal Service Obligation Fund.

Construction capex

Capital expended by tower companies to set up new towers is classified as construction capex. We estimate it to have accounted for ~51% of the industry's overall capex in fiscal 2022. With a need for speedy 5G deployment, we expect the pace of tower additions to grow going ahead, which will warrant the share of construction capex to remain constant. Thus, construction capex is expected to constitute ~60% of overall capex till fiscal 2024. Most tower additions will be done in rural areas as the telcos would look to expand their rural subscriber base against an already saturated urban subscriber base (urban tele density is on a decline). Additionally, tower density (per sq km) in urban areas is more than 0.18 towers (with metros having over 20 towers per sq km) versus less than 0.14 in rural areas.

Upgradation capex to account for a majority share in the pie

Transitioning from 4G to 5G requires several technical upgrades for telecom tower companies. They need to invest in new equipment, spectrum, backhaul capacity, network core upgrades, power supply capabilities, security measures, and rigorous testing to successfully transition to 5G technology. The tower sites may need additional antennas to support higher frequencies and beamforming capabilities. Significantly higher backhaul capacity is required for 5G as compared to 4G due to increased data rates and low latency requirements.

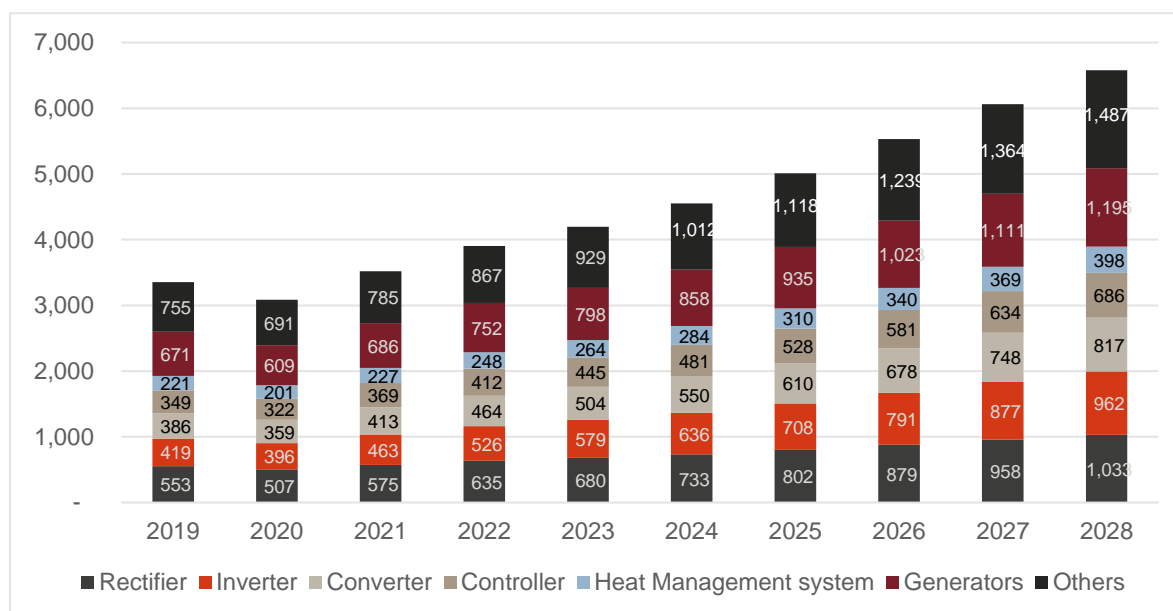
The number of 2G and 3G BTSs is expected to reduce further going forward as operators will push subscribers towards 4G with 3G BTS expected to be completely shut down by fiscal 2023/24. Moreover, 4G BTS additions will also likely slow down as major two players have announced their intent to limit 4G additions and focus on 5G. Incremental 4G BTSs will only be installed in sites that previously housed 2G/3G BTS. However, with the telecom services industry leader preferring a standalone mode of launch, the share of upgradation capex will be impacted.

3. Telecom Power Industry – Global and India

3.1 Global Telecom Power Industry

The increasing demand for mobile data and voice services, the growing adoption of 4G and 5G networks, and the need for reliable and uninterrupted power supply for telecom towers are the key factors driving the growth of the telecom power market. The Telecom Power System (TPS) market is projected to grow at a CAGR of 9.4% from 2023 to 2028, reaching a value of USD 6.6 billion by 2028.

Figure 16: Telecom power market by components, 2019–2028 (USD Million)



Source: Markets & Markets

Within TPS market, DC power systems market including components like rectifiers, inverters, converters, and controllers is expected to grow at a higher CAGR of 9.6%, while remaining market including components like Heat management systems and Generators is expected to grow at 8.4% CAGR over a period of 2023 to 2028.

Brief description of the components of DC power systems:

- **Rectifiers:** DC Systems powered by Rectifiers (AC-DC Converters) convert alternating current (AC) from the electrical grid into direct current (DC) that is suitable for charging batteries and powering telecom equipment. Rectifiers ensure a stable and regulated DC output, maintaining the required voltage levels for proper operation of the entire system.
- **Monitoring and Control Systems:** Monitoring and control systems provide real-time data on the status and performance of the entire DC power system. They allow operators to remotely monitor,

manage, and troubleshoot the system. Monitoring systems help prevent and address issues promptly, ensuring the system's reliability and reducing downtime.

- **Distribution Units:** Distribution units which are usually integrated inside the DC systems distribute the DC power from the rectifiers and batteries to various telecom equipment and loads, ensuring desired power distribution under various circumstances and balancing the load.
- **Grounding and Lightning Protection:** Grounding systems and lightning protection mechanisms ensure the safety of the DC power system and the connected equipment by directing excess electrical energy to the ground and mitigating the risk of lightning-induced surges.
- **Enclosures and Racks:** Enclosures and racks house and organize the various components of the DC power system, protecting them from environmental factors and physical damage and ensure the longevity and reliable operation of the components by providing a suitable environment and preventing unauthorized access.

Here are some of the key trends driving the growth of the telecom DC power system market and telecom ESS market:

- **The increasing demand for mobile data and voice services leading to growing adoption of 4G and 5G networks** – Growth of demand of telecom services at a higher rate than telecom infrastructure requires upgradation of BTS at existing sites or addition of BTS at new tower sites. New high capacity and high efficiency DC power systems and battery backup are required at these sites to service higher loads. 5G densification sites may also require new power systems serving specific needs.
- **The need for reliable and uninterrupted power supply for telecom towers** – To maintain high quality telecom network even in cases of brownouts and blackouts is increasing demand for DC Power systems and associated energy storage solutions.
- **Telecom Power Upgrades:** The older telecom power infrastructure is also more expensive to operate and maintain, which is something telecom operators are starting to become aware of. Cost savings through new high efficiency DC power systems, intelligent energy management, remote O&M, and intelligent hybrid systems are being identified and deployed.
- **Expansion of telecom network in bad-grid and off-grid locations and Increasing use of renewable power:** These are areas where electricity is not continuously available and telecom power infrastructure will see higher CAGR over the forecast period in this segment. With cost of solar panels, converters coming down substantially lot of tower Co's are solarizing ground base towers (especially the ones where electricity condition is poor) in order to reduce Opex. This is leading to an increase in demand for both standalone solar and hybrid DC systems along with energy storage for telecom sites.
- **Solution approach:** Tower Co's and Telco's are increasingly looking for complete Power Management solutions including high efficiency power conversion systems, smart integration of renewable power at site, and providing long cycle life, safe Li-ion batteries with cooling solutions as well. This helps in integration of site power management functions and deliver superior savings and insights.

- **Smart O&M:** Telco's and Tower Co's are using remote management systems to monitor power systems in real-time, predict failures, and schedule maintenance more efficiently.
- **Distributed Power Generation:** Distributed power generation, including microgrids and small-scale renewable installations are gaining traction. These systems add resilience to the telecom infrastructure and reduce dependence on centralized power grids.

Geographic Analysis

The telecom power system market is segmented into four key regions: North America, Europe, APAC, and RoW. APAC is expected to dominate the market during the review period, holding a 44.7% share in 2022. Europe is projected to hold a 23.8% share, followed by North America at 15.4%. The telecom power system (hybrid) market is concentrated in APAC due to its large population and the resulting growth of the telecom industry.

Asia Pacific is expected to grow at a CAGR of 11.3% during the forecast period. North America is a developed region for both the telecom sector and the telecom power system market. As a result, the market in this region is expected to have a lower CAGR of 6.2% by 2028 compared to other regions. This slower growth can be attributed to the fact that the market is already well-developed in this region, and there is less room for growth.

Certain countries such as South Korea and Canada, have embraced and implemented 5G network services ahead of others. Simultaneously, startups have concentrated on emerging digital service trends such as cloud computing, network security, and enhanced connectivity technologies. These developments have contributed to the overall growth of the telecommunications sector, subsequently driving expansion in the telecom power system market.

Table 6: Telecom power system market, by region, 2022–2027 (USD million)

Region	2023	2024	2025	2026	2027	2028	CAGR
North America	630.2	665.1	711.1	762.3	810.7	852.6	6.2%
Europe	984.1	1,049.6	1,134.6	1,230.6	1,324.6	1,410.9	7.5%
Asia Pacific	1,911.0	2,110.4	2,362.1	2,652.7	2,956.6	3,261.3	11.3%
RoW	671.9	728.8	801.6	884.7	969.4	1,051.6	9.4%
Total	4,197.2	4,553.9	5,009.3	5,530.3	6,061.2	6,576.4	9.4%

Source: Markets & Markets

Note: This includes all DC power systems (rectifiers, inverters, controllers, converters), Heat Management Systems, & Generators

APAC experiences high market growth due to increased telecom tower penetration in rural areas, expanding the mobile network for a growing subscriber base and improved connectivity. Meanwhile, North America's market growth is driven by its concentration of prominent telecom power sector companies. The region prioritizes innovative technologies and conducts extensive research and development activities, contributing to market expansion.

United States of America (USA/US)

The US is a global leader in 4G/LTE and 5G technologies, with 99.6% of its population having access to 4G, providing high-speed and secure connections. This widespread availability of mobile broadband at fast speeds supports the adoption of advanced technologies like IoT, robotics, big data analytics, and critical data communication. Organizations can establish dedicated LTE or 5G networks for uninterrupted operations and efficient communication, offering flexibility to workers.

Moreover, the US National Security Council plans to build its 5G wireless network infrastructure which will drive demand for telecom power systems. The presence of chip providers like Qualcomm, Intel, and Cisco, along with network infrastructure providers such as AT&T, T-Mobile, and Verizon, further strengthens the market. With ongoing research and development in the telecom sector, the US is poised to lead the North American telecom power system market.

United Kingdom (UK)

As of January 2023, there were 66.11 million internet users in the United Kingdom, and the internet penetration rate stood at 97.8% of the total population at the start of 2023. In March 2021, the number of smartphone users in the UK rose to 53.5 million, making it 78.9% of the population. These numbers are expected to increase continuously in the coming years. The UK is witnessing a growing trend of transforming cities into smart cities, supported by its robust economic, social, and technological foundations. Key telecommunication service providers like Vodafone Group and British Telecom (BT) are collaborating with leading telecommunication solution vendors to offer technologically advanced network solutions, including telecom power systems, throughout the country.

China

China is the largest economy in the Asia-Pacific region, with a nominal GDP of \$19.37 trillion in 2023. The telecom industry in China is mainly governed by three companies, namely China Mobile, China Unicom, and China Telecom, which have mobile networks as well as fixed-line telecom services. These companies were issued 5G licenses for commercial use in 2019. As of June 2022, China had 1.05 billion internet users, with 99.6% of them being cellphone users, and over 1.62 billion mobile phone subscribers. China is the world's largest mobile markets, telecom tower market and drives large demand for the telecom power systems and the batteries. It is a significant player in the APAC telecom power system market due to its investments in network infrastructure and the presence of major telecom companies like China Telecom and China Mobile.

The country's dense population drives the demand for mobile and data connectivity, leading to a focus on deploying advanced wireless infrastructures for enhanced connectivity.

Japan

Japan is renowned for its robust communication network infrastructure. The advancement and implementation of cutting-edge telecom network infrastructures offers a favorable environment for telecom power system providers to establish their leadership in the industry. The Ministry of Internal Affairs and Communication, along with the Communications Ministry of Japan, have actively supported domestic companies in launching 5G mobile services, creating further opportunities in the telecom sector. Major telecommunication operators in Japan, namely NTT Docomo, KDDI, SoftBank, and Rakuten, have received government approval for substantial investment plans amounting to USD 14.4 billion. These investments aim to develop wireless networks and will be carried out by the four mobile carriers mentioned above. By 2024, these top operators plan to deploy 140,932 5G base stations across the country, presenting significant opportunities for telecom power system providers.

Australia

The Australian telecommunications market size was valued at USD 21.78 billion in 2023. Telstra is the largest telecommunications company in Australia by market share, providing 18.8 million retail mobile services, 3.8 million retail fixed bundles and standalone data services, and 960,000 retail fixed standalone voice services. Other telecom operators in Australia include Optus, TPG Telecom, VHA, NBN, and more. Optus and Telstra combined own more than 50% of the telecom towers in Australia.

In partnership with Horizon Power, Telstra has implemented an off-grid power solution at cell towers in western Australia. This solution utilizes solar power as the primary source, supported by battery storage, to enable the transition of remote mobile towers from overhead power supply to a Standalone Power System (SPS). As the telecom infrastructure and power systems continue to improve and expand, TPG Telecom has announced its commitment to operate entirely on renewable energy sources for its telecom operations by the end of 2025.

Market share analysis

Delta Electronics from Taiwan, Eaton from Ireland, Huawei Technologies from China are the leading companies in the telecom power system market. These top three players collectively hold around ~50% of the market share, indicating a consolidated market structure.

Table 7: Telecom power system market: Degree of competition, 2021

Degree of Competition	Consolidated
Total Market Share of Top 3 Players	55–74%
Delta Electronics	15–19%
Eaton	13–17%
Huawei Technologies	10–14%

Source: Markets & Markets

As per Markets and Markets data, other key players in telecom DC systems are ZTE, Eltek and Vertiv group. However, the market has also seen the entry of several small and medium-sized enterprises in recent years, like Unipower (US), Dynamic Power (China), and Exicom tele-systems (India) adding further dynamism to the industry.

3.2 Indian Telecom DC power systems

Telecommunication power systems are specialized systems designed to provide reliable and uninterrupted power supply to telecommunication infrastructure, such as cell towers, base stations, data centers, and network facilities. These systems ensure that the telecommunication equipment remains operational even during power outages or unreliable grid conditions. These are the integrated systems that manage the generation, conversion, distribution, and control of electrical power. They are designed to provide reliable and efficient power supply to various electrical loads.

As per markets and markets, India is expected to be the fastest growing market at 10-12% CAGR over the period from 2023 to 2028, while other economies like North America and Europe will grow at 5-6% CAGR over the same period. The growth is mainly going to come from upgradation capex which Telco's are doing in light of network upgrades, efficiency measures and new tower additions.

Key stakeholders of the Indian Telecom Power Industry:

Major stakeholders are tower companies and operators, who have their captive telecom infrastructure require telecom power for their infrastructure needs. Then there are Mobile Switching Centres and Base Station Controllers, which also require power for their functioning.

Table 8: Stakeholders - Telecom power system market

Stakeholder	Role and Function
Telecom Operators	Provide telecommunication services and operate telecom networks
Telecom Tower Companies	Own and manage telecom tower infrastructure, lease tower space to operators
Power Solution Providers	Design, develop, and supply power solutions and infrastructure for telecom networks
Equipment Manufacturers	Produce telecom equipment, collaborate with power solution providers
Power Infrastructure Providers	Deploy and manage power infrastructure, ensure grid power supply to telecom equipment
Government Regulatory Bodies	Regulate the telecom sector, establish guidelines and standards
Renewable Energy Authorities	Promote and regulate the adoption of renewable energy sources in the telecom industry
System Integrators	Execute critical infrastructure turnkey EPC projects

Source: CRISIL MI&A

As per the stakeholder list tabulated above, key DC power solution providers are Delta Electronics, Exicom Tele Systems, Vertiv Energy, Lineage Power, Vrinda Nano Technologies, and Greenpole Power Solutions. While key players in backup power segment who provide Li-ion based ESS solutions are Exicom Tele Systems, Coslight India, Vision India, Exide, and Amara Raja.

Table 9: Players - Telecom power solution providers

Players	DC Power Systems	Telecom ESS
Delta Electronics India		
Vertiv Energy		
Lineage Power		
Greenpole Power Solutions		
Vrinda Nano Technologies		
Exicom Tele-Systems		
Coslight India		
Amara Raja Batteries		
Exide Batteries		
Vision Batteries		

Source: CRISIL MI&A

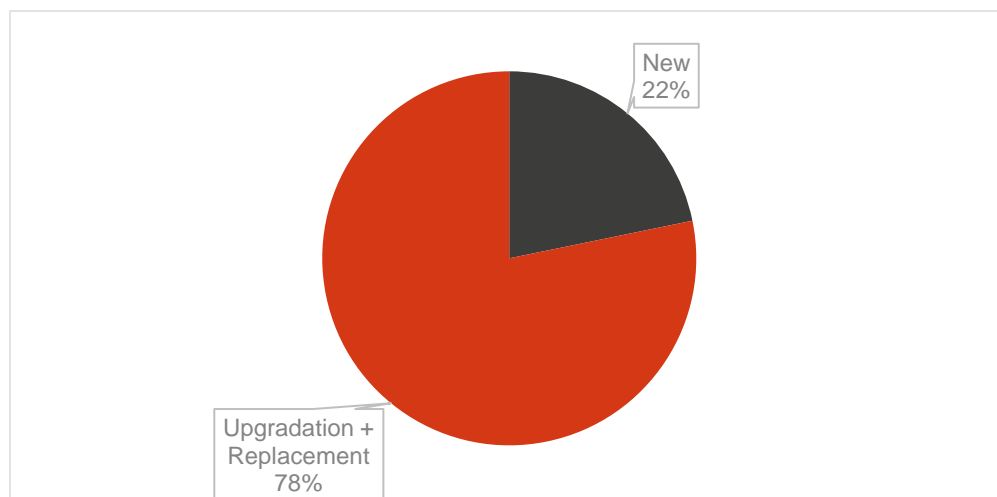
Owing to the tropical climate of the country, the Indian telecom power industry faces challenges such as high temperatures of 50 degrees Celsius during the summer months. On the other hand, voltage fluctuations and surges on grid lines are quite common especially if the telecom tower sites are close to nearby process industries. Inadequate maintenance of telecom sites also makes the sites prone to dust and high voltages. With such differing conditions and challenges across the length and breadth of the country, it becomes extremely important for the incumbent players to offer customised solutions meeting the diverse need of the country which can tolerate harsh environmental and electrical conditions.

Power outages in rural and distant locations are another set of problems faced by the telecom industry. As per the India Residential Energy Survey (IRES) 2020 survey done for the Council on Energy, Environment and Water (CEEW), on an average, urban locations face a 2-hour outage daily, while rural areas face a 4-hour outage and many bad grid sites face over 12 hours of outage as well. Hence, the need to have a reliable power electronics system to run the telecom towers.

Market size

The market size for telecom DC power systems (Including hybrid systems) is estimated at Rs ~15 bn for fiscal 2023. The upgradation and replacement demand are expected to drive the industry with 75% demand coming from the segment, while the balance 25% demand is expected on account of new tower additions.

Figure 17: New & Upgradation + Replacement mix



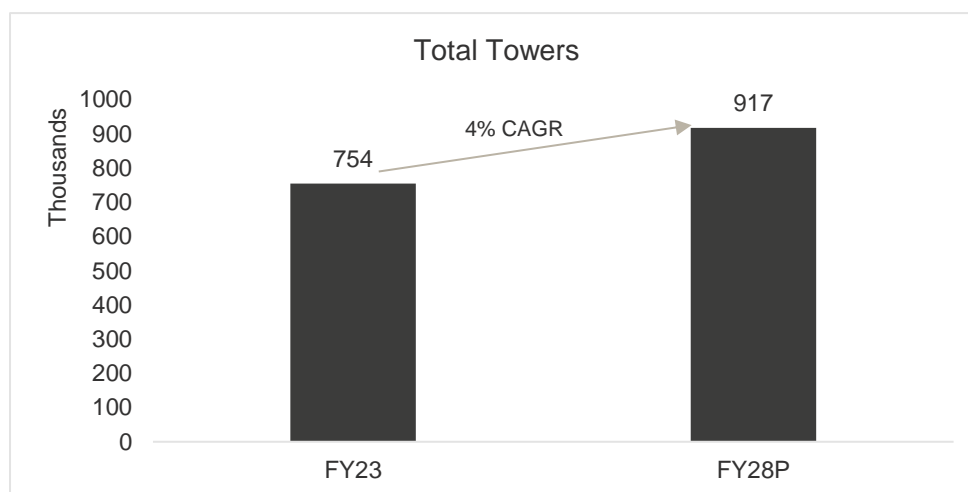
Source: CRISIL MI&A

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However, going forward, the new tower additions are expected to grow modestly at a CAGR of 4.0% from 7.5 lakh in fiscal 2023 to 9.0-9.2 lakhs by fiscal 2028. And most of the capex will happen towards upgradation of the towers for 5G, as almost ~80% of fiscal 24 tower population is expected to be upgraded by fiscal 28.

Hence, the growth in telecom DC power systems is expected to be driven primarily by the upgradations of the existing tower infrastructure and secondly due to the new tower additions supporting 5G roll out in the country and various government programs for enhancing the rural connectivity.

Figure 18: Tower infrastructure outlook (No of towers)



Source: CRISIL MI&A

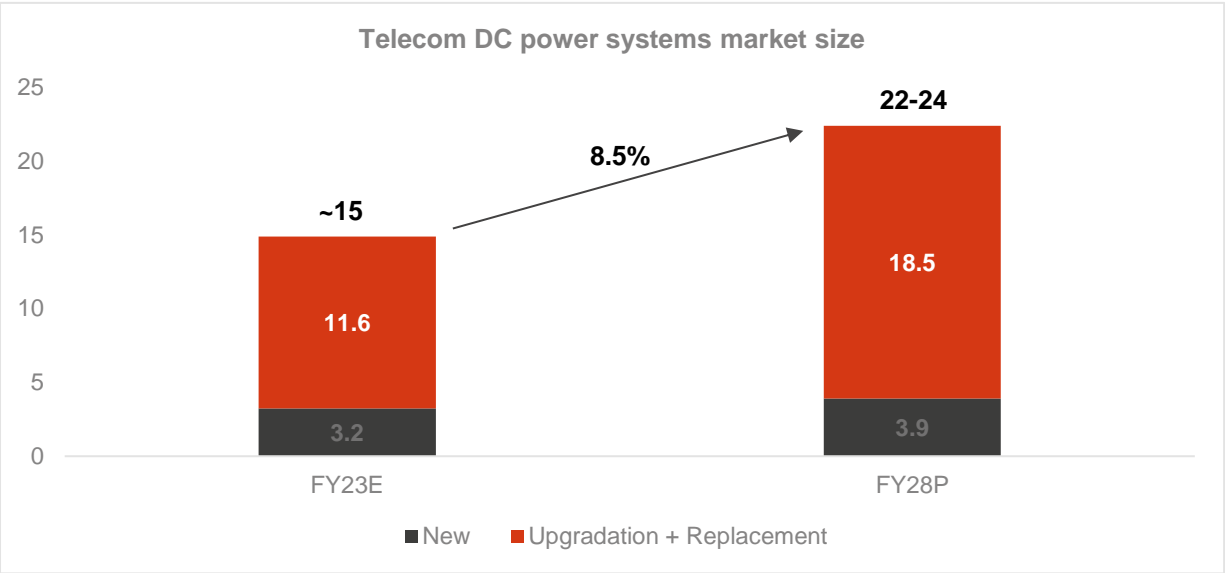
We expect upgradations to be done by Indus towers, Summit Digitel and other towers companies, while a significant share of new tower additions to be mainly put up for Reliance Jio’s 5G roll out. BSNL is also rolling out pan India 4G network and is expected to upgrade 1 lakh tower sites (Including 8k-9k new sites) via upgradation of both communication infrastructure and power infrastructure at these sites.

Under GoI 4G saturation program of connecting uncovered villages, BSNL is expected to install sites for 24360 villages across the country. All these sites are expected to be powered by solar energy and to have lithium-ion batteries for the power backup solutions.

To arrive at the market size, we have categorized the telecom towers in three power ratings, < 12kW, 12kW to 30 kW and >30 kW. Based on the primary interactions with the stakeholders, the cost of a typical DC power system has been arrived at. As the power rating increases, switch gear rating increases too, thus for every 20-40 kW, a 20-25% escalation in the base cost is being taken. For instance, for a tower of power rating of 15 kW, the cost of DC power system comes to Rs 60,000, while for a higher power rating of 30kW, the cost of the system would come to Rs 1,50,000 incorporating the escalation.

The telecommunications power systems market in India is expected to grow from ~ ₹15 billion in fiscal 2023 to ₹ 22 to 24 billion in fiscal 2028 at a CAGR of 8.5%, with an aggregate market potential of Rs 90-95 bn over the next 5 fiscals.

Figure 19: Telecom DC power systems market size (Rs bn)



Source: CRISIL MI&A

Key players in the Indian telecom DC power systems

Delta Electronics India Limited

Delta Electronics India Limited is a subsidiary of Delta Electronics, a global leader in power and thermal management solutions. They are operating in India since 2003 and is part of Delta, founded in 1971 with its Global Headquarters in Taiwan. It has a legacy of operating in India with market leadership in Telecom Power Solutions, Renewable Energy Solutions (Solar Inverters) and Display Solutions. It is also a leading provider of Industrial Automation Solutions, UPS & Datacenter Solutions, EV Charging Solutions, Rail Transportation Solutions, Energy Storage Solutions, DC Fans & Blowers, and Components. With more than 200 channel partners, sixteen regional offices, three manufacturing facilities (Rudrapur, Gurgaon, and Hosur), and two R&D centres (Gurgaon and Bengaluru), Delta has a significant presence throughout India.

Exicom Tele systems Ltd

Founded in 1994, Exicom Tele-Systems operates 3 Critical Power manufacturing facilities (in Gurgaon and Solan) for rectifiers, controllers, power systems and Li-ion batteries with capability to manufacture up to 2,00,000 modular rectifiers, up to 35,000 power systems, and 50,000 Li-ion batteries per year operating in critical power segment.

In Critical Power, it has leading Telco's and Tower Co's as its customers across India, Southeast Asia and Africa and is one of the few players having both DC Power and energy storage as part of its portfolio. The company makes a complete range of DC Systems including Indoor, Outdoor and Hybrid systems for all types of applications in telecom networks based on its, in house designed and manufactured rectifiers (AC-DC converters) and controllers. Exicom managed to garner ~16% market share in DC Power Systems. Exicom has already deployed 450,000 Li-ion batteries in telecom as of fiscal 2023 translating to over 2.0 GWH of storage capacity making it one of the leading players in this segment.

Vertiv energy

Vertiv Group Corporation is a global leader in designing, building, and servicing critical infrastructure for data centers, communication networks, and commercial and industrial facilities. The company offers hardware, software, analytics, and ongoing services to enable customers' applications to run continuously, perform optimally, and grow with their business needs. Vertiv's primary customers are businesses across three main end markets: data centers, communication networks, and commercial and industrial environments. The company's principal offerings include critical infrastructure solutions such as AC and DC power management, thermal management, and integrated modular solutions, integrated rack solutions, and services and spares.

Vrinda Nano Technologies

Vrinda Nano technologies (VNT) designs and delivers mission-critical technologies for high-growth segments, including data centers, telecommunication systems, utility-scale solar projects, commercial and industrial facilities. VNT offers electrical health safety, earthing, energy audit, PQ and thermography, lighting protection,

corrosion, and fire safety services. VNT currently serves the tower infra of lower power ratings, mostly less than 20 kW.

Greenpole

GreenPole is a leading global provider of efficient and green hybrid power solutions and related products for various industries in emerging markets. They design, engineer, and manufacture turnkey hybrid power solutions, including UPSs, gen-sets, batteries, solar streetlights, solar aviation lights, and renewable power. Their hybrid solution combines grid, genset, batteries, and renewable energy, ensuring lower fuel consumption. They also offer full turnkey low-cost solar powered telecom sites.

3.3 Indian Telecom Energy Storage Systems (ESS) - Lithium-Ion

Telecom ESS store electrical energy for later use to run telecom infrastructure. They can be integrated with other power backup solutions like UPS, generators, or solar power systems to provide reliable and efficient power backup for telecom infrastructure. Telecom power backup solutions are critical for ensuring uninterrupted operation of telecommunication networks, particularly during power outages or fluctuations. These backup solutions provide reliable and continuous power supply to telecom equipment, minimizing service disruptions and maintaining communication services.

However, Telecom ESS are part of the overall ESS gamut. India's installed renewable capacity has crossed the 150GW mark and this brings the total non-fossil fuel based installed energy capacity at 156.8 GW which is 40.1% of the total installed capacity of 390.8GW. At the recently concluded COP26, the government is committed to achieving 500GW of installed electrical capacity from non-fossil fuel sources by the year 2030. With this the need for Battery Energy Storage Systems is estimated to rise to maintain grid stability. In addition to grid storage, the BESS systems will be used mainly for providing backup, replacement of diesel gensets and with UPS in various commercial and industrial use cases and telecom is one large sector in such use cases.

A few years back, telecom ESS segment was largely dominated by Valve Regulated Lead Acid (VRLA) batteries. However, the landscape changed, after Jio rolled-out close to 2 lakh towers with Lithium-Ion (Li-ion) batteries. As a result, there is almost an equal mix of VRLA and Li-ion batteries in the current tower population.

Benefits of Li-ion batteries

Lithium-ion batteries offer several advantages over other types of rechargeable batteries, making them the most popular type of rechargeable battery, making them ideal for use in telecom applications and they are continuing to become more popular as technology improves, and the cost of lithium-ion batteries decreases.

Table 10: Comparison table of basic features of VRLA & Lithium-ion batteries

Feature	VRLA Batteries	Lithium-ion Batteries
Chemistry	Lead-Acid	Lithium-Ion (LFP)
Specific Density	Heavier weight	Lighter weight
Volumetric Density	Larger physical size	Smaller physical size
Charging Rate	Lower charging rate	Higher charging rate
Cycle Life	Lower cycles	Higher cycles
Scalability	Non-Scalable	Modular and scalable
Self-Discharge Rate	Higher self-discharge rate	Lower self-discharge rate
Charge Efficiency	Moderate charge efficiency	Higher charge efficiency
Temperature Range	Lower operating range	Higher operating range
Cost	Lower initial cost	Higher initial cost
Safety	Generally safe, but can release hydrogen gas	Generally safe, but risk of thermal runaway

Feature	VRLA Batteries	Lithium-ion Batteries
Environmental Impact	Contains lead and sulfuric acid, requires proper disposal	Lower environmental impact, recyclable

Source: CRISIL MI&A

Variety of telecom applications, where Li-ion batteries are increasingly being used -

- **Base station backup:** Provide backup power to base stations in the event of a power outage.
- **Central office facilities:** Backup for large telecom central offices that house critical equipment for routing and managing telecommunications traffic.
- **Hybrid Renewable sites:** A Larger backup at base station sites powered by renewable energy to use solar during evening hours and autonomy.
- **Small cell & densification sites:** Smaller and stand-alone Li-ion batteries for backup during grid failure
- **Other telecom applications:** Used in wi-fi sites, and routers.

Entry barriers for Li-ion batteries

- **Battery Chemistry and Safety:** Selecting the appropriate battery chemistry is crucial to meet the specific requirements of telecom applications. Ensuring the safety of the batteries, particularly in terms of thermal management and prevention of thermal runaway, is paramount in hot weather conditions. Partnership with a cell supplier having cells for Indian environment conditions is important for independent battery pack companies.
- **Battery Management System (BMS):** Designing an efficient and reliable BMS that manages charging, discharging, monitoring of individual cells, modules, pack, and that functions optimally to elongate battery life is essential. The BMS also has to provide multi-layer protection and has algorithms for accurate SOC (state of charge) and SOH (state of health) enabling efficient customer operations. Designing BMS is a complex task and needs multi skill set technology teams.
- **Supply Chain and Raw Materials:** Securing a stable supply of raw materials like lithium, cobalt, and nickel can be challenging due to market fluctuations and geopolitical factors. The supply of lithium carbonate which is the main raw material in LFP cells is concentrated in China and has fluctuated a lot in terms of price since COVID. To reduce risk of specialized material availability and pricing, batteries based on more commonly available raw material like Sodium ion are being explored by many global battery companies.
- **Environmental Concerns:** Addressing environmental concerns related to battery disposal and recycling is increasingly important, and compliance with environmental regulations can be challenging so appropriate tie ups with re-purpose and recycling companies is important for battery pack players.
- **Customization for Telecom:** Telecom battery packs often require customization to fit specific size, voltage, capacity and require integration with 3rd party equipment's such as DC Power systems, diesel gensets or remote monitoring systems. Also, in telecom applications, multi batteries are usually connected in parallel to meet desired capacity, which is technically challenging, and it is required for

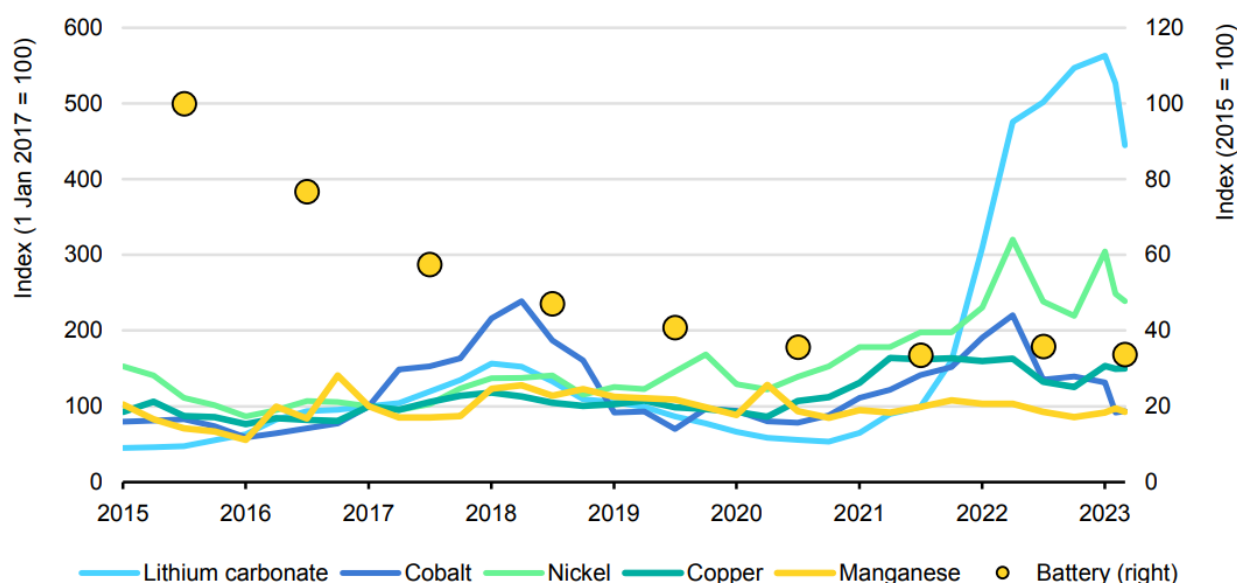
Battery Management System “BMS” to be able to handle such configurations. Players need to meet such customizations while maintaining cost-effectiveness.

- **Scaling Production:** Transitioning from small-scale development to large-scale production can be challenging and requires significant operational adjustments to deliver consistency.

Telecom ESS market overview (Li-ion batteries)

The prices of lithium-ion batteries have been declining steadily in recent years. This is due to several factors, including increased demand, technological advancements, and economies of scale. As lithium-ion batteries become more affordable, more telecom operators will switch to this technology from lead-acid batteries as they are less efficient and have a shorter lifespan than lithium-ion batteries. Compared to 2022, The US National Renewable Energy Laboratory (NREL) expects the costs of the batteries to fall by 47%, 32% and 16% by 2030 in its low, mid and high-cost projections, respectively. By 2050, the costs could fall by 67%, 51% and 21% in the three projections, respectively.

Figure 20: Price of selected battery materials and lithium-ion batteries, 2015-2023



Notes: Data until March 2023. Lithium-ion battery prices (including the pack and cell) represent the global volume-weighted average across all sectors. Nickel prices are based on the London Metal Exchange, used here as a proxy for global pricing, although most nickel trade takes place through direct contracts between producers and consumers. The 2023 battery price value is based on cost estimates for NMC 622.

Source: IEA analysis based on material price data by S&P, 2022 Lithium-Ion Battery Price Survey by BNEF and Battery Costs Drop as Lithium Prices in China Fall by BNEF. IEA. CC BY 4.0.

Telecom operators are using lithium-ion batteries to support new technologies, such as 5G and the Internet of Things (IoT). These technologies require a lot of power, and lithium-ion batteries are the most efficient and reliable way to provide this power.

Thus, the battery mix is expected to get skewed towards Li-ion in the years to come, as the towercos may move towards this alternative owing to its significant advances. We believe the addition to the existing population will be in the ratio of 85% for Li-ion and 15% for VRLA batteries.

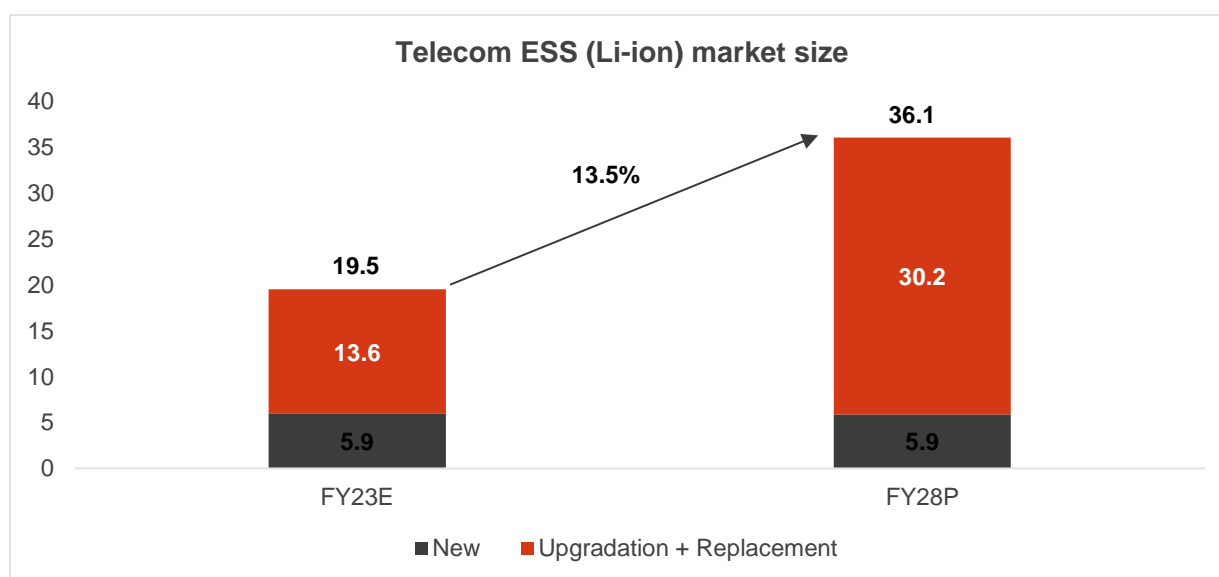
The growth of Li-ion in telecom will primarily be driven by the upgradations of the existing tower infrastructure and secondly due to the new tower additions supporting 5G roll out in the country.

- While Reliance Jio has an ambitious 5G roll-out plan over the next 3-5 years via new captive sites & tower sharing, Airtel is also expanding its 5G network, and making its existing tower infrastructure 5G ready via third party tower providers, mainly, Indus towers.
- Leading Indian Tower Co's such as Indus Towers and American Tower Corp who traditionally used to buy lead acid batteries have converted majority of their procurement to Li-ion batteries from fiscal '24.
- Vodafone Idea may go slow in the 5G adoption, owing to its weak financial position.
- BSNL recently awarded a large Li-ion battery tender for network augmentation amounting to ~21K battery packs in India. Other large projects being executed by BSNL such as 4G rollout and uncovered village connectivity are expected to drive demand for lithium ion-based battery packs over the next 3 years.

Market Size

The energy storage solutions market for telecommunications is expected to grow from Rs 19.5 billion in fiscal 2023 to Rs 36.1 billion by fiscal 2028 at a CAGR of 13.5%, with an aggregate market potential of Rs ~150 bn over the next 5 fiscals. Based on the price trends of Li-ion, we have assumed for de-escalation of -3.0% in the prices of the Li-ion batteries.

Figure 21: Telecom ESS market size (Li-ion) (Rs bn)



Source: CRISIL MI&A

Table 11: Backup power requirement for different power rating towers

Power ratings range	Typical power requirement	No of batteries required of 4 kW
< 12 kW	4 kWh	1
12 kW- 30 kW	12 kWh	3
> 30 kW	20 kWh	5

Source: Industry interactions, CRISIL MI&A

Telecom ESS is only a part of the overall ESS gamut. Globally, ESS are largely categorised into two major application buckets transportation and stationary. The stationary segment is further divided into Grid related, Industrial (Motive storage e.g., forklifts, followed by UPS and telecom applications), and Pump Storage Hydropower (PSH). Hence, the players catering to telecom ESS currently can also cater to industrial UPS, data centre, solar, and large-scale grid connected C&I projects.

Regulatory landscape

The regulatory landscape is aimed at promoting overall adoption of electric vehicles, use of storage in India's grid ecosystem and promotion of local cell manufacturing which will ultimately bring down cost of Li-ion battery products for all sectors.

- Production Linked Incentive (PLI) scheme: The government has launched a PLI scheme for ACC battery manufacturing with an outlay of INR 18,100 crore (US\$2.49 billion). The scheme is designed to attract investments in ACC battery manufacturing and to help India develop a domestic supply chain for ACC batteries.
 - The players who have been successfully awarded include Reliance New Energy Solar Ltd (20 GWH), Rajesh Exports (5 GWH), Hyundai Global Motors Company Ltd, while Exide industries (6 GWH), Amar Raja Batteries (12 GWH) and Larsen & Toubro are waitlisted (5)
- FAME India scheme: The government's FAME India scheme provides subsidies for electric vehicles. The subsidies are intended to make electric vehicles more affordable and encourage their adoption in India.
- There have been several other initiatives to promote Battery Energy Storage Systems "BESS" including RTC Power amendment by MOP to include storage; MOP draft proposal on incentives for rooftop solar plus storage projects, classification of Storage assets under Electricity Act 2003, allowing BESS to participate in ancillary services and VGF support by Central Government for BESS with an initial outlay of INR 9,400 Cr

These initiatives are expected to boost the demand for ESS in India and provide opportunities for domestic players to grow their businesses and thus offers an opportunity for domestic players to emerge and become key players.

Key players in the Indian telecom power backup systems

Coslight India

Coslight India, a subsidiary of Coslight International Group, is a leading manufacturer of batteries for industrial, solar, telecom, and electric vehicle applications. Established in 2007, Coslight India has production facilities in Una, Himachal Pradesh, and IMT Manesar, Gurgaon, Haryana. Their products are known for their reliability, security, economy, long-lasting, and environmental friendliness. Coslight India specializes in telecom integrated power units, DC-DG hybrid power systems, polymer/prismatic lithium-ion batteries, lithium solutions, and VRLA batteries.

Exicom

Founded in 1994, Exicom Tele-Systems operates in 2 key business verticals – Critical Power and electrical vehicle supply equipment. In Critical Power, it has leading Telco's and Tower Co's as its customers across India, Southeast Asia and Africa and is one of the few players having both DC Power and energy storage as part of its portfolio. Exicom has already deployed 450,000 Li-ion batteries in telecom as of fiscal 2023 translating to over 2.0 GWH of storage capacity making it one of the leading players in this segment.

Exide India Limited

Exide India Limited is a leading Indian battery manufacturer. With nine strategically placed factories, including seven dedicated to batteries and two producing home UPS systems, Exide provides comprehensive solutions for equipment selection, sizing, installation, operation, and maintenance. They also manufacture lead acid storage batteries for various industries, including automotive, power, telecom, infrastructure, and defense. Exide's manufacturing capabilities have a global scope due to partnerships with East Penn Manufacturing in the US, Oldham in the UK, and Furukawa in Japan. The brand prioritizes client needs and technological expertise, ensuring quality, performance, and service support for its products.

Amara Raja Batteries Limited (ARBL)

Amara Raja Batteries Limited (ARBL), a leading Indian battery manufacturer, offers a diverse range of lead-acid batteries for various applications, including automotive, industrial, and home use. ARBL is the preferred supplier to major telecom service providers, telecom equipment manufacturers, UPS sector, Indian Railways, and Power, Oil & Gas, Motive industry segments. The company manufactures home UPS/Inverter batteries under the brands Amaron and PowerZone™, distributed through a pan-India sale & service retail network. With a focus on sustainability and renewable energy, ARBL has ventured into lithium-ion batteries, an emerging segment in the energy storage market.

4. Energy Storage Systems (ESS) for Data Centres

The launch of 4G and 5G services, coupled with price war, has led to a paradigm shift in data usage and trends in the country. India is amongst the highest mobile data consumption rate in the world, with data usage of ~20 gigabytes per data subscriber per month at present. Added to this, corporate embrace of advanced technologies such as Internet of Things (IoT) and big data analytics is driving cloud consumption. This has led to a spurt in data centres demand in the country.

In a digitally connected world, the importance of data centres is huge. Data Centres are economic warehouses and provide the highly resilient infrastructure to ensure uninterrupted critical services to its customers with 100% uptime so that the business, operations, and systems of its customers including their equipment/servers (wherein data, platforms and apps are stored) function efficiently, effectively, and above all continuously. Companies and even government organisations are increasing their dependence on storing important data in a secure environment of data centres.

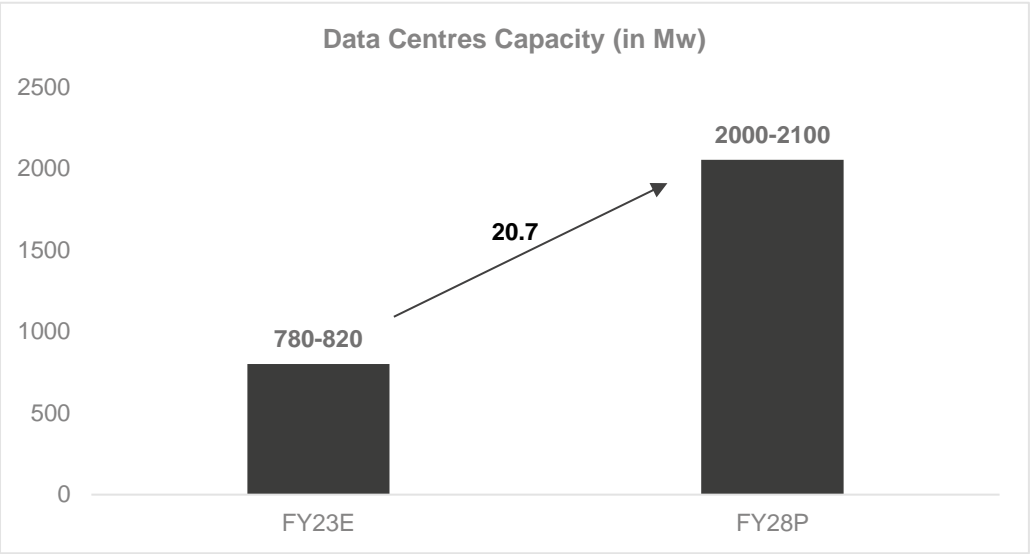
This growth is further propelled by visionary government schemes and initiatives such as Digital India, Make in India, Atmanirbhar Bharat, and subsidised land and stamp duty exemption, and others.

Some of the other key trends that are expected to shape the growth of data centers in India in the coming years:

- **The rise of edge computing:** Edge computing is a distributed computing paradigm that brings computing and data storage closer to the end-user. This can help to improve performance and reduce latency for applications that require real-time processing.
- **The growth of artificial intelligence (AI) and machine learning (ML):** AI and ML are becoming increasingly important for a wide range of applications, including facial recognition, natural language processing, and fraud detection. This will drive the demand for data centers that can provide the high-performance computing resources needed to run these applications.
- **The increasing adoption of blockchain technology:** Blockchain is a distributed ledger technology that can be used to record transactions in a secure and transparent manner. This has the potential to revolutionize a wide range of industries, including finance, supply chain management, and healthcare. The growth of blockchain technology will also drive the demand for data centers.

Data centres capacity in India is expected to double to 1,340-1360 megawatts (MW) by fiscal 2025 from 780-820 Mw in fiscal 2023, powered by the troika of data boom, digital adoption, and local data storage mandates, and further by fiscal 2028, it is expected to reach to 2,000-2,100 MW.

Figure 22: Data Centres capacity in India



Source: CRISIL MI&A

The coastal cities such as Mumbai and Chennai are likely to lead the capacity addition race, given their proximal access to sub-sea cables, optic fiber connectivity, uninterrupted power supply, and availability of skilled manpower. Mumbai, the financial capital of the country accounts for around half of the existing capacity and is expected to add ~200-300 MW further by fiscal 2025, while Chennai, Hyderabad and Pune will together add a further ~300-400 MW or so. All that capacity addition will require hefty investments, estimated at over Rs 40,000 crore to double the capacity base from current levels.

Data Centres require continuous uninterrupted power supply to cool the servers placed in racks. Thus, power alone accounts for 45-50% of their operating costs. Given the criticality of power, data centres operators need to keep enough back-up power for any outage in grid power, to meet service level agreements.

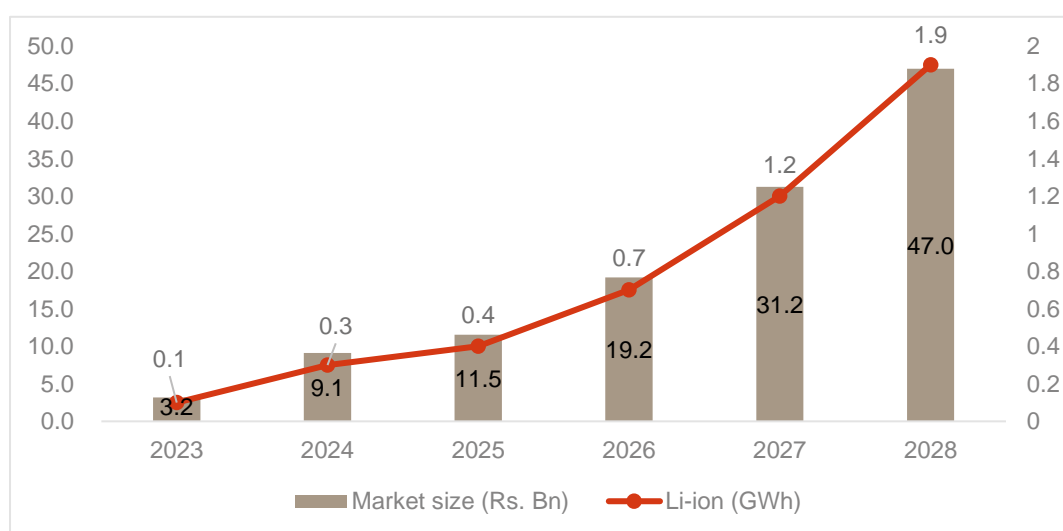
The energy storage systems help data centers optimize their energy usage, manage peak demand, and provide backup power during grid outages. These systems help data centers optimize their energy usage, reduce costs, and contribute to sustainability goals by reducing reliance on grid electricity during peak demand periods.

As more services are delivered to the network edge, there is a need to expand the number of data centres, which, in turn, require cutting-edge battery solutions. The proliferation of data centres has heightened the demand for accompanying infrastructure. This infrastructure's cost encompasses various components, including field operations, facility management, procurement, and information technology usage, posing a considerable challenge for companies looking to invest in energy solutions. Furthermore, reducing energy

expenses requires substantial resources, both in terms of labor and capital, precisely when operators are directing their investments toward expanding network capacity and coverage. However, the introduction of new battery solutions holds the promise of significant energy cost reductions, enabling operators to allocate their funds to other critical areas. For example, lithium-ion battery manufacturers are actively working on technological advancements and price reductions, which are poised to positively impact overall market growth.

The market size for lithium ion-based battery energy storage systems for data centres is estimated at Rs ~3.2 bn for fiscal 2023 and is projected to grow to Rs ~47 bn by fiscal 2028, with an aggregate market potential of Rs ~120 bn over the next 5 fiscals, as per India Energy Storage Alliance (IESA).

Figure 23: Market size of lithium-ion battery energy storage systems in Data Centres (Rs bn)



Source: India Energy Storage Alliance

5. Electric Vehicles (EV) Industry – Global & India

5.1 Global EV industry

Driven by a global focus on energy transition and the decreasing manufacturing costs, the world of transportation is experiencing an accelerated shift towards electrification. The global electric vehicle (EV) industry has evolved rapidly in recent years, driven by several factors, including technological advancements, and government policies. The modern EV revolution began in the early 2000s, with the introduction of the Tesla Roadster. It helped to raise awareness of EVs and paved the way for the introduction of other mass-market EVs, such as the Nissan Leaf and the Chevrolet Bolt.

Technological advancements have made EVs more appealing to consumers. Batteries have become more powerful and efficient, and charging infrastructure has improved. This has made it easier for EV owners to charge their vehicles, which has helped to reduce range anxiety. Technological advancements include the development of ultra-fast charging, battery swapping, V2V charging, increase in battery technology, and development of other parts like in-wheel motors and e-axles. These technologies have led to a fast-paced development of the EV market. For instance, the development of battery technology reduces the charging time of EVs, increases EV range, and reduces the cost of manufacturing budget segment EVs. E-axle technology allows easy manufacturing of EVs by smaller OEMs at lower costs by outsourcing these e-axles.

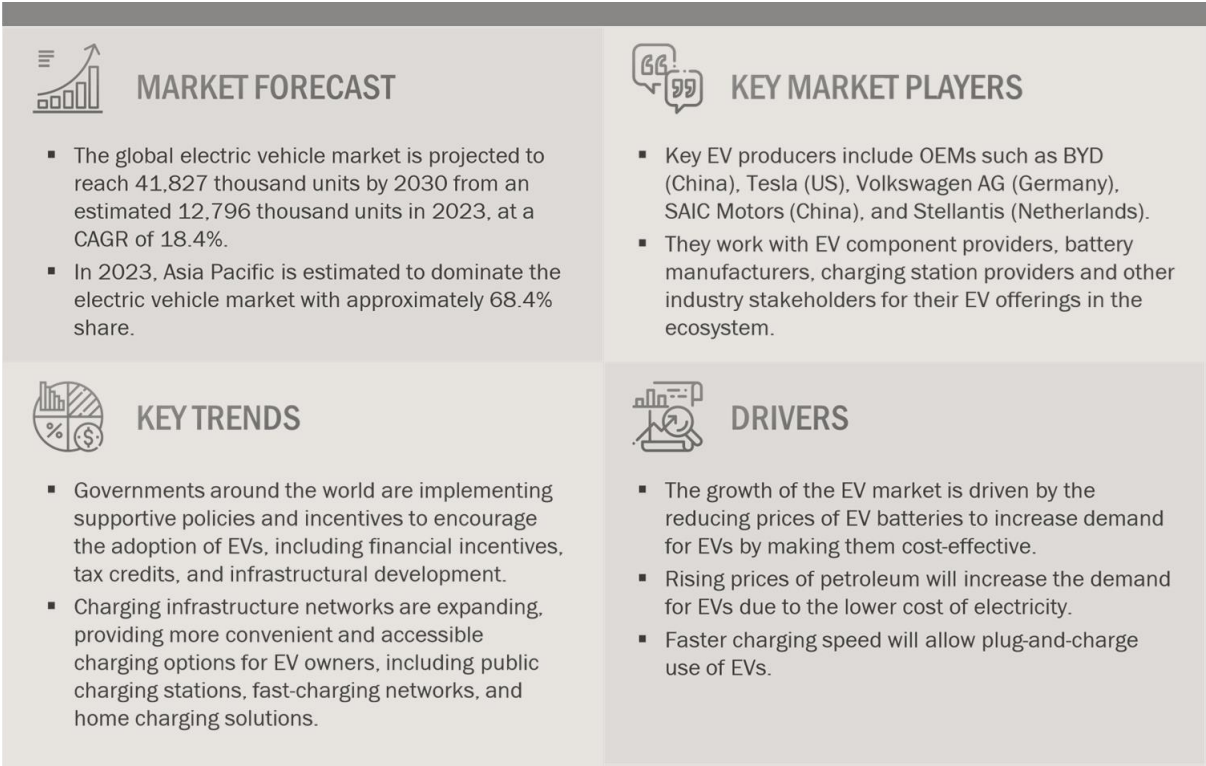
Government policies have also played a role in the growth of the EV industry. Many countries have introduced subsidies and tax breaks for EVs, and some have even set emission targets that require automakers to sell a certain percentage of EVs. The increasing global push for zero-emission transportation, propelled by government targets to decrease the reliance on fossil-fuel vehicles, is driving the rapid expansion of EVs worldwide.

Table 12: Government incentives - Tax credit reductions given across the table to drive EV growth

S. No	Country	OEM	Model	Technology Type	Subsidy Amount (USD)
1	USA	Tesla	Model 3	BEV	7,500
2	USA	Toyota	Prius	PHEV	4,500
3	UK	-	-	-	3,600
4	France	-	-	-	6,900
5	Germany	-	-	BEV	10,000
6	Germany	-	-	PHEV	7,330

Source: Markets & Markets

Figure 24: EV Market Overview (2023 to 2030)



Source: Markets & Markets

The three biggest EV markets globally are China, the United States, and Europe. China leads with over 60% of the global EV market share. The United States and Europe are the second and third largest markets, respectively.

Table 13: Key players in electric vehicle market

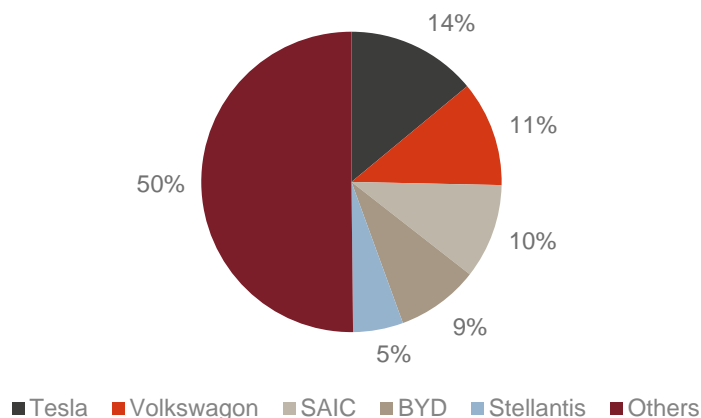
	TOP COMPANIES		
	<ul style="list-style-type: none">TeslaVolkswagen AGSAIC MotorsBYD	<ul style="list-style-type: none">StellantisToyota Motor CorporationBMW GroupGreat Wall Motors	<ul style="list-style-type: none">Nissan MotorsHyundai GroupGAC MotorsRenault Group
	OTHER KEY PLAYERS/TOP START-UPS		
	<ul style="list-style-type: none">Mitsubishi MotorsDaimler AGFord Motor CompanyGeelyRivianGeneral MotorsCheryFisker	<ul style="list-style-type: none">BAIC MotorsJACZoyteLucid MotorsLordstown MotorsNIOBytonXpeng	<ul style="list-style-type: none">WM MotorsNikola CorporationFaraday FutureFresco MotorsAltcraft Motor CompanyLeap Motors

Source: Markets & Markets

In 2021, Tesla was the bestselling EV manufacturer with around 14% of the global EV market share. The company also held around 79% of the EV market share in the US. Its Model 3 and Model S were the

bestselling EVs in 2021. Volkswagen AG was the next bestselling EV manufacturer in 2021. SAIC, BYD and Stellantis were the next best EV manufacturers.

Figure 25: Global electric PV market share



Source: Markets & Markets

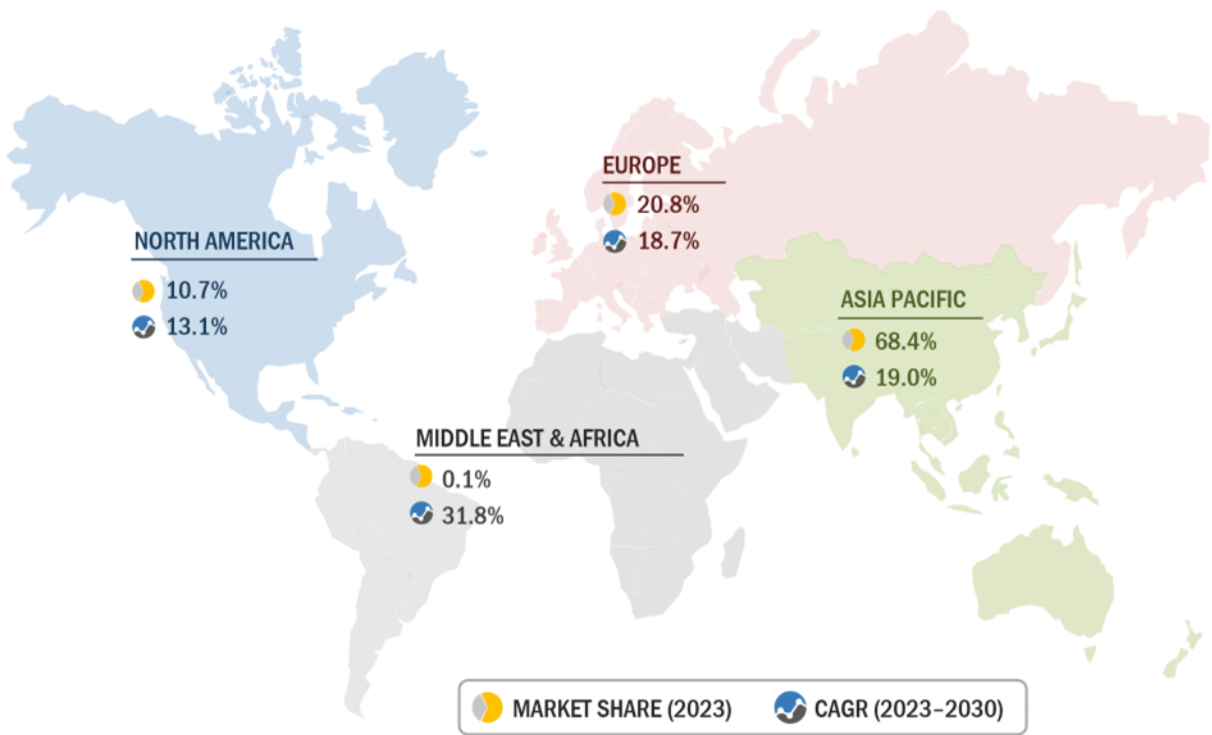
Global electric PV sales outlook

The global electric vehicle market is projected to reach 41.8 million units by 2030 from an estimated 12.8 million units in 2023, at a CAGR of 18.4%. The Asia Pacific region is projected to be the largest market for EVs during the forecast period. EV sales in China are expected to mainly drive EV sales in the Asia Pacific region. Other countries such as India, Japan, and South Korea as well as new markets, including Thailand, Indonesia, Malaysia, and Vietnam, will also contribute to the Asia Pacific EV market. South Korea is expected to be the second-largest EV market in the region in 2023, followed by India and Japan.

The European EV market is projected to reach 8.8 million units in 2030 from 2.7 million units estimated in 2023. Countries such as Germany, France, Spain, Italy, Denmark, and the UK are leading the EV market in this region. The upcoming UK mandate for having charging stations in all new apartments and residential complexes starting in 2022 will further speed up the demand for EVs in the country. Top providers, including BYD (China), Tesla (US), Volkswagen AG (Germany), Stellantis (Netherlands), and other top EV manufacturers, are operating in the European market.

The market for EVs in North America is expected to be led by the demand for low-emission cars in the region with the support of top OEMs, charging providers, and other industry participants. The North American electric vehicle market is projected to account for about 3.2 million units by 2030 growing at CAGR of 13.1% from 2023. The US is expected to remain the dominant market in this region for EVs and speed up its growth due to the new target of 500,000 public charging points and 50% EV sales by 2030, along with the large and fast-growing demand for EVs in the region. North America's EV charging station market is projected to reach 3,227 thousand units by 2030 from an estimated 1,365 thousand units in 2023.

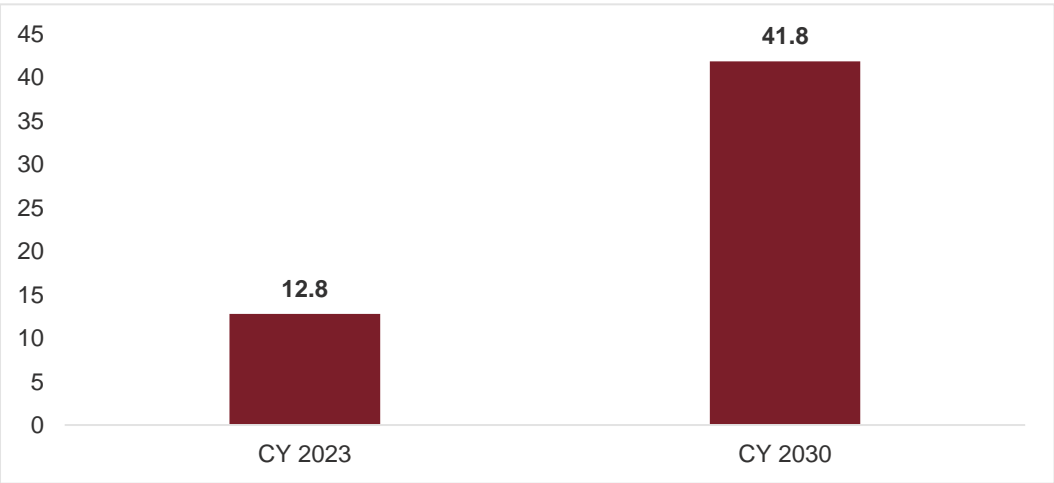
Figure 26: Asia Pacific to account for largest share of market in 2023



Source: Markets & Markets

With more model launches by OEMs, issues of range anxiety being addressed and declining battery prices, the global electric vehicle market for passenger cars is estimated to grow from an estimated 12,796 thousand units in 2023 to 41,827 thousand units by 2030 at a CAGR of 18.4% during the forecast period.

Figure 27: Global electric PV sales outlook (Million units)



Source: Markets & Markets

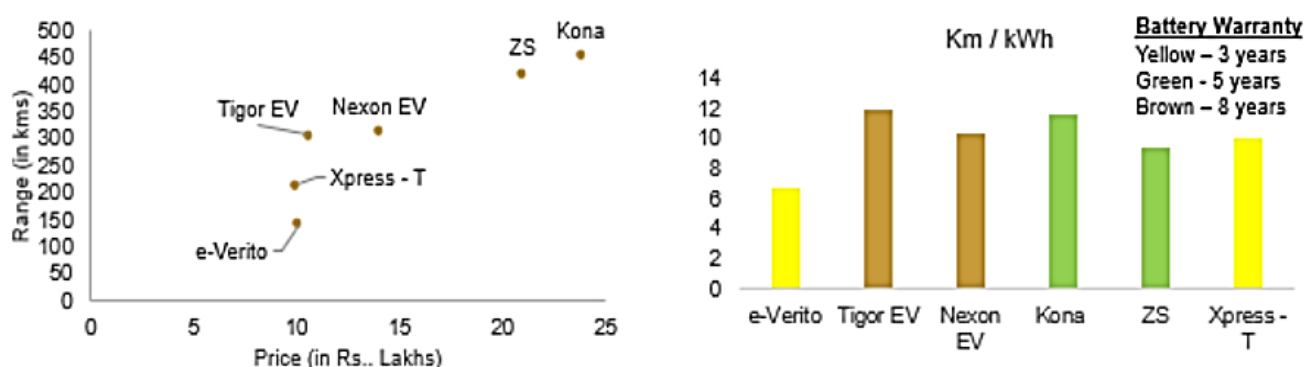
5.2 Indian EV industry

Indian EV industry is one of the fastest growing markets in the world with growth of over ~130% in fiscal 2023 from the last fiscal, i.e. fiscal 2022, despite lack of FAME demand incentive, albeit on a lower base. The EV penetration is expected to grow across vehicle segments, 2W, 3W, Passenger Vehicles (PV), Buses and Commercial Vehicles (CVs). This report largely towards PV, Buses, and CV segments. The key trends and growth drivers for EV industry include changes in regulations and policies, total cost of ownership and growing awareness about environmental issues.

Electric PVs to account for 8-10% of domestic sales by fiscal 2028

Although EVs are still in infancy in passenger vehicle segment, the penetration segment rose from 0.03% in fiscal 16 to 1.3% in fiscal 23.

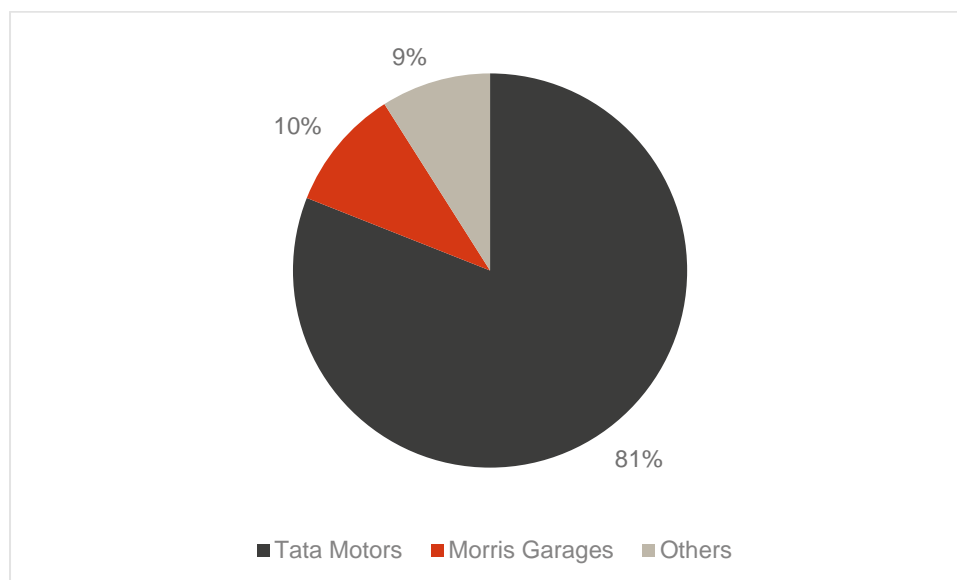
Figure 28: Electric PV models currently available



Source: CRISIL MI&A

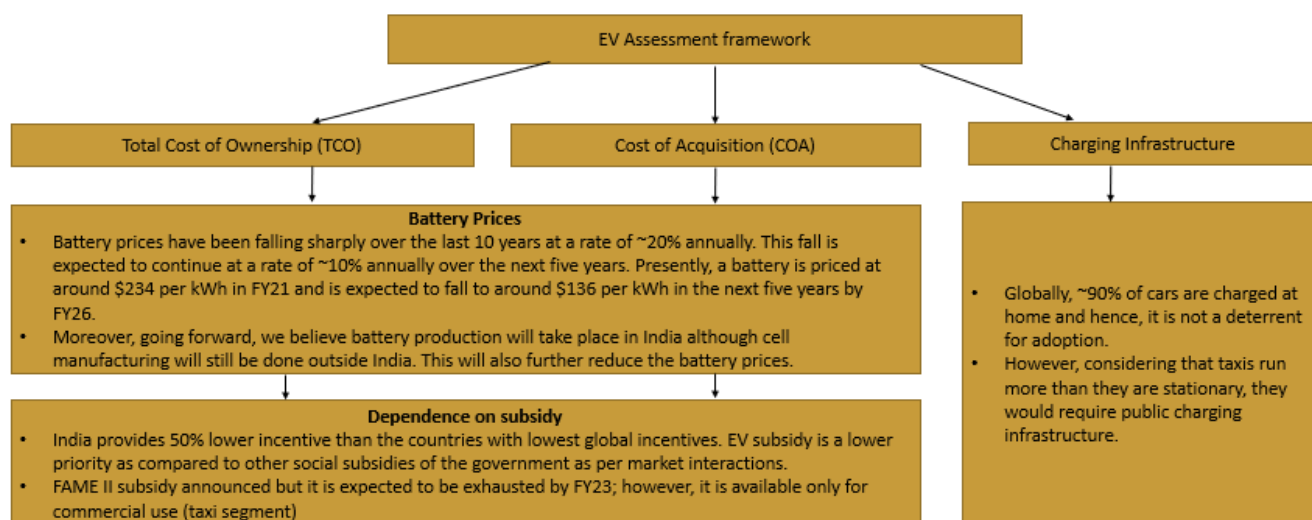
The overall PV penetration stands at ~1.3% with ~81% sales being garnered by Tata motors. Tata's Nexon EV, Tigor EV and latest Tiago EV have managed to gather good traction in an underdeveloped EV ecosystem owing to increased range, good build quality and extensive customer support given. MG captured 10% of market with its premium model ZS ev with rest of the market garnered by other players.

Figure 29: Electric PV market share player wise



Source: SIAM, Vahaan

Table 14: Electric vehicle assessment framework



Source: CRISIL MI&A

The Gol, through various ministries, has formulated policies, such as the FAME II subsidy policy, for the development of the EV sector in India. The FAME-II subsidy is incentivised only towards commercial use, and no benefits are provided to personal-car owners and also for public transport (which includes, 2W, 3W and Buses). CRISIL MI&A has analysed the ownership cost of an electric passenger car versus petrol, diesel and CNG variants for personal segments & cab aggregators.

As of fiscal 2022, the Total Cost of Acquisition (TCA) for EVs in the personal vehicles segment was lower than that for diesel, petrol and CNG variants by ~24%, 4% and 0%, respectively. In fiscal 2027, we expect the

economics to remain the same – TCA of EVs is expected to be lower than that of diesel and petrol vehicles, but higher than petrol and CNG variants. This is due to lower registration charges for EVs amid high loan-to-value (LTV) ratios.

On the other hand, the Total Cost of Ownership (TCO) of EVs in fiscal 2022 was 20-30% higher than that of all three variants. In fiscal 2027, we expect the economics to again remain the same – TCO of EVs is expected to be lower than that of all three variants by 10-20%. However, despite not-so-favourable cost economics, higher adoption has been witnessed initially by environment-conscious buyers. Accordingly, we expect EV penetration in this segment to reach 6-8% by fiscal 2027.

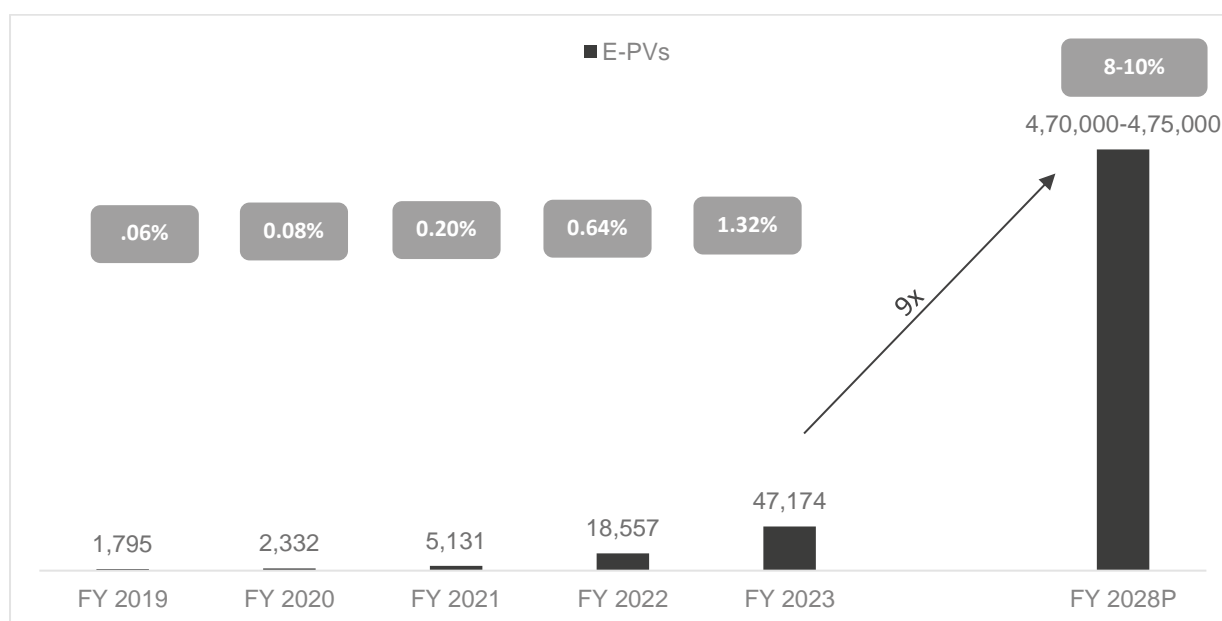
The taxi segment accounts for 10-15% of sales within passenger cars, and within the taxi segment, cab aggregators are expected to lead the adoption of EVs (an estimated 25-31% adoption by fiscal 2027, considering that adequate infrastructure is available by then).

As of fiscal 2022, the TCA of an EV for a cab aggregator was ~17% higher than that of a diesel vehicle, 26% higher than a petrol vehicle, and ~16% higher than a CNG variant. In fiscal 2027, we expect the TCA of EVs to be lower than that of diesel and petrol variants, but higher than that of a CNG variant. On the other hand, the TCO of EVs in fiscal 2022 was lower than that of petrol and diesel vehicles by ~29% and ~19%, respectively, and higher than that of a CNG variant by ~13%, attributable to the higher running of a commercial passenger vehicle and high fossil fuel prices. Cab aggregator segment expected to drive the EV initiative due to their running which is expected to lead to a ~4% penetration by fiscal 2026.

The lower battery cost (due to expected localisation led by the phased manufacturing programme or PMP) is expected to offset the lack of FAME subsidy and will help maintain the competitiveness of BEVs against diesel and CNG variants for cab aggregators in the long run. Currently, a limited number of charging stations, range anxiety and lack of large OEM presence are hindering EV adoption.

The EV PV market is estimated to grow by 9x between fiscal 2023 and fiscal 2028, at a CAGR of 50-60% with 8-10% EV penetration.

Figure 30: Domestic electric PV sales outlook (No of vehicles)



Source: Vahaan, CRISIL MI&A

Table 15: Key strategic investments/developments made by OEMs:

OEM	EV Plans
Maruti Suzuki	<ul style="list-style-type: none"> - Plans to launch its first electric vehicle by 2025 - Maruti Suzuki is building lithium-ion battery manufacturing plant in Hansalpur, Gujarat in a joint venture with Toshiba Corp and Denso Corp. Trial production for the same has begun from Aug 2021 with assembling of battery packs, before graduating to producing Li-ion cells from 2024-25 onwards - It is also expected to source technology from Toyota Motor Corp. and Denso Corp. for the development of a compact and ultra high efficiency powertrain - Suzuki Motor Corporation plans to invest Rs 7300 for EV battery plant by 2026 and 3100 to increase EV production by 2025
Hyundai & Kia	<ul style="list-style-type: none"> - Hyundai is expected to launch 6 EV models by 2028 with investment close to Rs. 4000 crores and Kia will be launching three new EVs each by 2024. The brands will share R&D and platforms to cut the cost of manufacture and launch the EVs at competitive prices - In talks with battery makers and suppliers to localise a large portion of manufacturing in order to bring the cost down and has earmarked \$200 million investment for the purpose - Global Kona has a range of 482 kms on a single charge and 64KWh battery capacity, launched in India in August 2019 - The companies are expected to launch Ioniq 5 and EV6 in 2022 followed by e-NIRO in 2023 - Expected to test EV-based mobility solutions on ride-sharing and car rental platforms Ola and Revv respectively
Toyota	<ul style="list-style-type: none"> - World's largest carmaker Toyota will invest \$35 billion as it aims to introduce 30 battery electric vehicles (BEV) globally by 2030. The company has set a target for Toyota and Lexus brand to sell around 35 lakh BEVs by 2030, up from their previous target of 20 lakh. - Lexus will launch EVs in all segments by 2030 and go all-EV in Europe, North America and China by 2030, and stop selling combustion engine vehicles completely in 2035. - Toyota bZ4X electric vehicle is scheduled for a launch in North America, China and select European markets come 2022 - To jointly develop electric vehicles with Maruti Suzuki and come out with better hybrid solutions for the Baleno and Vitara Brezza - Toyota and Panasonic to setup a JV for producing batteries for EVs
Renault	<ul style="list-style-type: none"> - Renault to launch electric Kwid, Zoe and K ZE in the Indian market soon - Plans to launch 10 BEV's by 2025 and all electric vehicles would account for ~90% of new sales by 2030 - Renault will work with French start-up Vektor to develop a new high-performance battery for larger models, which will be built in a separate new plant that will open with 10GWh capacity and have the potential to increase that to 20GWh by 2030

Nissan	<ul style="list-style-type: none"> - The second generation Nissan Leaf is expected to make its India debut in /FY23; Leaf will be imported as a CBU unit and homologation procedure is in progress - Keen to bring the ENote to India but will wait till the ecosystem grows a comprehensively for Electric car in India - Conducting a feasibility study to manufacture electric vehicles in India for Indian customers as well as foreign countries, and set up an EV battery manufacturing unit along with a giga factory
Tata Motors	<ul style="list-style-type: none"> -Tata motors is planning to invest Rs 1500 crores to develop 10 more new offering in electric vehicles in next five years -Tata Motors has announced the plan to roll out 10 new BEVs in its domestic portfolio by 2025. -Post \$1 billion investment by TPG rise climate, Tata Motors to invest Rs 15,000 crores in its EV business in the next 4-5 years -Tata motors unveiled new EVs Avinya and Curvv under it new GEN3 skateboard based platforms
Mahindra & Mahindra	<ul style="list-style-type: none"> -M&M raise Rs 1935 from British International Investment development of its product portfolio between 2024 and 2027 across its SUV and LCV range -Mahindra plans to invest Rs 3,000 crore in the EV business till 2023-24. This includes development of e-SUVs, e-quadracycle, and electric small and light commercial vehicles. It is looking at a total of 16 EV launches (8 in the SUV category) by 2027 - Mahindra to launch a series of new electric vehicles under its Born Electric Vision by 2025

Source: CRISIL MI&A

The market for EVs could be affected by numerous factors, such as:

- Perception of EV features, quality, driver experience, safety, performance, and cost.
- Perception of the limited range over which EVs may be driven on a single battery charge and about availability and access to sufficient public EV charging stations.
- Competition, including from other types of alternative fuel vehicles (such as hydrogen fuel cell vehicles), plug-in hybrid EVs and high fuel-economy internal combustion engine ("ICE") vehicles;
- EV supply chain disruptions including but not limited to availability of certain components (e.g., semi-conductors), ability of EV OEMs to ramp-up EV production, availability of batteries, and battery materials;
- Concerns regarding the stability of the electrical grid.
- Availability of service centers and skilled workers for EVs repairs.
- The number, cost of ownership and variety of EV models available for purchase; and
- Changes in government mandates, regulations or quotas regarding the sale of EVs.

Electric bus market to grow at 55-60% CAGR over the next 5 years

Electric bus market has grown at a CAGR of 72.3% from fiscal 21 to fiscal 23 with total of 4,423 electric buses plying as on fiscal 2023. The electric bus market is estimated to achieve penetration of 14%-16% by fiscal 2028 which translates into growth at a CAGR of 55% - 60%. While it is projected to grow at 55-60% CAGR by fiscal 2028, we expect e-buses population to be ~59.1K. The EV penetration in buses segment increased from 0.01% in fiscal 16 to 2.8% in fiscal 23. Maharashtra to lead among the states with almost 11,000 – 12,000 e-buses deployment expected during fiscal 24 to fiscal 28. Tenders by MSRTC and BEST to aid the demand in state.

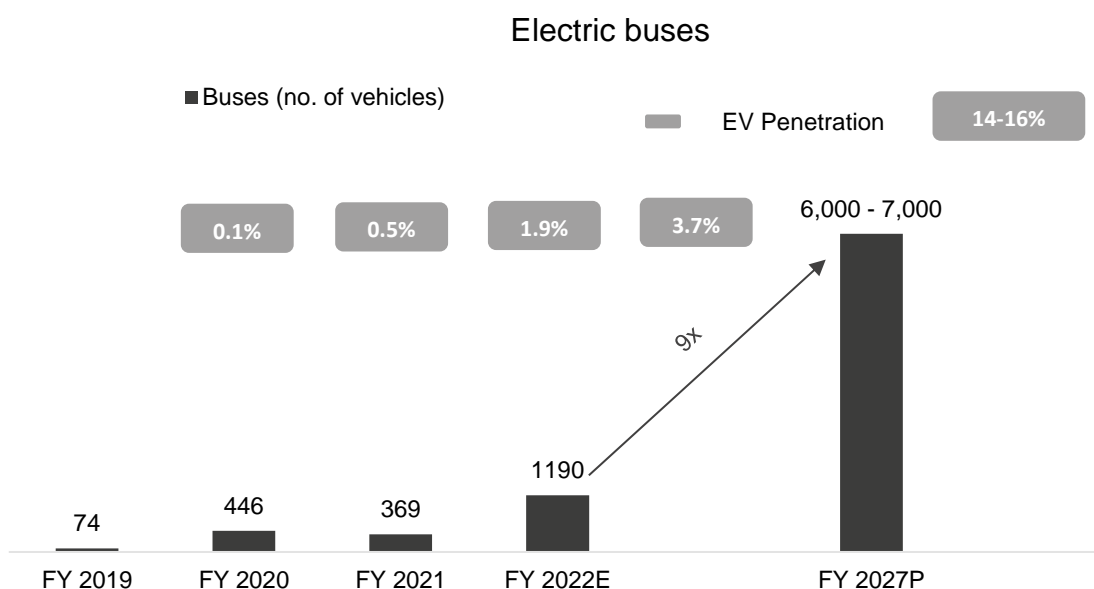
Due to the government support through FAME and focus on quicker adoption of EVs in public transport, there has been a significant increase in electric bus sales in the last couple of years. Under the FAME-II incentive, the government will provide subsidy amounting to Rs. 20,000 per kWh of battery used in an electric bus and a maximum of Rs. 50,00,000 per bus for 7,090 buses. The batteries used in such buses needs to be 'advanced batteries' with specific energy density of at least 70Wh/kg and cycle life of at least 1000 cycles. The total

demand subsidy under FAME-II scheme is Rs. ~9000 crore, a portion of which would go to buses. FAME-II scheme has resulted in a decrease in the price of EVs buses and commercial fleets. Any reversal of the scheme, going forward, may lead to a decline in the adoption / demand of EVs.

Operational profiles of buses with fixed routes and regular stops make them suitable for charging at pre-determined intervals and specific locations. With other incentives from the central and state governments, the sales of electric buses are expected to reach 17,000-18,000 units (~14-16% of total bus sales volume) in fiscal 2028.

In the bus segment, owing to the excessively high battery cost, there is a difference of 4-5x in the initial purchase cost of a diesel/CNG bus and an e-bus. As a result of this high differential, the breakeven period is more than 20 years between electric and diesel powertrains despite 30-35% lower operating cost for EVs. The cost of ownership of an e-bus is ~1.5x that of a standard diesel bus, primarily due to high purchase cost. Owning a CNG bus is Rs 13-14 million cheaper than owning an electric one. While this cost gap would reduce going forward, e-buses are still expected to need significant capital by fiscal 2027.

Figure 31: Electric bus domestic sales outlook



Note: N.M = Not meaningful

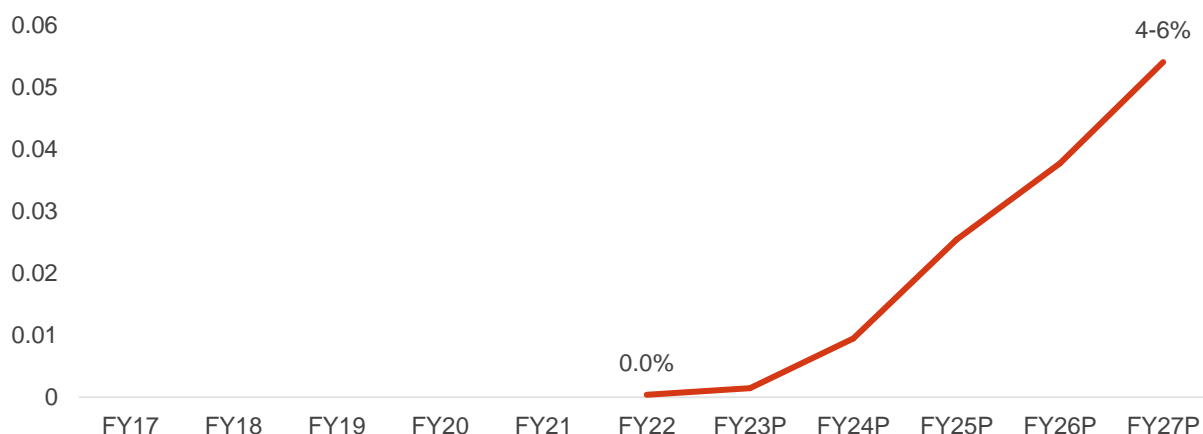
Source: Vahaan

Electrification in Light Commercial Vehicles (LCV)

Currently, most of the EVs used in the commercial segment as goods carriers are three-wheelers. However, as the cost differential between electric and diesel vehicles start reducing, CRISIL MI&A expects new models to be launched. This will drive sales in the segment as the third mile/last mile logistics and local distribution of goods are well suited applications for EVs.

Ramp-up in the battery swapping station network, shift in preference of transporters and fleet operators towards vehicles with battery swapping features, and pick-up in MaaS (mobility as a service) concept are likely to provide a tremendous push to electrification in the LCV segment.

Figure 32: Electric penetration in LCV



Source: SIAM, CRISIL MI&A

Consequently, as depicted in the chart above, EV sales in the LCV goods segment can rise to 30,000-35,000 vehicles by fiscal 2027. This would be about 4% to 6% of the total LCV goods vehicle market, as CNG offers better TCO (Total cost of ownership) and will be preferred over electric variants.

Electrification in Heavy Commercial Vehicles (HCV)

EV adoption in the HCV segment is expected to be negligible in near future as operational profile makes them highly expensive. Further, the current charging infrastructure is not suitable for larger HCV batteries, which will make electric adoption unviable for some time.

There could be some minor penetration in ICVs going forward; however, for MCVs and MAVs, CRISIL MI&A expect the dominance of diesel fuel to continue with LNG making some inroads.

Policy initiatives by the government to push electrification

Table 16: Summary of the key government policies

Policy	Target beneficiary	Segment	Timeline	Amount of incentive (INR billion)	Comments
FAME	Battery Electric Vehicles of public and commercial transport	2W	Mar'24*	35.0	While the current subsidy is not extended for SCVs or MHCVs, The Society of Manufacturers of Electric Vehicles (SMEV) has suggested inclusion of light commercial vehicles (LCV) and medium and heavy commercial vehicles (M&HCV) on a project-mode basis as India must prepare for the
		3W		2.5	
		4W		5.5	
		Buses		43.0	

Policy	Target beneficiary	Segment	Timeline	Amount of incentive (INR billion)	Comments
					transition to e-mobility in trucks and heavy commercial vehicles in three to four years
PLI	Battery Electric Vehicles Hydrogen Fuel Cell Vehicles Advanced Automotive Technology components	All Auto	5 years from date of commissioning	259.4	The scheme has two components viz. Champion OEM incentive scheme and Component Champion incentive scheme. Total 95 applicants have been approved under this PLI scheme
	Battery makers (ACC)#	All Electric vehicles		181.0	The ACC battery manufacturer will need to ensure a minimum 60 percent domestic value addition at the Project level within five years
		Stationary storage			
PMP	Battery Electric Vehicles of public and commercial transport Electric vehicle components	2W	April'22	BCD increased by 10 to 15% on all key components and CKDs, SKUs, CBUs	GST on Electric Vehicle is 5% compared to 18-22% for petrol/diesel vehicles. The whole idea is make it cheaper to the customer. However, despite higher customs duty, the Lithium ion battery set-ups are still in WIP in India and will continue to be imported in the medium term. Hence the government has further released a notification in Nov'21 that the EV charger manufacturers shall comply with minimum of 50% of domestic value addition in manufacturing and hence mentioned the implementation dates for each of key charging components
		3W			
		4W			
		Buses			
		Trucks			
		Battery makers			
		Charging equipment makers			
	<i>*Note: (SMEV) has sought an extension of subsidies for EVs under the FAME-II scheme FAME II scheme should be linked to e-mobility conversion rather than being time-based</i> <i>#ACC : Under the PLI Scheme, central government has started National Programme on Advanced Chemistry Cell (ACC) Battery Storage in India for setting up manufacturing facilities with a total manufacturing capacity of 50 Giga Watt Hour (GWh)</i>				

Source: Ministry of Heavy Industries, CRISIL MI&A

Currently, in India, the charging infrastructure required for EVs is not in place. Indian automobile industry seeing a slew of regulations and norms over the past few years, and the implementation of the National Electric Mobility Mission Plan 2020 becomes a key monitorable for the sector over the next five years.

EV policies of various states of India

Many state governments have come forward and are providing incentives on purchase of an electric vehicles, wherein the benefit provided is in addition to FAME-2 policy benefits.

- Delhi has announced an EV policy that would provide purchase incentives of Rs. 10,000/kwh, subject to a maximum of Rs 1.5 lakh/vehicle for the first 1,000 electric cars. The policy also provides 100% exemption on road tax until 2023.

- Maharashtra is providing an incentive of Rs. 5,000/kwh, subject to a maximum of Rs 1.5 lakh/vehicle for the first 10,000 electric cars. The policy also provides 100% exemption on road tax until 2025. An additional early-bird discount of Rs 5,000/kwh (a maximum of Rs 1 lakh, if purchased before the end of fiscal 2022) as well.
- Gujarat has announced an EV policy that would provide purchase incentives of Rs 10,000/kwh, subject to a maximum of up to Rs 6 lakh/vehicle for the first 20,000 electric cars. The policy will remain valid until 2025.
- Bihar is providing an incentive of Rs. 10,000/kwh subject to a maximum of Rs 1.5 lakh/vehicle for the first 4,000 electric cars. The policy also provides 100% exemption on road tax until 2024.
- Odisha has announced a subsidy of 15% subject to Rs 1 lakh for electric cars until 2026.
- Meghalaya is providing an incentive of Rs 4,000/kwh for the first 2,000 electric cars. The policy also provides 100% exemption on road tax until 2026.
- The Telangana government is also providing a 100% exemption of road tax and registration fee on purchase of first 5,000 electric cars until 2025.
- The Tamil Nadu government is providing 100% exemption on road tax on purchase of electric cars until 2022.
- Haryana government is providing direct benefit up to INR 10 lakhs on purchase of EV in state and relaxation in registration fees.
- Chhattisgarh EV policy is providing incentives on EV purchase along with other measure to boost infrastructure aiming to have 15% of new registration to be EVs by 2027.
- Maharashtra and Rajasthan offer up to Rs.5 lakh subsidy for setting up fast charging infra. UP and Tamil Nadu provide 20% and 25% of the infrastructure cost respectively, for setting up a DC fast charging stations. Other states also have their charging policies in a way to facilitate setting of up initial batch of fast charging stations in a phased manner either by offering capital subsidy to the energy operators or SGST reinstatement.

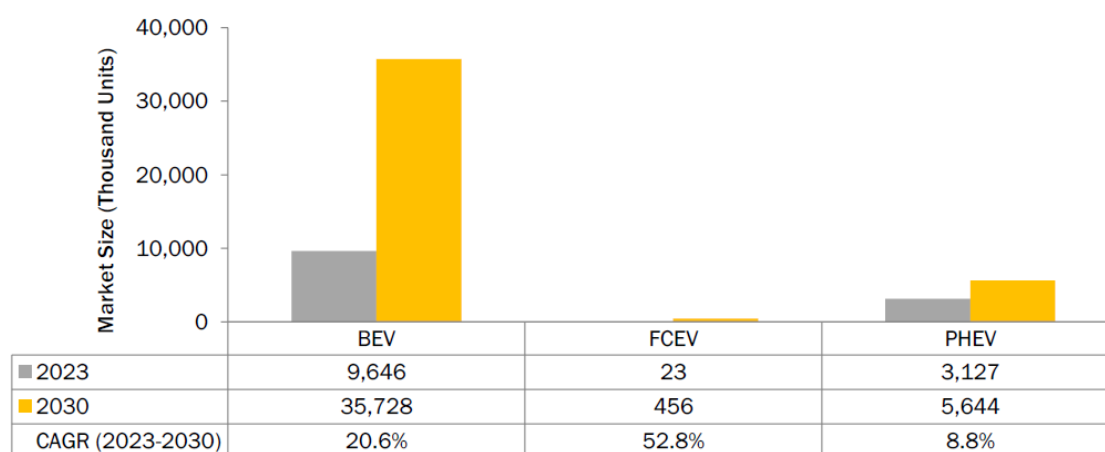
6. EV Charging Infrastructure Business – Global & India

Electric Vehicle Supply Equipment (for the purpose of this report defined as 'EVSE' or 'EV Charger(s)') means - an element in Electric Vehicle Charging Infrastructure (EVCI) that supplies electrical energy for recharging the battery of electric vehicles (EV). Public Charging Station (PCS) is an EV charging station where any electric vehicle can get its battery recharged. EV charging infrastructure and services are critical to the adoption and acceptance of electric vehicles.

6.1 Global EVSE Industry

The global sales of EVs performed strongly in 2022, with a significant increase of 55% compared to 2021, with a total of 10.5 million units (Battery Electric Vehicles: 7.7 million units and Plug-In Hybrid Electric Vehicles: 2.8 million units) delivered worldwide. An increase in the adoption and use of electric vehicles has accentuated the need to develop charging infrastructure. Leading markets for electric vehicles, such as China, US, and Germany, are investing significantly in EV charging infrastructure along with R&D for faster and more efficient charging methods. As EV adoption continues to increase, the demand for charging infrastructure is likely to grow exponentially, especially in areas with high concentrations of EV owners. The global electric vehicle market is projected to reach 41.8 million units by 2030 from an estimated 12.8 million units in 2023, at a CAGR of 18.4%. The North American electric vehicle market is projected to account for about 3.2 million units by 2030 growing at CAGR of 13.1% from 2023. The European electric vehicle market is projected to account for about 8.8 million units by 2030 growing at CAGR of 18.7% from 2023

Figure 33: Electric Vehicle Charging Station Market, By Region, 2023–2030 (Thousand Units)



Source: Expert Interviews and MarketsandMarkets Analysis

Note: BEV: Battery Electric Vehicle | PHEV: Plug-in hybrid electric vehicle | FCEV: Fuel cell electric vehicle

Globally, the EV Charging market for public chargers is projected to grow exponentially from an estimated 2.61 million units in 2022 to 16.39 million units by 2027, at a CAGR of 44.4%.

Market Size of Global EVSE industry:

The global electric vehicle charging station market is projected to reach 16,399 thousand units by 2027 from an estimated 2,608 thousand units in 2022, at a CAGR of 44.4%. The wide range of product offerings by OEMs has attracted a high number of consumers, resulting in an increased market for electric vehicles.

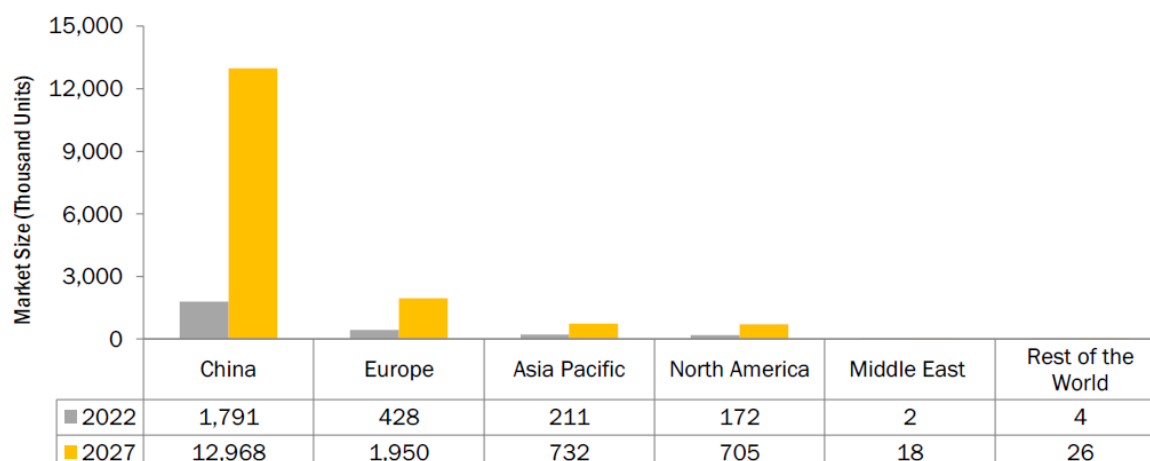
An increase in the adoption and use of electric vehicles has accentuated the need to develop charging infrastructure. Leading markets for electric vehicles, such as China, US, and Germany, are investing significantly in EV charging infrastructure along with R&D for faster and more efficient charging methods. As EV adoption continues to increase, the demand for charging infrastructure is likely to grow exponentially, especially in areas with high concentrations of EV owners. This has led to investments in deploying more public charging stations by governments, businesses, and other organizations, to meet the needs of EV owners. The key trends going forward include shift towards smart charging capabilities, ultra-fast charging capabilities, stringent operation performance requirements of operations, and making chargers future proof by adopting new regulatory standards and smart grid integration related technologies. Governments across countries are trying to upgrade grid infrastructure to support EV charging needs.

In 2022, China was estimated to dominate the electric vehicle charging station market with approximately 68.6% share. The level 2 charging segment is expected to hold the largest market share in 2022, while the level 3 charging segment is expected to be the fastest-growing segment during the forecast period.

Governments are working with manufacturers to build charging and manufacturing facilities and offering exemptions in taxation. They have set targets for reducing fossil fuel vehicle sales in their countries and set policies to support the growth of EVs and EV charging stations with regulations and incentives. UK has promoted a bill that mandates all new apartments to have charging stations from 2022.

Public and private charging stations play a significant role in this scenario. A modern public charging station can charge up to eight times faster than a regular residential outlet, thus charging an EV fully within one to four hours, depending upon battery capacity. Due to advancements in high-end charging technology, the demand for fast-charging equipment is significant. The electric vehicle charging station market has attracted significant investments from OEMs. For instance, as of December 2022, Tesla (US) claims to have installed over 40,000 superchargers worldwide.

Figure 34: Electric Vehicle Charging Station Market, By Region, 2022–2027 (Thousand Units)



Source: Markets and Markets

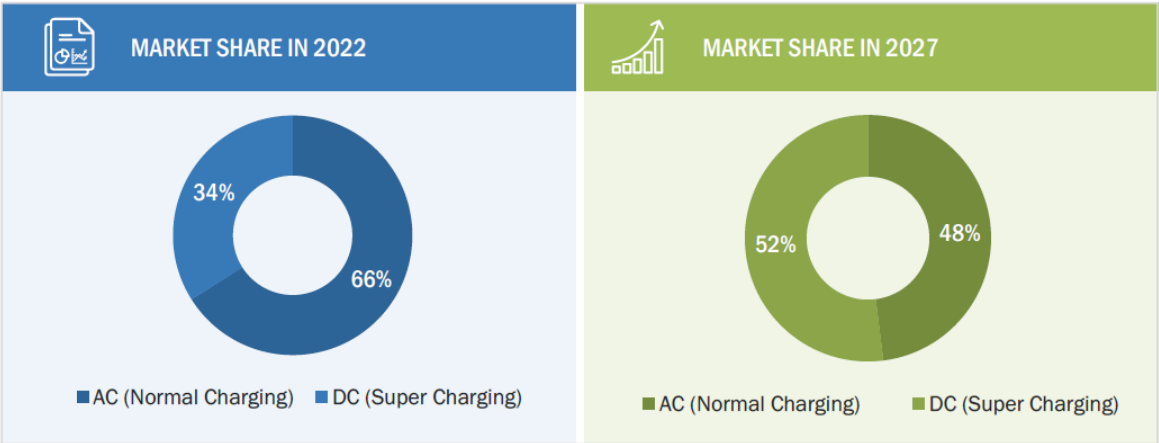
During the forecast period, China is projected to be the largest and fastest-growing market for electric vehicle charging stations. Higher EV sales would drive the growth of charging stations in the region. China is investing significantly in producing electric vehicle charging stations to provide charging solutions for the increasing number of EVs in the country. OEMs such as BYD also plan to establish production plants in other parts of the world to manufacture electric buses and trucks to meet demand.

Due to the rising demand for EVs in Europe, the need for EV charging stations is also rising. According to a report by the European Environmental Agency in November 2022, 11.4% of all new vehicle registrations in Europe have been EVs. The number of charging stations has grown by approximately 32.4% YoY in 2022. The European market is important as it is expected to grow rapidly following leading European markets such as Norway and Netherlands. UK, Germany, and France are other leading markets in Europe in terms of the growth of EV charging stations. Shell (Netherlands), ABB (Switzerland), Fastned (Netherlands), Siemens (Germany), Engie (France), EVBox (Netherlands), GreenFlux (Netherlands), Virta (Finland), and BP (UK) are some of the top charging providers operating in the European market.

The growing demand for EVs in North America will drive the market for electric vehicle charging stations. This region also has top OEMs, charging network providers, and software solution providers. The US is expected to remain the largest market in this region for electric vehicle charging stations and will speed up its growth due to the new target of having at least 500,000 public charging points by 2030. The market in this region is projected to reach 705 thousand units by 2027 from an estimated 172 thousand units in 2022.

Asia Pacific is a fast-growing market for EV Chargers as rapid urbanization is driving demand for clean and sustainable transportation options. The Asia Pacific market is projected to reach 732 thousand units by 2027 growing at a CAGR of 28.3% during the forecast period.

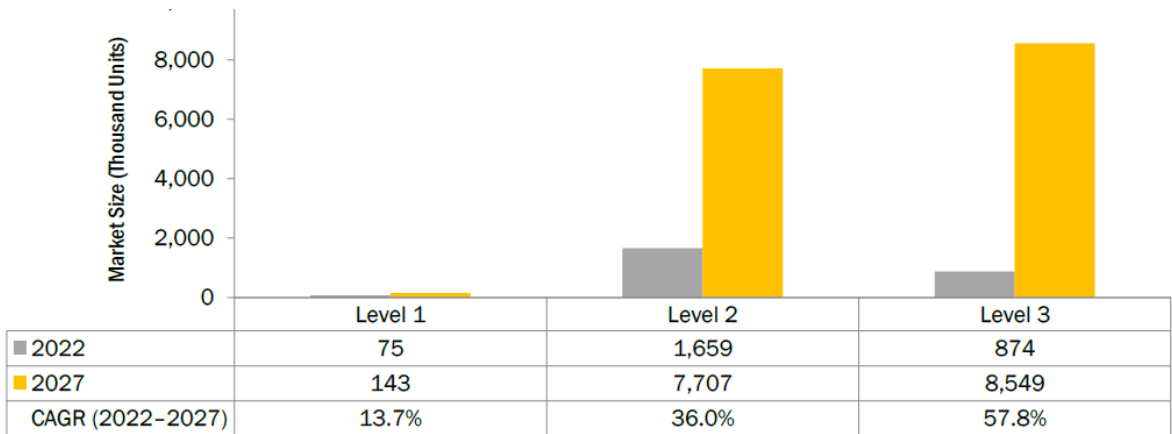
Figure 35: Segment wise growth



Source: Markets and Markets

The EV charging market is divided into AC (normal chargers) and DC (superchargers). Currently, normal chargers are dominant in the market, but the growth of superchargers is expected to outpace normal chargers during the forecast period. This is due to the increasing deployment of supercharging stations in North America (particularly US and Canada), Asia Pacific (China and Japan), and Europe (UK, Netherlands, Germany, and France) to offer fast charging solutions as EV adoption increases. Although normal chargers are expected to grow at a slower pace than superchargers in terms of numbers, they are expected to hold a larger market share by the end of the forecast period. There is an expected rise in demand for ultra-fast chargers in the coming years.

Figure 36: Level 2 charging to lead market during forecast period



Source: Markets and Markets

ABB is one of the largest manufacturers and providers of EV charging stations globally, with over 17,000 DC fast chargers and over 1,000,000 level 1 and level 2 chargers installed in over 85 markets worldwide. In November 2022, it formed a strategic alliance with Tallarna Ltd. (UK), a climate technology startup, to expand its offerings in user-friendly energy management technologies.

Tesla is regarded among the best-selling electric car manufacturers in the plug-in and battery electric vehicle segments. The company designs, develops, manufactures, and markets high-performance electric car battery energy storage equipment, including EV charging stations and solar panels. It has also built a significant network of charging stations. The company primarily operates through the automotive and energy generation & storage segments. It has established charging stations in more than 40 countries, such as Australia, Canada, US, UK, UAE, China, France, Germany, Italy, Russia, Japan, and South Korea. It claims to have installed more than 40,000 superchargers in 4,470 stations worldwide.

ChargePoint operates the largest network of independently owned EV charging stations in 14 countries, which reached 174,000 chargers by March 2022. The company has made EV charging its core competency with various new innovative methods to complement it, thus becoming one of the leading EV charging networks worldwide.

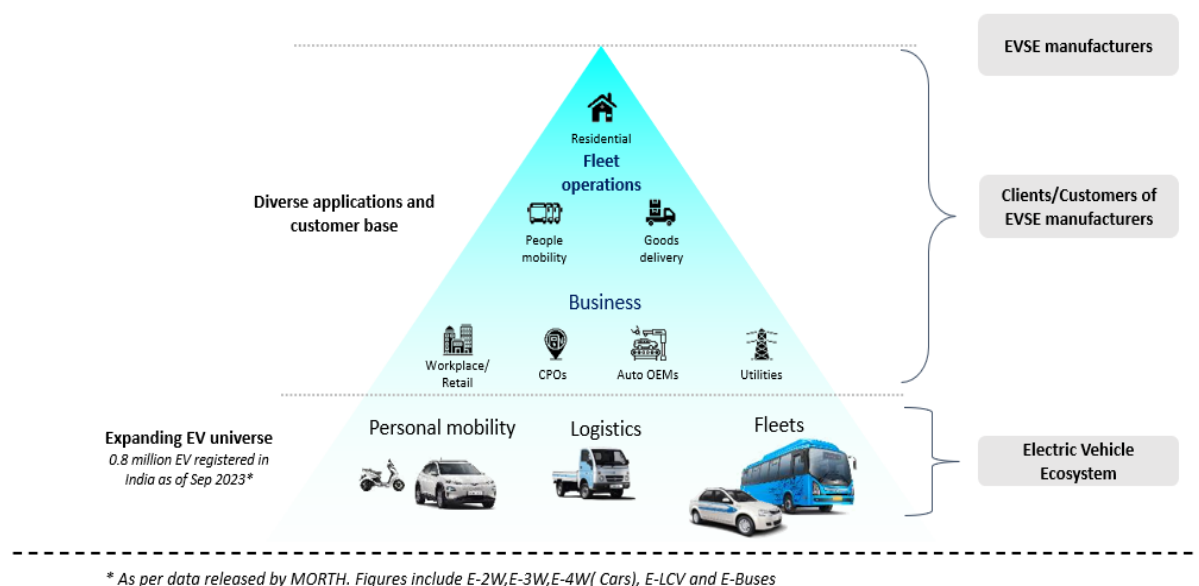
Key Global Trends in EVSE industry

- The development of megawatt charging stations is expected to lead to faster charging times, ultimately reducing the charging time to minutes.
- The integration of IoT in EV charging is expected to enhance user experience and enable more efficient charging management. This trend is anticipated to increase the popularity of EVs and boost the development of EV infrastructure.
- The development of megawatt charging stations is expected to lead to faster charging times, reducing the charging time to minutes. Pantograph charging, which enables EVs to charge while in motion, is emerging as a promising trend.
- The integration of IoT in EV charging is expected to enhance user experience and enable more efficient charging management. Adopting these trends is anticipated to increase the popularity of EVs and boost the development of EV infrastructure, thus creating new market opportunities for businesses in the EV charging industry.
- Vehicle-to-Grid (V2G) EV charging is a system that has a bi-directional electrical energy flow between plug-in EVs and the power grid. V2G charging technology is a key opportunity for manufacturers as it is expected to transform the world of EVs and shape the future of EV charging.
- The use of renewable energy to power EV charging stations is one of the key opportunities for electric vehicle charging station market players. Solar-powered charging stations are ideal for homeowners or commercial buildings due to the decreasing price and easy installation.

6.2 Indian EVSE Industry

EVSE manufacturers meet the need for EV chargers by supplying to OEMs with charging equipment for retail EV consumers and charge point operators who put up charging stations in public places. EVSE manufacturers are also partnering with EV fleet operators to develop the most appropriate charging solutions for their fleet.

Figure 37: EVSE customers and EV ecosystem



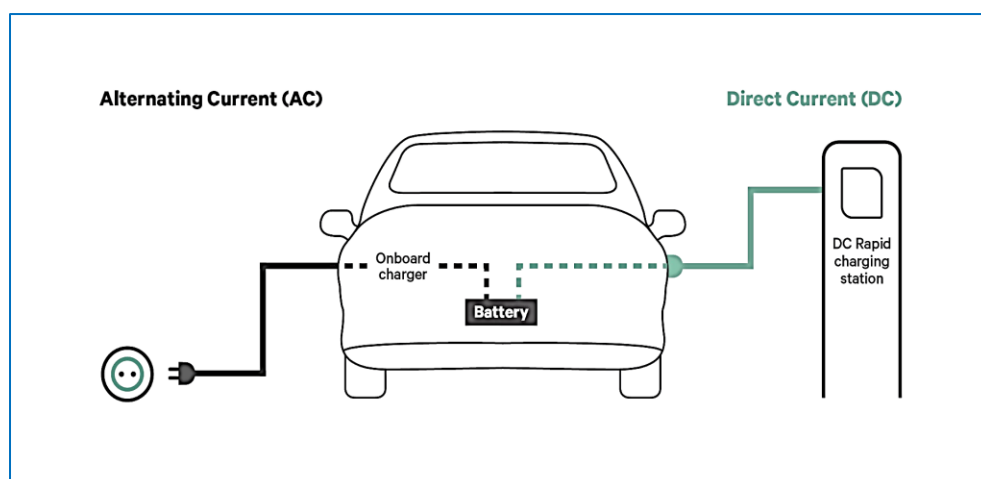
Source: CRISIL MI&A

Types of chargers based on source of power:

EV charging involves supply of direct current (DC) to the battery. As electricity distribution systems supply alternate current (AC) power, a converter is required to provide DC power to the battery.

- In the case of an AC EVSE, the AC power is delivered to the onboard charger of the EV, which converts it to DC power.
- A DC EVSE converts the power externally and supplies DC power directly to the battery, bypassing the onboard charger.

Figure 38: AC vs DC Charging



Source: CRISIL MI&A

EVSEs have different power ratings or levels based on charging requirements, which in turn determine the input power requirements for charging infrastructure.

Types of chargers based on speed of charging:

The charging levels for electric vehicles (EVs) in India are like global standards.






- **Level 1 Charging:** L1 charging is a slow type charging for EVs. L1 chargers plug directly into a standard 230-volt AC outlet. The average power output of an L1 charger is <3.3 kW. L1 charging primarily occurs in residential settings, and there are very few L1 chargers built for public use.
- **Level 2 Charging:** L2 charging is the most prevalent type of charger. L2 chargers operate at 208-240 volts and output is anywhere from 7 kW to 22 kW of AC power. L2 charging provides a faster charging speed compared to L1, allowing for quicker replenishment of the EV's battery. L2 chargers can be found in residential townships as an amenity for occupants and visitors, public locations such as parking garages, OMC retail outlets, grocery stores, malls, hotels, and workplaces.
- **Level 3 Charging:** L3 charging, also known as DC fast charging or rapid charging, is the fastest charging option for EVs. L3 chargers operate at higher voltages and currents, allowing significantly faster charging times. It can provide a substantial amount of range in a short period, typically ranging from 30 minutes to an hour for an 80% charge. L3 chargers are commonly found at public charging stations along highways, rest areas, depots, and other high-traffic locations.

Electrification trends in India and penetration of L1, L2 and L3 chargers:

Since EVs are the form of transportation of the future, investments in the infrastructure needed for EV adoption are being made by stakeholders across the value chain. As can be seen in the below chart, the electrification in the two wheelers and three wheelers segment has been higher compared to passenger cars, as on fiscal 23, both of which can be charged by L1 charger. CRISIL MI&A estimates Passenger car electrification, whose

current penetration is at lower single digit of 1.2% to grow to ~ 8 -10% penetration in the next 5 years. In this scenario, the charging infrastructure is expected to move more towards L2 chargers.

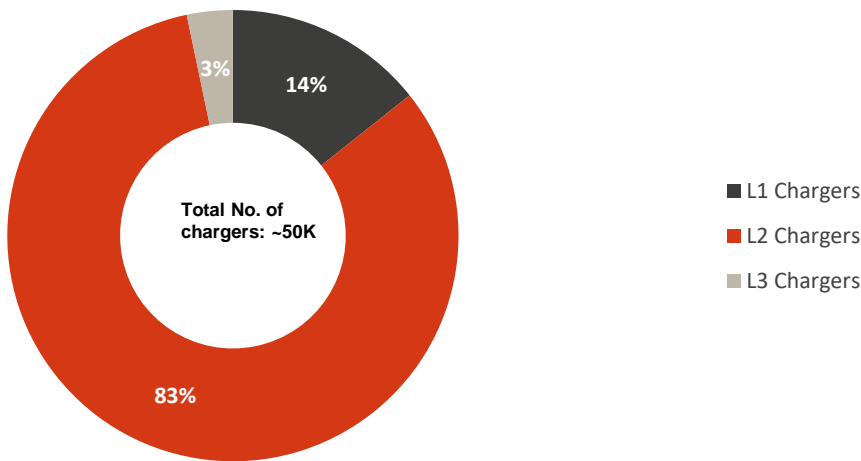
Table 17: Penetration of electric vehicles segment wise

	2023	2025	2028
	1.2%	2-6%	8-10%
	4.7%	7-11%	20-25%
	10.3%	18-22%	30-35%
	0.4%	1-5%	1-6%
	6.2%	7-11%	14-16%

Source: SIAM, Vahan, CRISIL MI&A

The Public charging Station segment is dominated by L1 and L2 chargers. Currently, L3 chargers have minimal presence in the PCS segment. State Transport Undertakings (STUs) are generally responsible for procuring and operating buses running within the state and hence the necessary charging infrastructure. However, L3 chargers’ share in the PCS segment is expected to grow exponentially in the next five years driven by government’s push for electric buses and visibility in terms of tenders floated by OMCs for setting up L3 charging stations as well as the investments by private Charge point operators.

Figure 39: Current share of L1, L2 and L3 chargers in India: fiscal 23



Source: BEE, CRISIL MI&A

Note: The above chart doesn't include the L1/L2 chargers of residential segment and fleet operators' captive stations. It includes the PCS and e-buses charging stations segment.

As mentioned above, L1 chargers are slow chargers and L2, L3 are classified as fast chargers because of their charging speed.

Entry Barriers for EVSE manufacturers and charge point operators

Technology evolution: Electric mobility is a dynamic space that necessitates continual technology innovation in areas such as quicker charging speeds, compatibility with various EV models, footprint, regulatory compliance, and increased user experiences. So, EV Charger manufacturers need to have broad skill set of technology capabilities in software, hardware and system design to make such continual improvements

Performance requirements: Customers typically expect 95%+ uptime, at least 95% power conversion efficiency, working temperature range of -10 to 55 degrees and wide output voltage in DC Chargers of 200V to 1000V to ensure compatibility across vehicle ranges. These criteria aid in the reduction of energy expenses and the achievement of high uptime.

Grid Infrastructure Compatibility: EV chargers must be compatible with current and future grid utilities, such as smart grid systems and vehicle-to-grid (V2G) technologies. Making room for such improvements in the future is critical for making the product future proof. For example, the upcoming ISO15118 standard defines a new type of communication between the charger system, vehicle, and smart grid.

Partnerships and Alliances: For EV Charger to work seamlessly, it needs to seamlessly work with EV ecosystem of central management systems of various CPO's, all existing and new EV models plying on road and with grid where there is functionality of grid load management. EV chargers who have integrated with maximum of such ecosystem players will have more advantage in the market.

Service setup: Established OEMs have pan India sales and therefore, such OEM's and Charge Point Operators would require EV Charger manufacturers to have national presence. Companies having national service presence would have an advantage over others.

Business models based on end-use segment:

Typically, two wheelers and three wheelers can be charged by 3 KW to 6 KW chargers, which are either by home charging or public charging and form a small portion of the pie. This report focuses on the **four-wheeler and bus charging modules** across the segments mentioned below which broadly represents the Indian EVSE market as well.

- **Residential segment:** Portable chargers generally use 230V/15A single phase plug which can deliver a maximum of up to 3 KW of power. The EVSE supplies AC current and the onboard charger in the EV converts it to DC for the battery to be charged. Off late, for Electric cars with higher battery capacities

(>40 Kwh), OEMs are offering AC fast chargers of 7.2 KW and 11 KW rating wall mount chargers which will be installed at the buyer's home.

- **Public charging stations:** DC rapid charging offers the fastest charging option and is mainly used in commercial locations or public charging stations and not suitable for residential settings. Public Charging Station generally has one or more chargers or combination of chargers which has a particular power rating and prescribed number of connector guns. For example, a 60 KW charger with 2 connector guns can charge 2 cars simultaneously with 30KW or a single car by 60 KW. Also, a charging station can comprise of AC or DC chargers or a combination of both – the prescribed standards and guidelines are discussed in the sections ahead.
- **Depot charging stations:** Depot charging stations are installed for charging the Electric buses at respective bus depots. State Transport Undertakings (STUs) are generally responsible for procuring and operating buses running within the state and hence the necessary charging infrastructure. Depot charging requires buses to be parked in the depot to be charged during their off time. This could be done either at night or day depending on the operations plan and prevailing electricity tariffs. Plug-in charging is the most used technology for depot charging. Electric Bus volume has grown at a CAGR of 72% from fiscal 21 to fiscal 23 and growth from fiscal 23 to fiscal 28 projected at 50-60% CAGR. Despite having production constraints, the government continues to float tenders. Hence state transport undertakings have the need to ramp up the installation of E-bus charging infrastructure in bus depots to match the upcoming electric fleet. The total cost of ownership for an electric bus is lower compared to diesel and CNG buses owing to the subsidy offered by Central and state governments.
- **Fleet operators - captive charging stations:** Ride-hailing companies and cab aggregators are electrifying their fleets as the government pushes for use of more electric vehicles (EVs) in public transport systems. These companies have set up captive charging facilities for their fleet in large hubs that can charge 100-200 cars parallelly. These start-ups leverage the economic advantage offered by setting up charging hubs in sparsely used spaces like -2 or -3 level basements in establishments like IT parks, Malls, Hospitals etc. where large loads are available for charging.

EV charging infrastructure aims to promote a distributed network of EV charging points for users to plug into at various locations - at residences, apartment buildings, office campuses, shopping malls, retail outlets of OMCs, metro and railway stations, bus depots, etc. Such a distributed network approach has multiple advantages for users and operators, ranging from ease of access to financial viability.

Figure 40: EV chargers - Business models based on end use segment

Charging Scenarios / users

Residential & Retail segment



Products /Solutions

Wall mount charger offered by OEMs along with the purchase of vehicle. Typically, in the range of 7.2 to 11 KW AC charger which requires a 3-phase residential connection.

Charging stations installed in key areas for public as a supplement to residential charging.



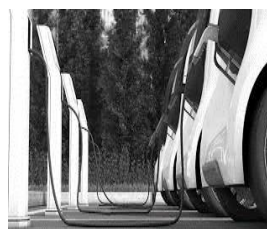
Charging stations are operated by PSUs, Private players, OMCs and network operators. The power is supplied either by discoms or captive

Charging of e-buses run by STUs, schools, corporates.



E-Buses are charged at depots by 200 KW DC fast chargers. The power rating is expected to increase going ahead as more e-buses come

Fleet operators who offer e-fleet for urban mobility solutions.



Fleet operators are urban mobility service providers who offer electric car riding platforms. Currently there are very few start-ups in this space, most of which have captive charging stations where bulk of fleet can be

Current market size of EV charging infrastructure as on fiscal 23

In terms of automobile sales, India is the third largest vehicle market in the world, trailing China, and America as of current year 2022. Manufacturers and governments are working towards adoption of alternate fuels and powertrains in the automotive space in India. The automotive industry is a substantial contributor to India's economy, accounting for ~7.1% of GDP and employing a significant number of people according to Press Information Bureau. The government is also prioritizing the transition to clean transportation, as evidenced by the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India (FAME) I, II and anticipated FAME III scheme to expedite shift to electric mobility.

According to the CRISIL MI&A, India's domestic electric passenger car industry is expected to increase at a CAGR of 51% between 2023 and 2028, reaching ~4 lakh annual sales by 2028. Multiple OEMs have announced launches of EV models anticipated to come by 2025, which are expected to have longer ranged and thus may address consumers' anxiety with respect to vehicle range. Following this, the second major concern generally seen would be charging convenience. As a result, charging infrastructure takes center stage in encouraging EV adoption. There is a growing focus on expanding the charging infrastructure network across the country. Public charging stations are being installed in cities, highways, and commercial areas, making it more convenient for EV owners to charge their vehicles. There is an increasing adoption of fast charging technologies, such as DC fast charging, to reduce charging times and provide greater convenience to EV users.

Setting up charging stations demands a considerable quantum of investment, which includes capital expenditure, grid connection fees, and operations and maintenance expenditures. It is vital for the smooth

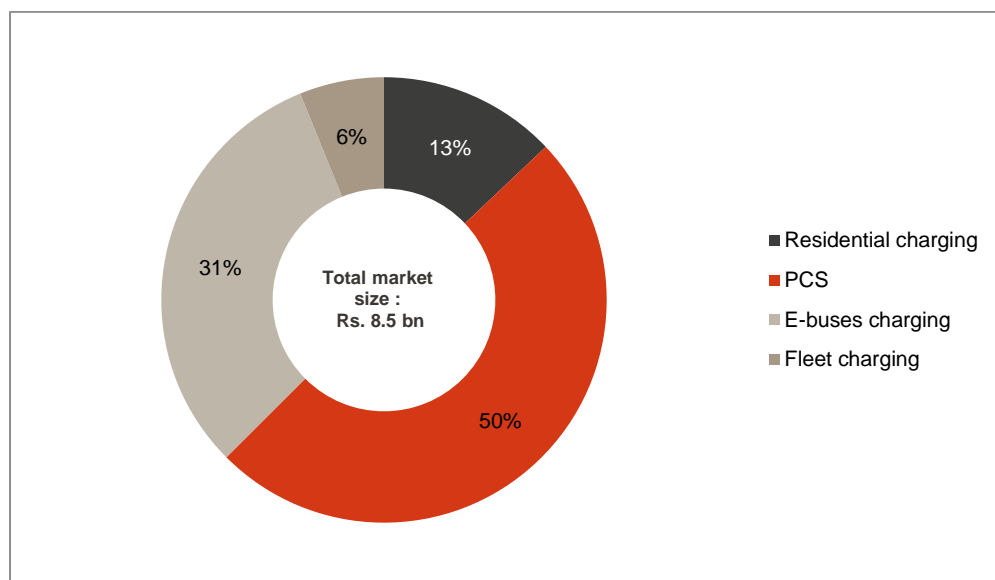
operation of EVSE infrastructure to provide proper communication between grid and charge station companies. Grid connectivity can be challenging in non-metro locations such as highways and wayside stops, and establishing the grid connection may be more expensive in such areas compared to urban pockets. Another issue for EVSE infrastructure development is assuring charger compatibility. As a result, in the charging infra segment capital availability as well as technical skill is required.

To address this issue, the leading EV charger manufacturers in India are currently engaged in manufacturing a diverse product portfolio of AC and DC chargers. ABB, Delta Electronics, Exicom Tele systems, Mass-Tech, Ador are some of the country's major EVSE manufacturers, collaborating with leading EV OEMs to develop chargers based on the latest designs and algorithms.

Charge Point Operators (CPOs) are responsible for establishing and managing charging points. Government charge point operators include EESL, REIL, BESCO, other state nodal agencies (SNAs), and retail arms of government oil companies that are electrifying their petrol stations. Tata Power, Statiq, Fortum, Volttic, Magenta Mobility, Ather Grid, Zeon, and others are among the private sector companies. All CPOs also have agreements with Network Service Providers (NSPs) for data transfer required for real-time EVSE status/monitoring.

DISCOMs (Distribution Companies) play an important role in establishing electric infrastructure and providing power to charging stations. In other circumstances, DISCOMs operate charge point operators in specific localities, like Bengaluru, where BESCO (Bangalore Electricity Supply Company) also operates charging stations. As a result, across the value chain, India now has a strong diversity of companies.

Figure 41: Business segment wise chargers' share: fiscal 23



Source: BEE, CRISIL MI&A

CRISIL MI&A estimates the current EV charging market to be valued at ~Rs.8.5 billion as of fiscal 23. The overall number of chargers is estimated at nearly 50,000, with the residential category leading by far with a 61% share in terms of volume. According to data from the Bureau of Energy Efficiency, a total of 8,751 Public

Charging Stations (PCS) are active in the country as of June 2023. This is a 13x increase over the 650 charging outlets in 2019. A total of 419 Public Charging Stations (PCS) are operational across national highways in the country.

Under phase-II of FAME-India Scheme, Rs. 100 crore is allocated for the development of charging infrastructure. The Ministry has sanctioned 2,877 electric vehicle charging stations in 68 cities across 25 states/UTs. Further, 1576 charging stations across 9 Expressways and 16 Highways under phase-II of FAME India Scheme has also been sanctioned. In recent years, there has been a sustained and increased governmental intervention at the state and national levels to enable the implementation of charging infrastructure.

The first and most important step has been to treat EV charging as a "service." This permits anyone to set up and run an EV charging station without a license. States have implemented fiscal and nonfinancial incentives, including reduced tariff rates for the manufacture and operation of chargers. Furthermore, electrical regulators' treatment of 'EV Charging Station' as a separate category under Tariff Order has been a move in the right direction for encouraging e-Mobility in the country. The GST rate on EV chargers/charging stations decreased from 18% to 5%. Further trends discussed in sections ahead.

Recent trends and developments – investment plans of the leading operators

Leading Charge Point Operators and EVSE manufacturers in India are investing in the development of EV charging infrastructure to address the lack of charging infrastructure, which is one of the major challenges to the widespread adoption of EVs in India. EVSE manufacturers are a critical component in the value chain of the EV eco system, and as such, they are strategizing their investments and partnerships at the present time.

- **Tata Power:** Tata Power is one of the leading players in India's EVSE market. Over 500 EV charging stations have been placed in over 100 cities, and the company has partnered with HPCL (Hindustan Petroleum Corporation Limited) to construct EV charging stations at HPCL's retail shops.
- **Jio-BP:** Jio-bp, a Reliance Industries Limited and BP joint venture, is developing its EV charging infrastructure across India. Jio-bp has collaborated with Mahindra & Mahindra to establish EV charging networks at M&M dealerships and workshops around the country. Citroën India has announced a strategic partnership with Jio-bp will install DC fast chargers across Citroën's key dealership network and workshops across the country in phases.
- **Fortum:** Fortum, which forayed into India's EV charging infrastructure space in 2017, has rebranded its 'Fortum Charge & Drive' EV charging business. The company is switching to a new brand identity – Glida and has over 450 charging points in key cities such as Hyderabad, Bengaluru, Delhi-NCR, Ahmedabad, Surat, and Mohali, etc. It aims to reach close to 1,000 charging points by fiscal 24. The company plans to invest Rs 100 crore into setting up these additional charging stations.
- **ZT Solar:** Delhi-based enterprise ZT Solar has partnered with Clean City SA, an engineering company from Switzerland, to bring efficient e-mobility fast charging stations to India. The joint venture is reported to introduce hydrogen-based patented technology process, Integrated Multi Generation System (IMGS)

through a long-term direct technology investment of USD 3.86 billion to support India's public and private bodies with scalable, combustion-free, and cost-effective EV capabilities.

- **Exicom:** Charging solutions provider Exicom Group is investing INR 100 crore in building a new electric vehicle (EV) charger facility in Hyderabad, Telangana. According to the company, the new facility will be commissioned in under 18 months from now. The new plant is estimated to produce 126,000 AC chargers and 10,800 DC chargers annually.
- **Zeon Charging:** Zeon Charging, a Tamil Nadu-based electric charging infrastructure company, will invest Rs 250 crore in the installation of 400 EV chargers across the state. This five-year investment is specifically for setting up chargers in Tamil Nadu, and we have identified spots and will add these chargers at 70-100 locations within the next two years. In addition, Zeon will have 300 locations around the state, both in cities and along roads, during the next five years.
- **Delta Electronics:** Delta Electronics recently introduced their green EV charging solution at ELECRAMA 2023. It has put prototypes in a few of its sites and intends to extend deployment with the help of charge point operators and system integrator partners. The company is prepared for expansion, with R&D centers in Taiwan, India, and Europe, as well as production operations in Thailand and India.
- **ChargeZone:** ChargeZone, a tech-driven EV charging infrastructure company in India, has raised \$54 million in Series A1 funding round led by global impact investment management firm BlueOrchard Finance. The company plans to raise an additional \$75-100 million in equity as part of Series A2 during 2023-2024. The investment will be deployed to accelerate the next phase of expansion of its retail and public EV charging network across India, including State and National Highways.

Government policies and regulations driving the growth of EV charging stations in India

Building a sustainable and specific EV charging and integrated solutions is required to fortify the Indian EV sector. These solutions are expected to bridge the current infrastructure gap and establish a reliable charging station network throughout urban, regional, and rural areas. Consequently, the range anxiety among potential EV buyers is expected to be addressed and widespread adoption of electric vehicles would be encouraged.

Government policies and regulations are aimed at creating an enabling environment for the growth of EV charging infrastructure in India. They provide incentives, guidelines, and support to encourage the installation of charging stations and promote the adoption of electric vehicles.

Figure 42: Government policies and regulations

2013	2015	2019	2019	2022
• National Electric Mobility Mission Plan 2020 <ul style="list-style-type: none"> • Target to achieve 6-7 million sales of hybrid and electric vehicles year on year from 2020 onwards • Aims to enhance national fuel security, provide affordable and environmentally friendly transportation, • Aims to promote the development of charging infrastructure for electric vehicles 	• FAME <ul style="list-style-type: none"> • FAME -1 total financial layout for the scheme was Rs. 795 Cr • Timeline: Launched for 2 year period between fiscal 16 to fiscal 17 Later extended four times for 6 months (that is until fiscal 19) • Financial layout further increased to Rs. 895 crore. 	• PMP <ul style="list-style-type: none"> • Central government has reduced and rationalized basic custom duty on electric vehicles, its assemblies/sub-assemblies, parts and inputs of the sub-assemblies/parts from Jan 2019 • Government has increased the basic customs duty on the imported Electric vehicle components and set a target date for achieving indigenization of the xEV components • GST on Electric Vehicle is 5% compared to 18-22% for petrol/diesel vehicles. 	• FAME – II <ul style="list-style-type: none"> • In March 2019, the ministry notified FAME–II scheme, with increased layout of Rs 10,000 crores which includes a spill over from FAME-I of Rs. 366 crore • FAME-II scheme was notified for five years and has a deadline of March 31, 2024 to complete its targets of supporting 15.62 lakh electric vehicles. 	• PLI <ul style="list-style-type: none"> • National Programme on Advanced Chemistry Cell (ACC) Battery Storage in India for setting up manufacturing facilities with a total manufacturing capacity of 50 Giga Watt Hour (GWh) with an outlay of Rs.18,100 crore. • Automobile and Auto Component PLI schemes with a budgetary outlay of ₹25,938 crore.

Source: Ministry of Heavy Industries and Public Enterprises; March 2019 PMP notification

Additional to above incentives, some of the states are also offering incentives for charging infrastructure:

- Individual EV owners prefer to charge on their own premises, with studies showing that 50% to 80% of all EV charging by individuals occurs at home, while another 15% to 25% happens in the workplace.
- Commercial vehicles and EV fleets, on the other hand, charge at captive charging hubs or through the public EV charging network.
- Capital subsidies and tax concessions aim to subsidize the cost of the EVSE meant primarily for public use. State incentives favor plug-in charging facilities, with few incentives on offer for battery-swapping equipment. While not explicitly mentioned, it is expected that the incentives may be availed by both public sector undertakings (PSUs) and private players interested in setting up charging infrastructure.
- Andhra Pradesh, Maharashtra, Bihar, Punjab and Madhya Pradesh provide varying levels of capital subsidies for fixed numbers of public charging stations.

EV charging market and segmentation outlook

Market size for Public charging infrastructure and Projected growth over the next 5 years (fiscal 23 – fiscal 28)

As per the data published by the Bureau of Energy Efficiency, there are 3,773 PSU operating Charging stations and 4,978 privately operated charging stations as of June 2023 The 3.3 KW to 7.4 KW Bharat AC -001 and

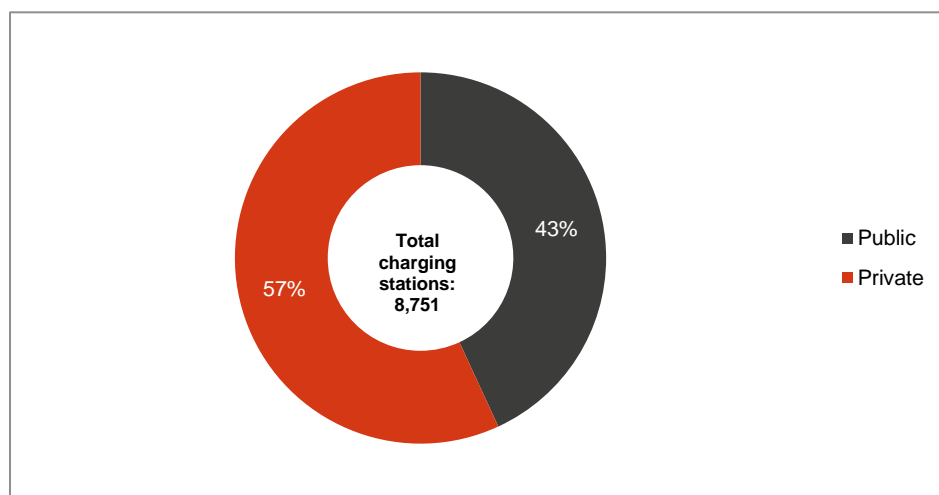
Type- II AC chargers dominate the public charging market, accounting for more than 60% of the market. The Indian government has issued certain guidelines for public charging infrastructure, as described in Table below. The Bureau of Indian Standards has issued IS:17017 as the basic standards for EV charging. It recommends both Combined Charging System Type-2 (CCS-2) (beside AC Type-2 charger) and CHAdeMO as the EVs standards for India for fast charging. However, CCS-2 is the most preferred mode of charging in India, as it is supported by a wider range of electric vehicle manufacturers and can be used for both AC and DC charging.

Table 18: Electric Vehicle Chargers as per BIS Guidelines

Charge type	Charger connectors	Rated Output Voltage (V)	No. of Connector Guns (CG)	Charging Vehicle
Fast	Combined Charging System (CCS) (min 50 kW)	200-750 or higher	1	4 W
	CHArgeDeMOve (CHARdeMO) (min 50 kW)	200-750 or higher	1	4 W
	Type 2 AC (min 22 kW)	380-415	1	4 W, 3W, 2W
Slow/Moderate	Bharat DC 001 (15 kW)	48	1	4 W, 3W, 2W
	Bharat DC 001 (15 kW)	72 or higher	1	4 W
	Bharat AC 001 (10 kW)	230	3 of 3.3 KW each	4 W, 3W, 2W

Source: Annexure- II, Charging Infra guidelines, Ministry of Power

Figure 43: Share of Public vs Private Charge point operators in Public charging space



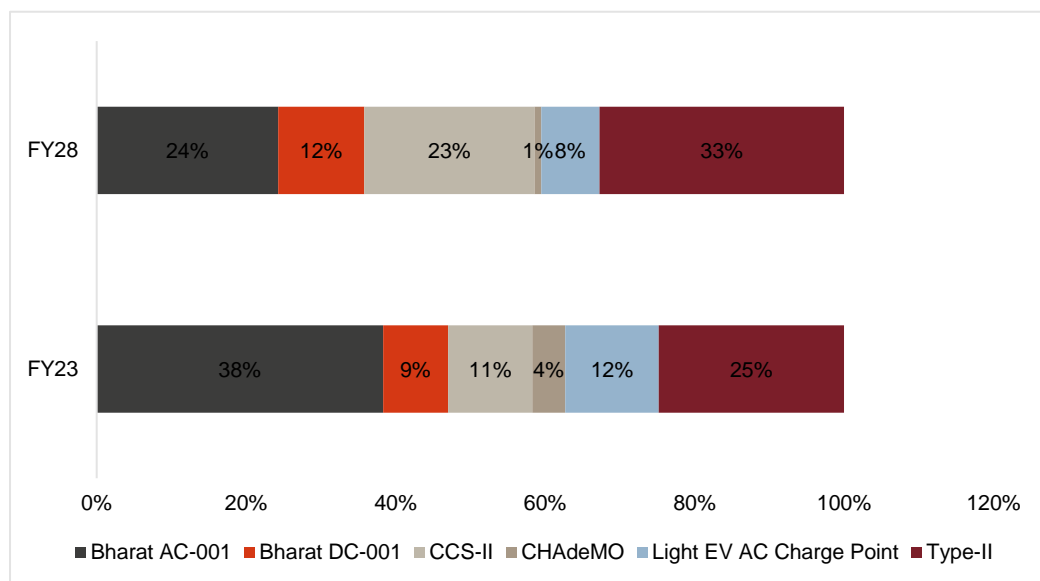
Source: Bureau of Energy efficiency, CRISIL MI&A

Many charging station operators are implementing fast-charging DC chargers, which shortens the charging time for electric vehicles. CPOs are integrating their stations with digital platforms to provide users with real-time information on charging station availability and location.

The government is also now pushing for installation of more CCS-2 type chargers. CCS-2 (Combined Charging System 2) is a standard for DC fast charging electric vehicles (EVs). It can provide power at up to 350 kilowatts

(kW) (max 500 amps) and uses Combo 2 (CCS2) connectors. CCS-2 charging stations are equipped with a 60 kW or 50 kW DC charger and CCS-2 connectors. These charging stations usually have multiple charging points to accommodate multiple vehicles simultaneously.

Figure 44: Different types of connectors' share in overall PCS space: Review & Outlook



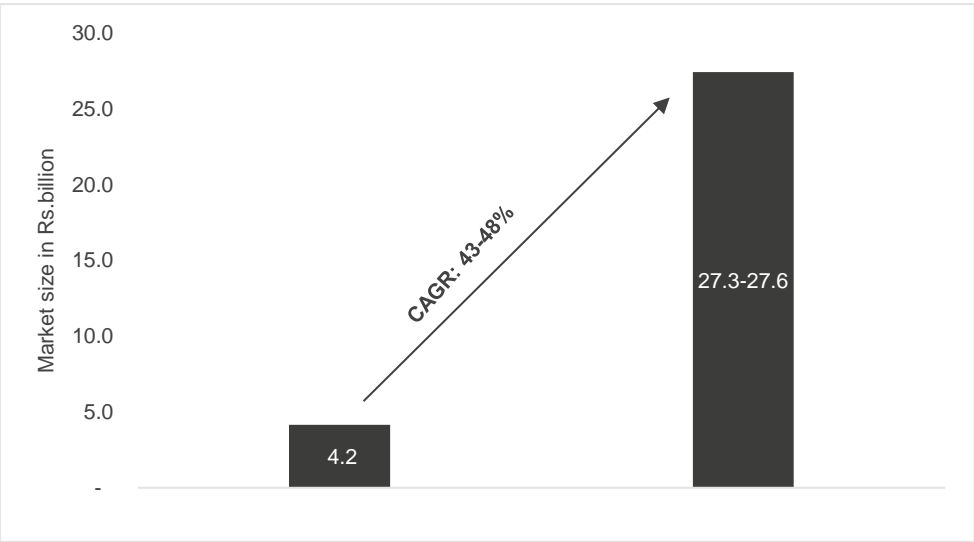
Source: Bureau of Energy efficiency, CRISIL MI&A

The EV charger demand in India witnessed a significant increase in last 2 fiscals of '22 and '23, owing to increasing EV penetration. Of the 8,752 public charging stations, close to 50% stations have been provided by private players, few of the major ones being Delta Electronics, ABB, Exicom, Mass-Tech etc. JioBP, ChargeZone, Statiq are some of the leading charge point operators of EV charging stations in the country.

With respect to Public sector units, Convergence Energy Services Limited (CESL) which is a subsidiary of Energy Efficiency Services Limited (EESL), NTPC Vidyut Vyapar Nigam Ltd, OMCs such as Indian Oil Corporation Limited (IOCL), Hindustan Petroleum Corporation Limited (HPCL), Bharat Petroleum Corporation Limited (BPCL), State boards such as Kerala State Electricity Board (KSEB), Bangalore Electricity Supply Company Limited (BESCL) etc are some of the leading players that have floated tenders/set up stations or offering space for retail outlets.

This diverse market offers AC, DC, and Fast Charging stations to cater to different EV needs. Further, real estate companies such as Lodha Group, MyGate, and Rustomjee Group, collaborated with Charge point Operators to deploy EV charging solutions in their new & existing properties.

Figure 45: Review & Outlook Market size of public charging stations: Review and outlook



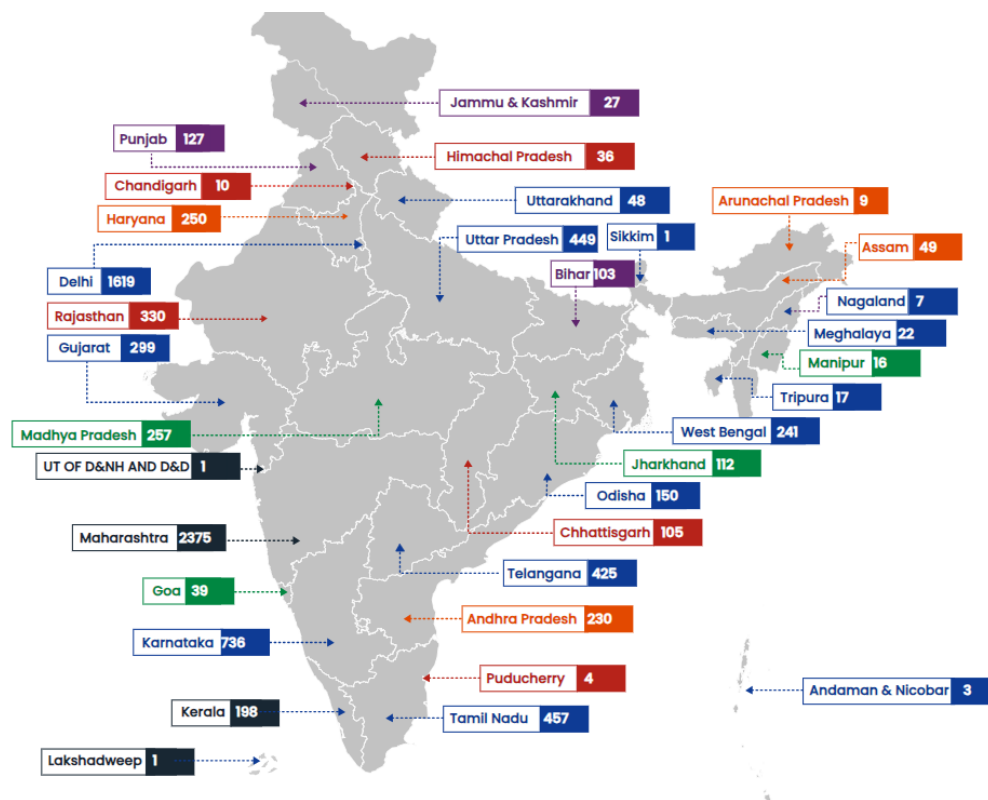
Source: Bureau of Energy efficiency, CRISIL MI&A

Public charging stations are spread across various cities and states across India. Delhi has the highest number of public charging stations in the country, with 1,600+ stations. Other states with a significant number of charging stations include Maharashtra, Karnataka, and Uttar Pradesh.

It is estimated that ~ 10 per cent of fuel pumps across the country now offer charging stations for electric vehicles. The number of charging stations in the country is growing as fuel-pump owners have taken note of the rise in demand for alternative energy facilities. The number of charging stations at OMCs is estimated to have grown 2.5 x times in the last one year.

States such as Haryana, Kerala, Madhya Pradesh & Andhra Pradesh provide attractive capital subsidies for the deployment of a limited number of fast and slow EV chargers. Further, Delhi & Maharashtra emerge to be favorable locations for installing private charging due to the availability of additional state subsidies. Also, some of the state's regulatory commissions have announced tariffs for EV charging as a separate category in their tariff orders.

Figure 46: State wise Public Charging Stations

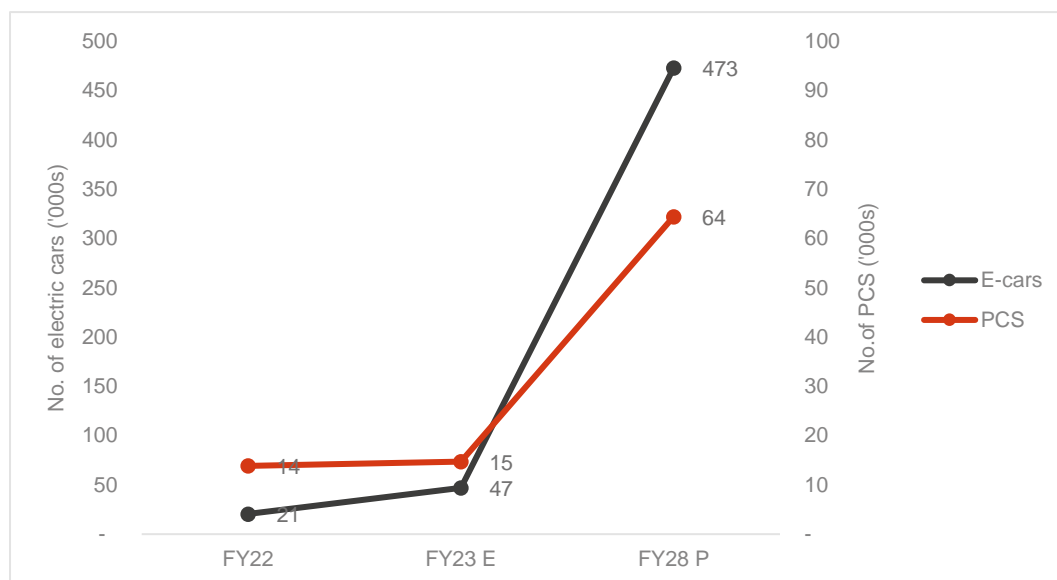


Source: Bureau of Energy efficiency, CRISIL MI&A

Efforts taken by the Department of Heavy Industries through the FAME Scheme and the release of EOI for the deployment of charging stations have aided in the widespread installation of chargers across the nation. State governments are also taking active steps to increase the EV charging network in the state by providing attractive incentives in the form of capital subsidies and 100% reimbursement of state goods & services tax.

Considering the above growth factors and improved utilization level coupled with the 60-65% growth expected in the electric passenger segment, CRISIL expects the PCS market size to grow at a CAGR of 42-48% in the next 5 years.

Figure 47: Trend of Number of electric cars vs public charging stations



Source: Vahan, Bureau of Energy efficiency, CRISIL MI&A

Key highlights of Charging Infra Guidelines

- De-licensing of EV charging business
- At least 1 charging station in a grid of 3km by 3km in cities
- At least one charging station for every 25 km on both sides of highways.
- At least 4 fast charge points mandatory at heavy duty charging stations.
- OMC retail pumps to be given priority for EV charger installations.
- Online integration and data management mandatory for charging station operators.

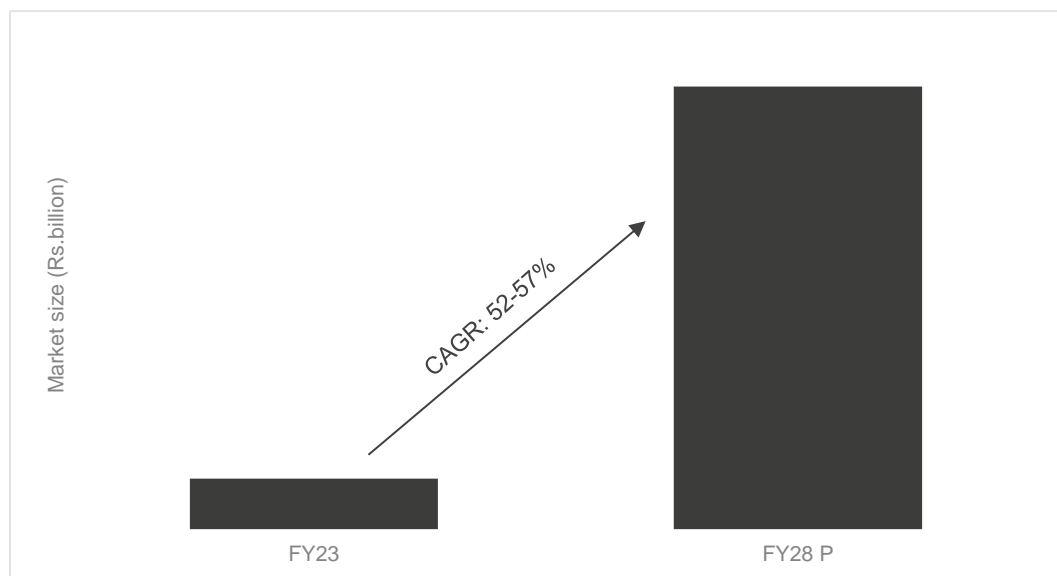
Market size for Fleet operator charging infrastructure and Projected growth over the next 5 years (fiscal '23 – fiscal '28)

The population of fleet operators in the commercial EV space is expected to be ~ 50-60% of the total commercial PVs. These fleet operators charge their fleet captively. Captive charging stations refer to charging infrastructure that is specifically installed and operated by electric vehicle (EV) fleet operators for their own use. These stations are dedicated to charging the fleet vehicles and are typically located at the fleet's depots or other designated areas.

Captive charging stations provide EV fleet operators with control over their charging infrastructure, ensuring convenient and reliable charging for their electric vehicles. These stations can be customized to meet the specific needs of the fleet, helping to optimize fleet operations and support the transition to electric mobility. These stations can help reduce downtime for EV fleet operators by ensuring that vehicles are charged and

ready to go when needed. This can help improve fleet efficiency and reduce the risk of delays or missed appointments. They can also be customized for charging speed, power output, and connector type.

Figure 48: Market size of captive charging stations for fleet operators: Review & outlook



Source: CRISIL MI&A

Currently ~ 40% of the captive charging stations are estimated to be fast charging stations with a rated power output of 20-30 KW and the balance being slow charging station. This share is expected to increase to ~ 50% going ahead. With the commercial fleet operator's population expected to go up by 50%, coupled with an increase in the share of fast chargers, the market is expected to grow at a CAGR of 52-57% in the next 5 years.

Table 19: Overview passenger vehicle commercial fleet segment

Segment →	EV Fleet operators
FY23 proportion of sales	~55-60%
Mode of operation	▪ Only local: ~90%
	▶ >200 km (24 hrs ops): 25-30%
	▶ ≤200 km (14-16 hrs ops): 70-75%
	▪ Only outstation: ~10%
Segments catered	▪ Individuals
	▪ Corporates
Key organised players	Blusmart
	Lithium Urban
	GoGreen Cabs
	Cab-E
Segment definition	Aggregates cabs, and provides cab services Ex: Blusmart , cab-E
	Employee Transportation services Ex: Lithium Urban

Source: CRISIL MI&A

Key trends in EV Fleet segment

The upstart in the EV fleet segment, BluSmart, operates a fleet of electric cars leased directly and deploys the fleet with salaried drivers, unlike competitors who do not own any vehicles.

- Uber had been conducting a pilot with fleet partners to assess the viability of its electric vehicle products, which has been priced 20-25% above its entry-level UberGo offering. Ola is planning to start its own EV cab service and will begin the pilot in Bengaluru with around 1,000 cabs. The cabs will be available on the Ola app as a separate category along with regular cabs and its auto service.
- EV ride-hailing platform BluSmart Mobility, recently raised around USD 42 million in a mix of equity and debt funding from BP Ventures and several other existing investors to ramp up its existing EV fleet capacity.
- Tata Motors, the biggest supplier of EV cars to fleet operators has a production capacity of ~ 50,000 cars a year, largely driven by its passenger vehicle. Its four EV models include Nexon EV, Tigor EV, Tiago EV and the fleet-only Xpres-T EV. In July 2021, the automaker launched the 'XPRES' brand exclusively for fleet customers, and the XPRES-T EV is the first vehicle under this brand. Considering the increasing EV fleet orders, Tata motors has ramped up capacity significantly by increasing localization.

Market size for Residential charging infrastructure and Projected growth over the next 5 years (fiscal '23 – fiscal '28)

Residential charging with a wall mount charger is a convenient and efficient way to charge electric cars at home. EV owners can plug in their vehicles and leave them to charge overnight, ensuring that they are fully charged and ready to go in the morning. Wall mount chargers may come with additional features such as Wi-Fi connectivity, mobile app control, and scheduling options. These features can help optimize charging and provide greater convenience for EV owners. Wall mount chargers can provide faster charging speeds than standard household outlets. This can help reduce charging time and ensure that EVs are ready to go when needed. Wall mount chargers can be customized to meet the specific needs of EV owners. They can be installed in a convenient location, and the charging power can be adjusted to match the EV's requirements. Installing a wall mount charger can add value to a home, as it provides a convenient and desirable feature for potential buyers.

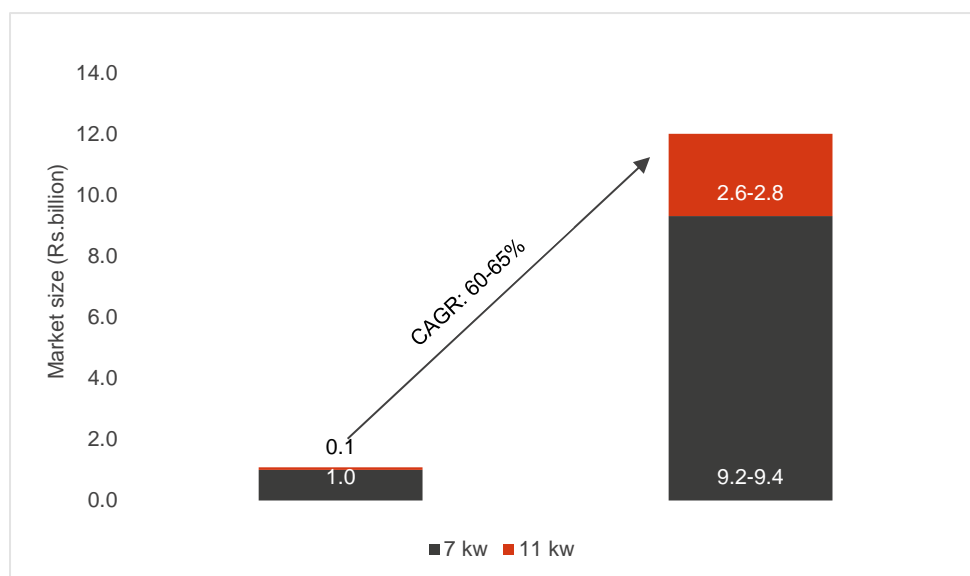
Table 20: EV models in India and charger options

OEM	EV Models	Portable Charger	Wall mount charger	Wall mount Charger rating
Tata Motors	Nexon Max	✓	✓	7.4 Kw AC
	Nexon Prime	✓	✗	7.4 Kw AC
	Tiago XT	✓	✗	7.4 Kw AC
	Tiago XZ+	✓	✓	7.4 Kw AC
	Tigor (All variants)	✓	✗	
MG	ZS EV	✓	✓	7.4 Kw AC
	Comet	✓	✗	7.4 Kw AC
Hyundai	Kona	✓	✓	7.4 Kw AC
	Ionoq	✓	✓	11 Kw AC
BYD	Atto 3	✓	✓	7.4 Kw AC
	e6	✓	✓	7.4 Kw AC
M&M	XUV 400	✓	✓	7.4 Kw AC
	e-verito	✓	✗	
	e2o	✓	✗	
	eKUV100	✓	✗	

Source: Company websites, CRISIL MI&A

The Tata Nexon EV is one of the most popular electric vehicles in India. It comes in two variants: Nexon EV Prime and Nexon EV Max. The Nexon EV Prime has a battery capacity of 30.2 kWh and offers a range of up to 312 km on a single charge. The Nexon EV Max, on the other hand, has a larger battery capacity of 42.2 kWh and provides a range of up to 419 km. This variant comes with a wall mount charger of 7.2 KW installed by the OEM dealer at the buyer's residence. The above table details the EV models which are offered with Wall mount chargers. The MG ZS EV is another electric car with a higher battery capacity in India. It has a battery capacity of 44.5 kWh and offers a range of up to 419 km on a single charge. The Hyundai Kona comes with a battery capacity of 39.2 kWh and provides a range of up to 452 km on a single charge.

Figure 49: Market size of Residential charging infrastructure: Review & outlook



Source: CRISIL MI&A

Currently the market is dominated by 7KW chargers which is expected to be the trend 5 years down the lane. Because players like Tata motors, MG are expected to bring more and more hatch backs, smaller SUVs into the electric space, which would like require smaller chargers or maximum of 7 KW charger. However, high end SUVs like the Ioniq and Volvo are expected to be launched in the coming years, which would offer 11 KW chargers. The 60-65% CAGR can be attributed to 50-52% CAGR expected in electric passenger car sales and increasing share contributed by 11 KW wall mount chargers.

Market size for Electric bus charging infrastructure and Projected growth over the next 5 years (fiscal '23 – fiscal '28)

To combat the problems of pollution and lack of buses, fleet augmentation using the electric buses presented itself as an ideal solution.

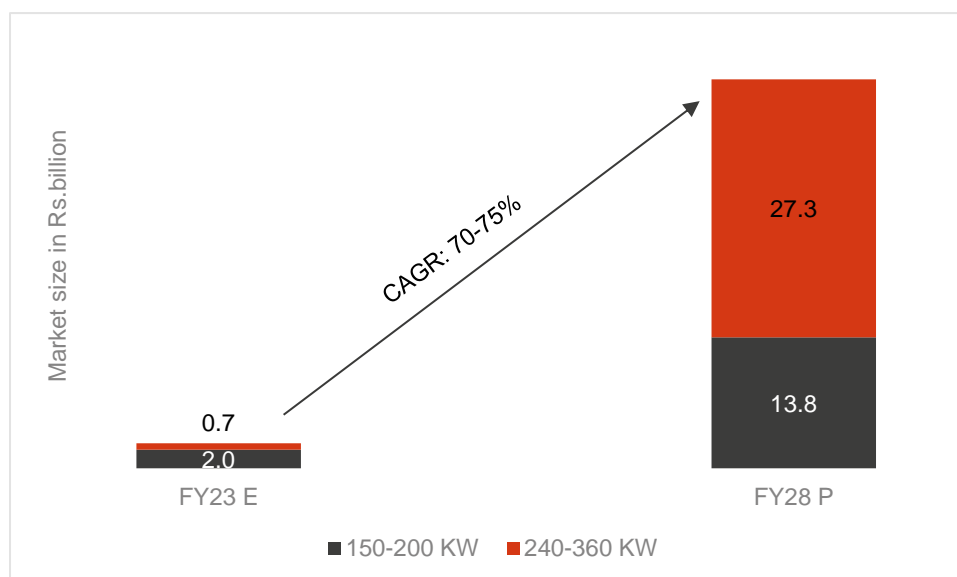
The Ministry of Road Transport and Highways (MoRTH) has asked state transport undertakings (STUs), responsible for procuring and operating buses, to replace over 32,000 old diesel buses with electric vehicles. According to a MoRTH estimate, 25 STUs own a total of 32,062 buses that are more than 10 years old. Most ageing buses currently in use by STUs are BS-II or BS-III diesel buses. STUs are keen on scrapping these old buses as they are inefficient and polluting.

Switching to electric buses is a good scheme, but STUs have seen a slowdown after Covid-19 due to operational losses. Electric buses are expected to reduce costs due to subsidy, lower operating cost, and government support.

To accelerate the process of adaptation of electric vehicles, the Department of Heavy Industries launched Faster Adoption and Manufacturing of Electric Vehicles India (FAME India). Under the FAME scheme, the State

Transport Undertakings (STUs) or City Transport Undertakings (CTUs) are given subsidies for the procurement of electric buses for the public use as well as to put up the supporting charging infrastructure. Benefitting from the scheme, many cities have already started electric bus operations.

Figure 50: Market size of E-Bus charging stations



Source: CRISIL MI&A

As part of FAME- I about 425 electric and hybrid buses, as sanctioned under the first phase of the scheme are deployed across various cities in the country with government incentive of about Rs 280 crore. The Ministry of Heavy Industries had also sanctioned about 520 charging stations/infrastructure for Rs 43 crore. Buses have been identified as a key segment for subsidies within FAME-II as well, with an allocation of Rs 3,935 crore for supporting 8,700 e-buses. As part of this, the Department of Heavy Industry (DHI) has sanctioned 6,265 e-buses to 65 cities/STUs/state government entities which includes 600 e-buses for intercity operations and 100 e-buses to Delhi Metro Rail Corporations (DMRC) for last mile connectivity.

Overall, with both public and private sector participation, the Electric bus population till date is estimated at ~ 4,400 and a total of 1,100+ L2/L3 chargers have been set up for servicing them. The market size of E-bus charging stations as on date is estimated to be ~Rs. 2.6 billion. Close to 75% of this share is contributed by 150-200 KW charging stations.

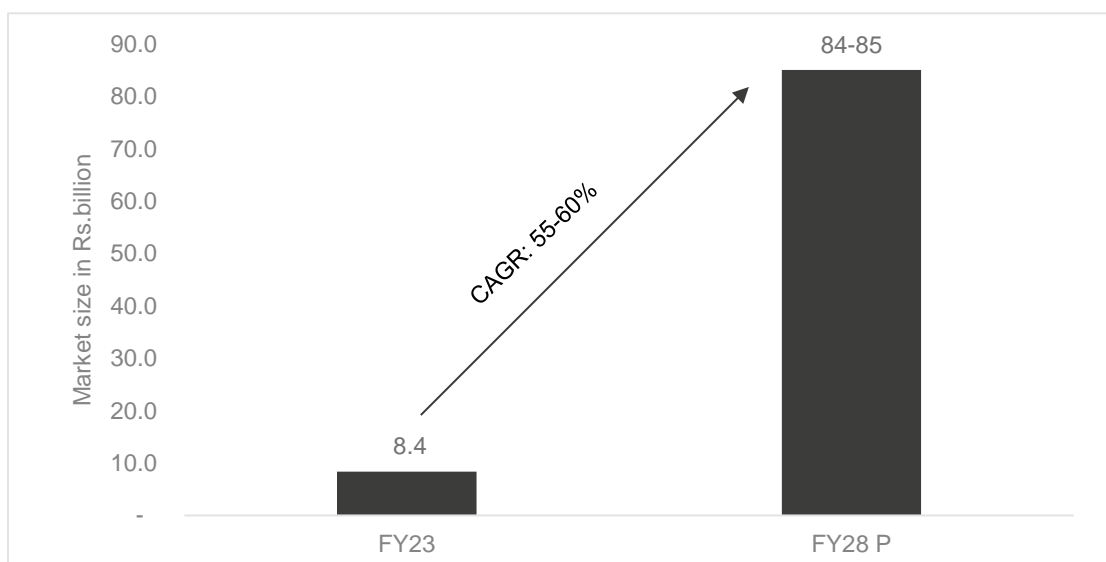
Electric buses receive a subsidy of Rs 20,000/KWh of battery capacity, double the amount for most other segments. And OEMs are now moving towards higher battery capacities to accommodate longer ranges. Hence the industry is expected to shift towards 240-360 KW charging stations in the coming five years, taking the market size to Rs.40.7-41.3 billion.

EV charging infrastructure overall - Outlook for next five years

The public charging station market, which contributes ~50% of the overall EVSE market size as of fiscal 23 is expected to grow at a CAGR of 43-48% in the next five years. The E-buses charging stations market is expected to grow at a faster rate at a CAGR of 70-75% owing to higher scope of penetration. Residential charging segment is expected to grow at a CAGR of 60-65% and will continue to lead ~ 13-14% of the overall pie of EVSE market. Fleet charging market is expected to grow at a CAGR of 52-57% led by more commercial fleet operators entering the EV fleet market.

Overall, rise of EV penetration in passenger vehicles ("PVs"), Fleets and Buses will cause the demand for EV Chargers for all key segments combined to grow at a CAGR of 55%-60% between fiscal 2023-fiscal 28.

Figure 51: Market size of overall charging infrastructure



Source: CRISIL MI&A

The penetration of electric vehicles in the passenger car segment increased from 0.03% in fiscal 16 to 1.3% in fiscal 23. This is expected to go to 8-10% by fiscal 28. Similarly, the electric vehicle penetration in electric buses segment increased from 0.01% in fiscal 16 to 2.8% in fiscal 23. This is expected to go to 14-16% by fiscal 28. The Union Minister of Heavy Industries sanctioned Rs. 800 crores in March 2023 under FAME India Scheme Phase II to the PSU Oil Marketing Companies (OMC) - Indian Oil (IOCL), Bharat Petroleum (BPCL), and Hindustan Petroleum (HPCL) - for setting up 7432 public fast charging stations across the country. The OMCs have sufficient land in the premises of their Retail Outlets which can be utilized for the setting up of the charging stations.

The OMC wise proposed installation of charging stations including upstream infrastructure is as below:

Table 21: OMC wise proposed Chargers to be installed

OMC	Chargers of 50/60 KW capacity	Chargers of 100/120 KW capacity	Total
IOCL	2,707	731	3,438
BPCL	1,739	595	2,334
HPCL	1,216	444	1,660
Total	5,662	1,770	7,432

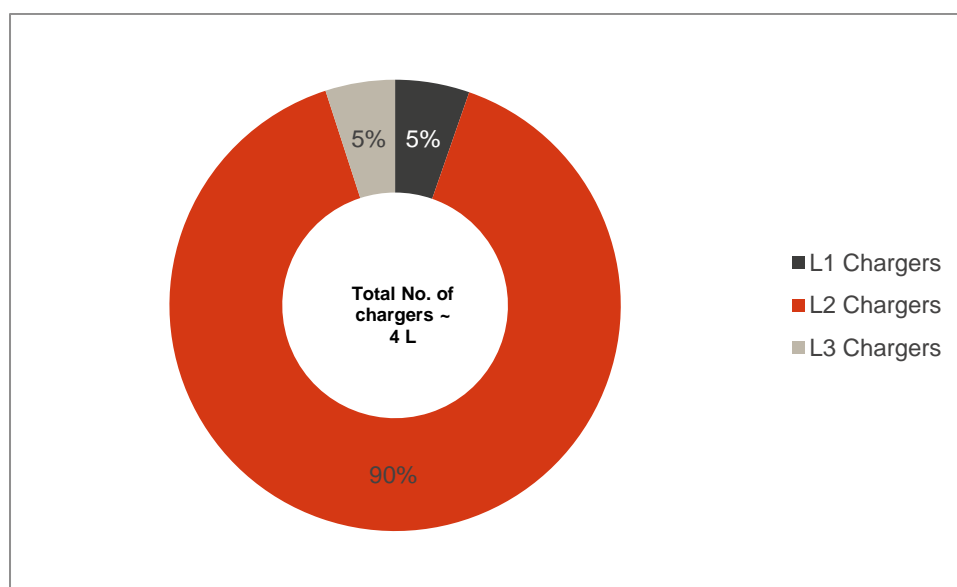
Source: CRISIL MI&A

Additionally, many Charge point operators are rolling out plans for setting up DC fast charging stations in the next 2-3 years. Also, more STUs adopting e-buses, school buses moving towards electrification and FAME and state subsidies offered to e-buses.

Accordingly, the share of L2 and L3 charging infrastructure is expected to go to 90% and 5% respectively, of the overall EVSE market as can be seen in the chart below.

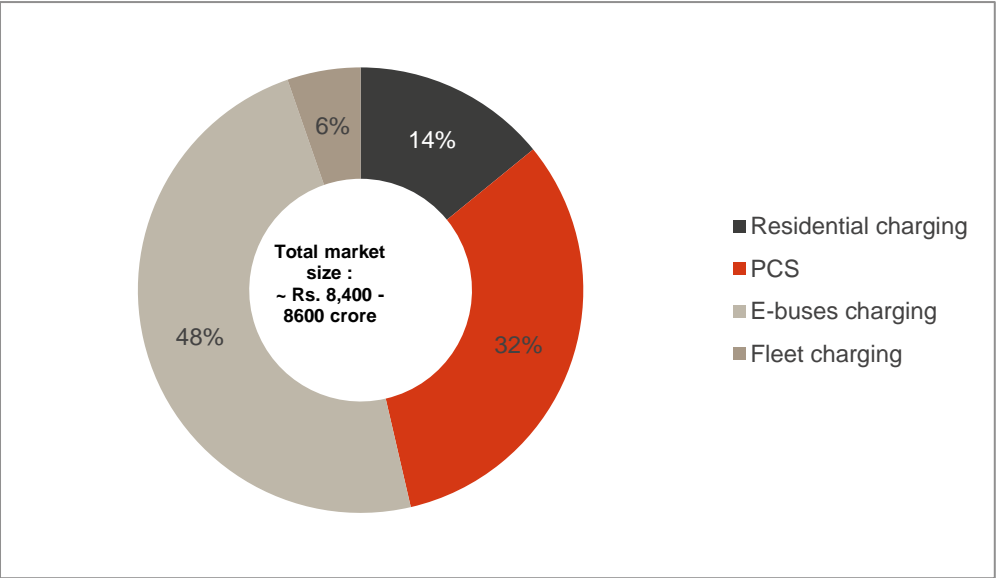
The residential charging market will remain around 13%, Public charging stations market size will increase at a CAGR of 45-50% mainly attributed to the L2 and L3 chargers planned to be set up private players and OMCs in the next 2 to 3 years The current ecosystem is for 150-200 KW charging. Going ahead, 240 KW to 360 KW rated stations are expected to be installed which will be costed higher. Hence the E-bus charging market will remain dominant.

Figure 52: Projected share of L1, L2 and L3 chargers in fiscal 28



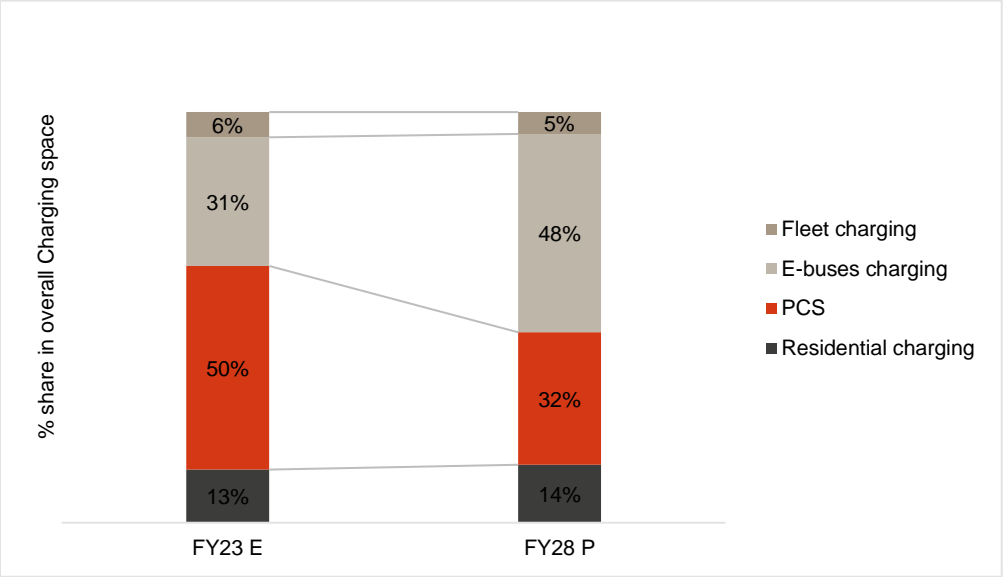
Source: CRISIL MI&A

Figure 53: Projected market size of EV charging infrastructure fiscal 28



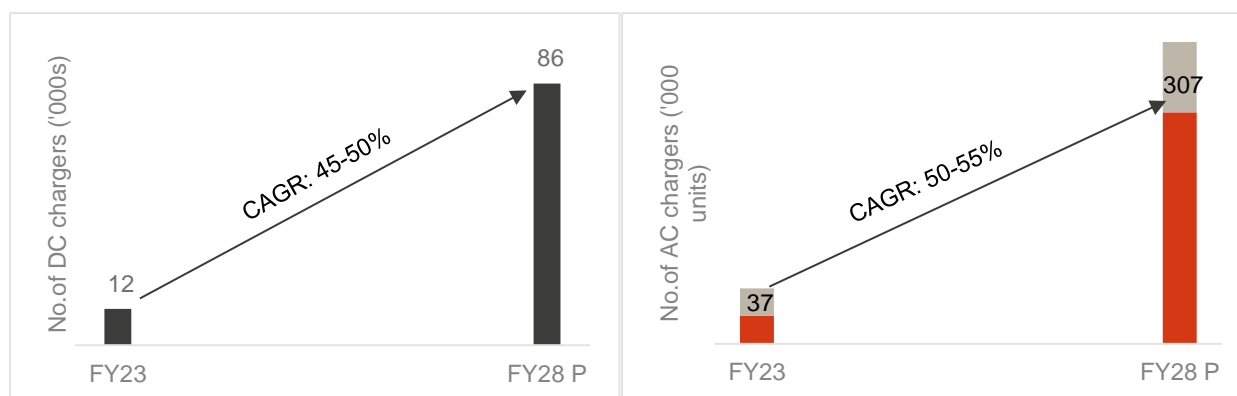
Source: CRISIL MI&A

Figure 54: Segment wise share in EV charging infrastructure in the next five years



Source: CRISIL MI&A

Figure 55: DC and AC chargers' growth in volume in next five years



Source: CRISIL MI&A

DC Charger, primarily driver by E-bus charging and public charging market, is expected to grow from 12,000 units in FY 2023 to 86,000 units in FY 2028 at a CAGR of 45-50%. AC Chargers are expected to grow from 37,000 units in FY 2023 to 307,000 units in FY 2028, primarily driven by home charger sales.

The electric charging infrastructure market is at a nascent stage in India at ~ Rs.8.4 billion. Nevertheless, with all the growth factors mentioned above like the government push in the form of favorable policies, incentives and subsidies, lower cost of ownership, growth in underlying segments of electric passenger cars and electric buses, upcoming investments in EV charging space, are expected to increase the market by ~10x the existing size i.e., to Rs 8.6 billion by fiscal 28.

Overall, to support the shift towards EVs, the EV charging network will need to ramp up its capacity, presenting a significant, industry-wide market opportunity for EV charging products with a projected total addressable market ("TAM") of Rs 8.6 billion by fiscal 28 in India.

7. Player Profiles & Competitive Financial Benchmarking

Delta Electronics India Limited

Delta Electronics India Limited is a subsidiary of Delta Electronics, a global leader in power and thermal management solutions. They are operating in India since 2003 and is part of Delta, founded in 1971 with its Global Headquarters in Taiwan. Delta Electronics India Private Limited is a group entity and a leading Power and Energy management company. Delta Electronics India operates in three business categories: Power Electronics, Automation, and Infrastructure.

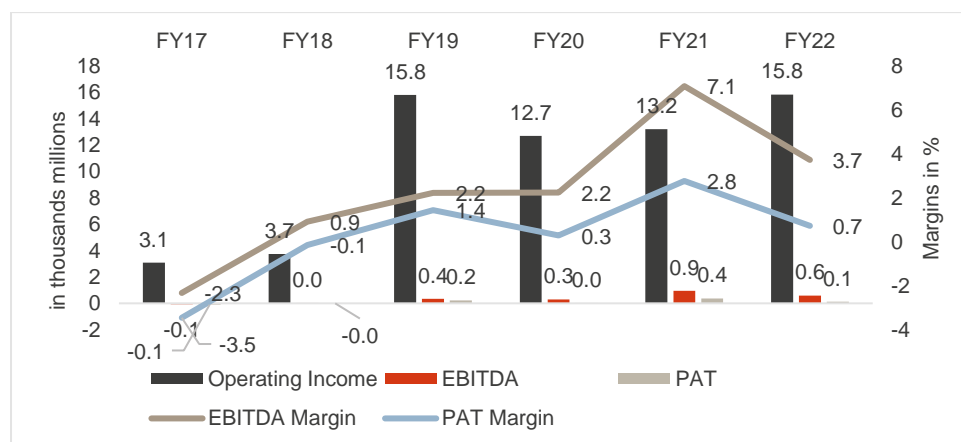
It has market leadership in Telecom Power Solutions, Renewable Energy Solutions (Solar Inverters). It is also a leading provider of UPS & Data center Solutions, EV Charging Solutions, Energy Storage Solutions, DC Fans & Blowers, and Components. With more than 200 channel partners, sixteen regional offices, three manufacturing facilities (Rudrapur, Gurgaon, and Hosur), and two R&D centres (Gurgaon and Bengaluru), Delta has a significant presence throughout India.

Table 22: Key financial indicators

(In Millions)	FY17	FY18	FY19	FY20	FY21	FY22
Operating Income	3075.8	3744.3	15816.5	12715.4	13224.5	15847.3
EBITDA	-71.6	34.4	353.7	285.2	937.7	590.9
PAT	-106.3	-5.3	228.9	36.9	366.5	115.7
EBITDA Margin (%)	-2.3	0.9	2.2	2.2	7.1	3.7
PAT Margin (%)	-3.5	-0.1	1.4	0.3	2.8	0.7

Source: Company annual reports, CRISIL MI&A

Figure 56: Key financial indicators – Delta electronics



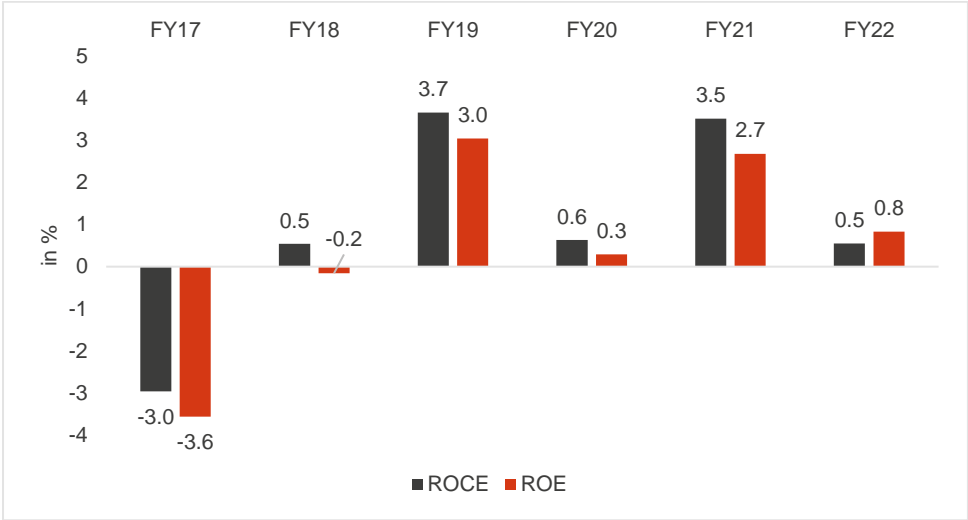
Source: Company annual reports, CRISIL MI&A

Table 23: Key return ratios

(In %)	FY17	FY18	FY19	FY20	FY21	FY22
ROCE	-3.0	0.5	3.7	0.6	3.5	0.5
ROE	-3.6	-0.2	3.0	0.3	2.7	0.8

Source: Company annual reports, CRISIL MI&A

Figure 57: Key return ratios – Delta electronics



Source: Company annual reports, CRISIL MI&A

Exicom Tele-Systems

Founded in 1994, Exicom Tele-Systems operates in 2 key business verticals – Critical Power and electrical vehicle supply equipment. It is a vertically integrated company with capabilities from design, engineering, manufacturing and after sales support. It has 3 manufacturing facilities in Gurugram, Haryana and Solan (Himachal Pradesh) and are supported by in house team of R&D engineers with expertise in areas of power electronics design, battery & BMS design and EV charging technology. It has R&D center in Gurugram and Bangalore and has significant presence throughout India with its service network.

Exicom was amongst the first entrants in the EV Charger manufacturing segment in India and has a leading market share in EV Charging products with 60% market share in residential charging and 25% market share in public charging space as of fiscal 2023. Exicom is one of the few companies in India which has a full stack of AC and DC chargers portfolio ranging from 3.3kW to 360kW with pan-India after sales service as well. It counts leading Auto OEM's, Charge Point Operators and Fleet Operators as its customers and has deployed over ~35K chargers across 400 locations in India as of March 31, 2023.

In Critical Power, it has leading Telco's and Tower Co's as its customers across India, Southeast Asia and Africa and is one of the few players having both DC Power and energy storage as part of its portfolio. Exicom has already deployed 450,000 Li-ion batteries in telecom as of fiscal 2023 translating to over 2.0GWH of storage capacity making it one of the leading players in this segment with ~10% market share. Exicom recently won a large Li-ion battery order amounting to ~21K battery packs from BSNL in its pursuit of network augmentation.

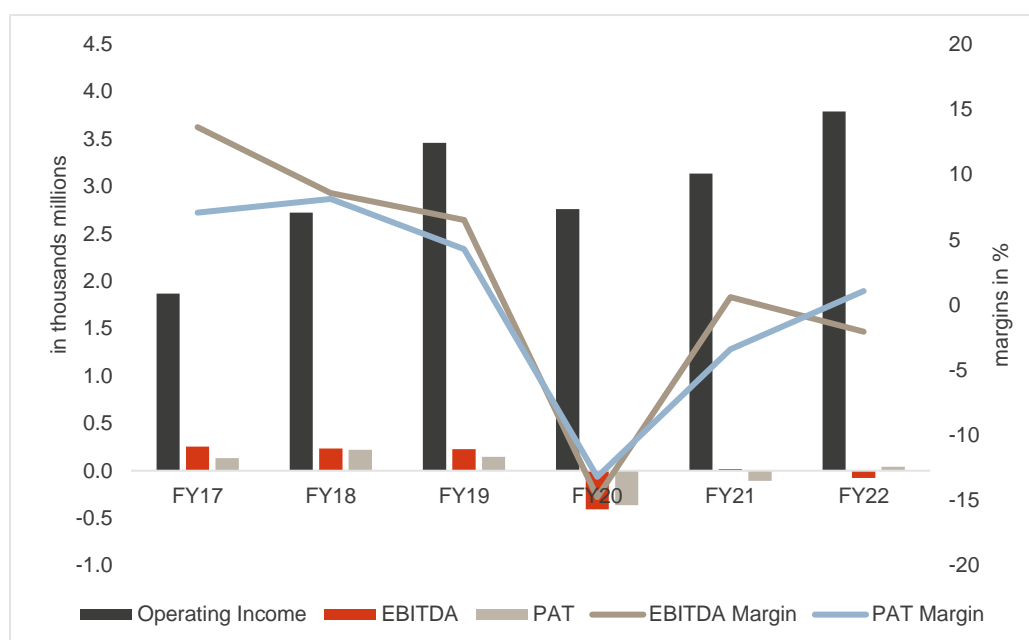
The company makes a complete range of DC Systems including Indoor, Outdoor and Hybrid systems for all types of applications in telecom networks based on its, in house designed and manufactured rectifiers (AC-DC converters) and controllers. Exicom has 16% market share in DC Power Systems market in India as of fiscal 2023.

Table 24: Key financial indicators

(In Millions)	FY17	FY18	FY19	FY20	FY21	FY22
Operating Income	1869.1	2724.6	3460.8	2761.7	3136.4	3792.6
EBITDA	255.0	233.6	225.9	-407.5	19.0	-77.6
PAT	132.4	221.7	148.1	-364.6	-106.6	40.5
EBITDA Margin (%)	13.6	8.6	6.5	-14.8	0.6	-2.0
PAT Margin (%)	7.1	8.1	4.3	-13.2	-3.4	1.1

Source: Company annual reports, CRISIL MI&A

Figure 58: Key financial indicators – Exicom Tele-Systems



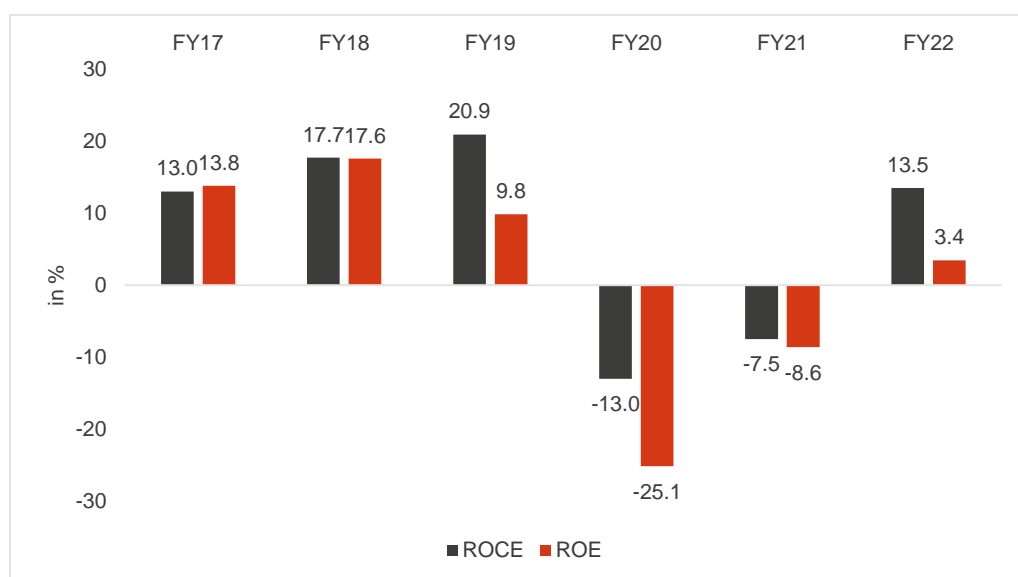
Source: Company annual reports, CRISIL MI&A

Table 25: Key return ratios

(In %)	FY17	FY18	FY19	FY20	FY21	FY22
ROCE	13.0	17.7	20.9	-13.0	-7.5	13.5
ROE	13.8	17.6	9.8	-25.1	-8.6	3.4

Source: Company annual reports, CRISIL MI&A

Figure 59: Key return ratios – Exicom Tele-Systems



Source: Company annual reports, CRISIL MI&A

Vertiv Energy Private Limited

Vertiv Energy Private Limited is a leading global technology solutions provider specializing in critical infrastructure and energy management. Vertiv Energy is dedicated to powering and protecting critical applications and data centers that are vital to businesses and societies worldwide. Vertiv Energy offers a wide range of services like Energy Management Solutions, Uninterruptible Power Supply (UPS) Systems, Thermal Management Solutions, Renewable Energy Integration, Energy Consultancy Services.

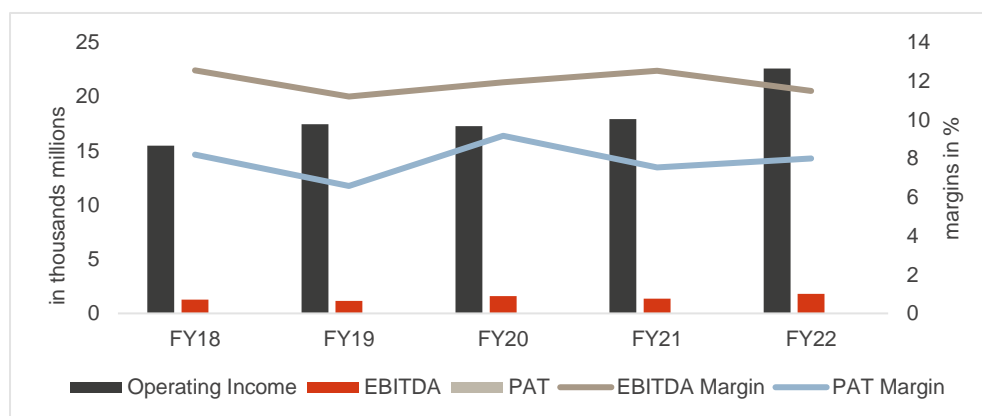
Vertiv's primary customers are businesses across three main end markets: data centers, communication networks, and commercial and industrial environments. The company's principal offerings include critical infrastructure solutions such as AC and DC power management, thermal management, and integrated modular solutions, integrated rack solutions, and services and spares.

Table 26: Key financial indicators

(In Millions)	FY18	FY19	FY20	FY21	FY22
Operating Income	15482.0	17445.2	17256.4	17927.5	22594.2
EBITDA	1943.0	1953.6	2058.4	2247.7	2594.8
PAT	1268.7	1148.0	1582.7	1352.0	1807.4
EBITDA Margin (%)	12.6	11.2	11.9	12.5	11.5
PAT Margin (%)	8.2	6.6	9.2	7.5	8.0

Source: Company annual reports, CRISIL MI&A

Figure 60: Key financial indicators – Vertiv energy



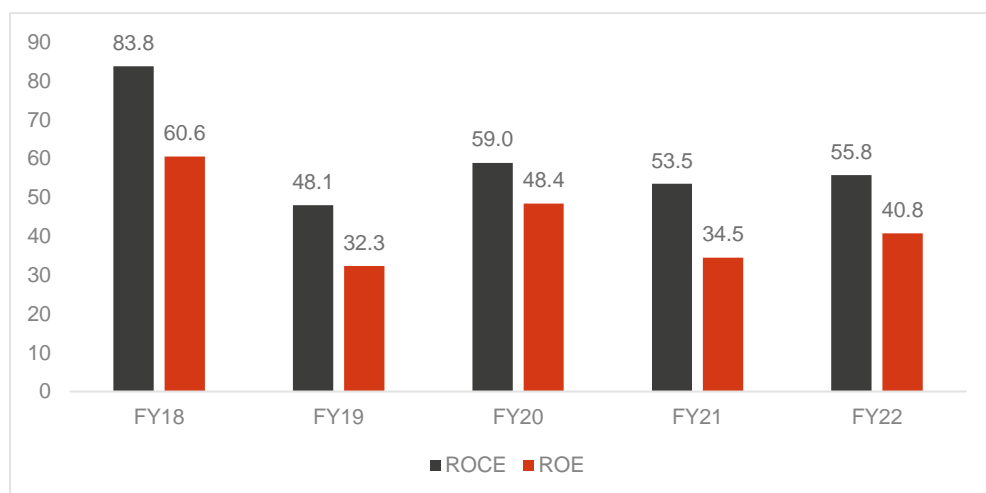
Source: Company annual reports, CRISIL MI&A

Table 27: Key return ratios

(In %)	FY18	FY19	FY20	FY21	FY22
ROCE	83.8	48.1	59.0	53.5	55.8
ROE	60.6	32.3	48.4	34.5	40.8

Source: Company annual reports, CRISIL MI&A

Figure 61: Key return ratios – Vertiv energy



Source: Company annual reports, CRISIL MI&A

Greenpole Power Solutions India Private Limited

GreenPole is a leading global provider of efficient and green hybrid power solutions and related products for various industries in emerging markets. They have been established with a vision to contribute significantly to the renewable energy sector. They design, engineer, and manufacture turnkey hybrid power solutions, including UPSs, gen-sets, batteries, solar streetlights, solar aviation lights, and renewable power.

The company offers wide range of services in Solar Power Solutions, Energy Storage Solutions, Energy Management Solutions, and Consultancy and Project Development

They specialize in designing, installing, and maintaining solar power systems for commercial, industrial, and residential applications. These solutions include solar panels, inverters, battery storage systems. The company offers advanced energy storage solutions to store excess solar energy and optimize power usage. These systems provide backup power during grid outages and can help businesses reduce their reliance on conventional power sources.

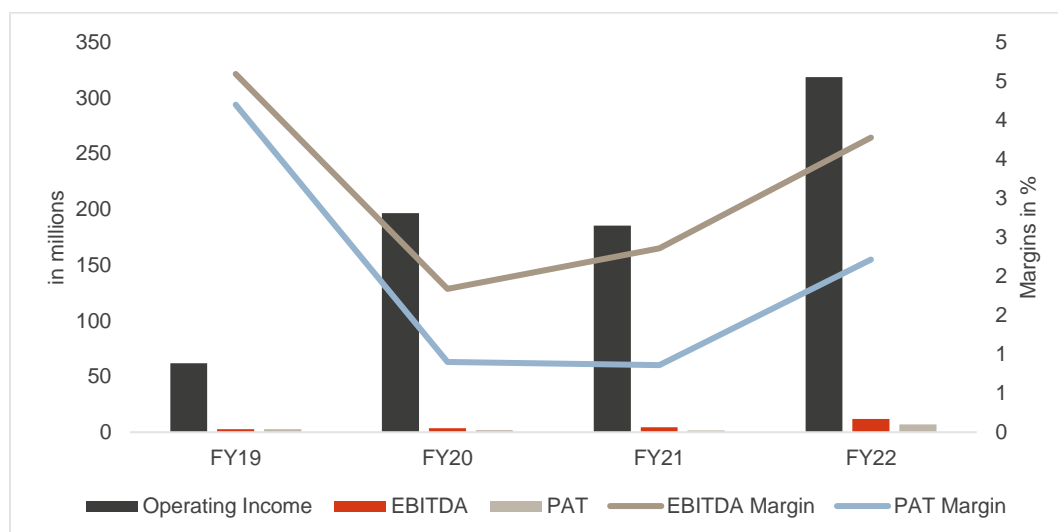
Their hybrid solution combines grid, genset, batteries, and renewable energy, ensuring lower fuel consumption. They also offer full turnkey low-cost solar powered telecom sites.

Table 28: Key financial indicators

(In Millions)	FY19	FY20	FY21	FY22
Operating Income	61.9	196.4	185.2	318.6
EBITDA	2.8	3.6	4.4	12.0
PAT	2.6	1.8	1.6	7.0
EBITDA Margin (%)	4.6	1.8	2.4	3.8
PAT Margin (%)	4.2	0.9	0.9	2.2

Source: Company annual reports, CRISIL MI&A

Figure 62: Key financial indicators – Greenpole Power Solutions



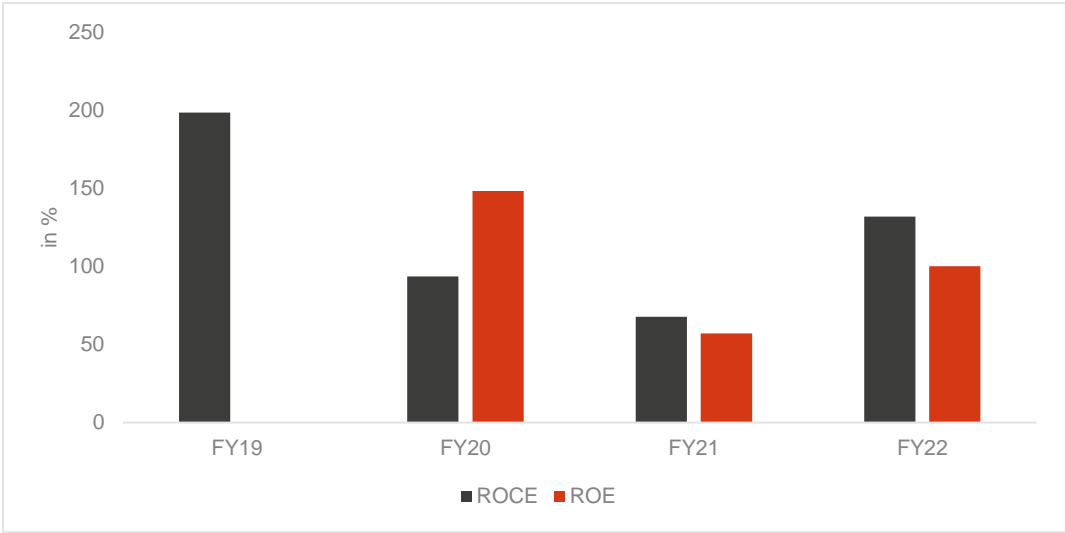
Source: Company annual reports, CRISIL MI&A

Table 29: Key return ratios

(In %)	FY19	FY20	FY21	FY22
ROCE	198.7	93.6	67.9	131.9
ROE	0.0	148.3	57.1	100.1

Source: Company annual reports, CRISIL MI&A

Figure 63: Key return ratios – Greenpole Power Solutions



Source: Company annual reports, CRISIL MI&A

Vrinda Nano Technologies Private Limited

Vrinda Nano technologies (VNT) is headquartered in Gurugram, Haryana and was incorporated in 2003. It designs and delivers mission-critical technologies for high-growth segments, including data centers, telecommunication systems, utility-scale solar projects, commercial and industrial facilities. With their integrated approach they offer solutions for Energy Conservation, Fire Safety, Lightning & Surge Protection, and Asset Monitoring.

They offer services in electrical health safety, earthing study, lightning protection study, energy audit, Power quality and thermography, corrosion, and fire safety services. They also conduct a comprehensive corrosion study to assess and resolve material damage.

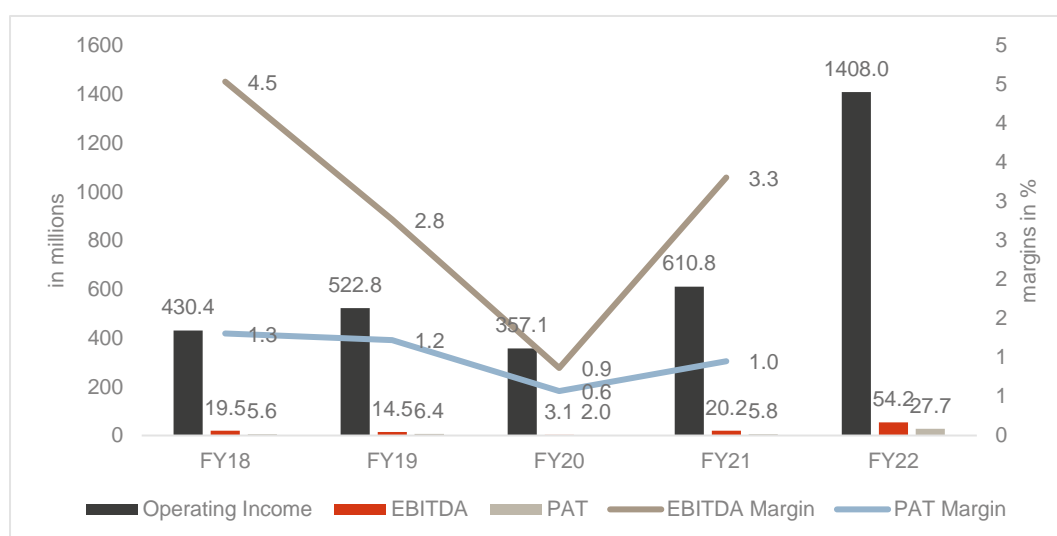
In Telecom Solutions, with their robust and convenient telecom solutions, they transform business organizations through an advanced spectrum of IoT-enabled systems and super high-efficiency SMPS systems to achieve a seamless network. Some of their products include Super High Efficiency SMPS, Small Cell Solution, Smart Panel with AMF – Retrofit, High-Efficiency Rectifiers, Inverter Module, MPPT, Smart Controller, AMF Panels (ATS), SNMP Gateway.

Table 30: Key financial indicators

(In Millions)	FY18	FY19	FY20	FY21	FY22
Operating Income	430.4	522.8	357.1	610.8	1408.0
EBITDA	19.5	14.5	3.1	20.2	54.2
PAT	5.6	6.4	2.0	5.8	27.7
EBITDA Margin (%)	4.5	2.8	0.9	3.3	3.8
PAT Margin (%)	1.3	1.2	0.6	1.0	2.0

Source: Company annual reports, CRISIL MI&A

Figure 64: Key financial indicators – Vrinda Nano Technologies



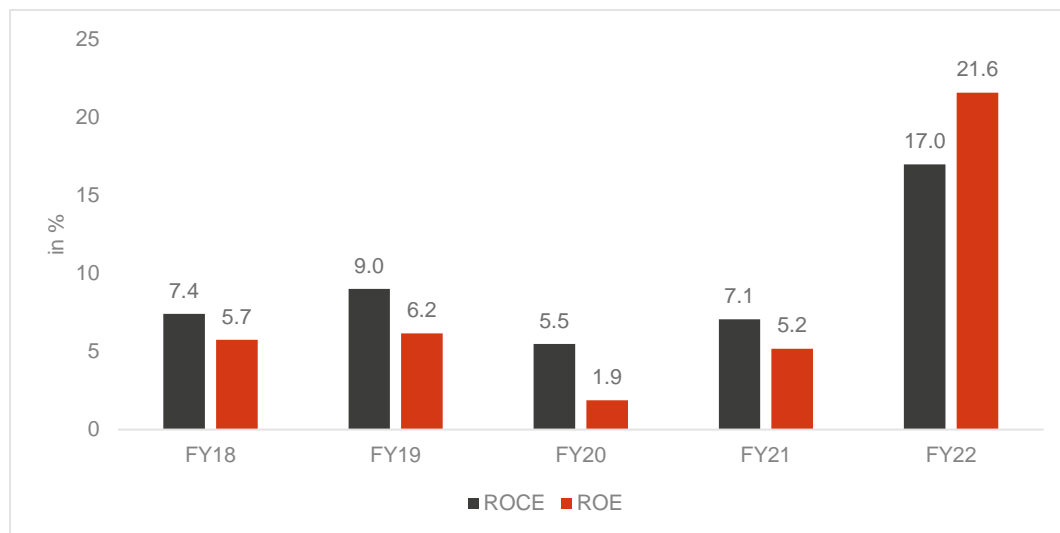
Source: Company annual reports, CRISIL MI&A

Table 31: Key return ratios

(In %)	FY18	FY19	FY20	FY21	FY22
ROCE	7.4	9.0	5.5	7.1	17.0
ROE	5.7	6.2	1.9	5.2	21.6

Source: Company annual reports, CRISIL MI&A

Figure 65: Key return ratios – Vrinda Nano Technologies



Source: Company annual reports, CRISIL MI&A

Coslight India Telecom

Coslight is the world's leading manufacturer of batteries for use in industrial, solar, telecom, and electric vehicle applications. Established in 2007, it has production facilities in Una, Himachal Pradesh, and IMT Manesar, Gurgaon, Haryana. It is a wholly owned subsidiary of Coslight International Group and has offices all over the world as well as more than 15 production and R&D sites in China and India.

The company is primarily in charge of providing Sales and Service support for the Africa, Middle East/GCC, India, and Asia Pacific Region. They are dedicated to supporting telecom infrastructure both internationally and in India.

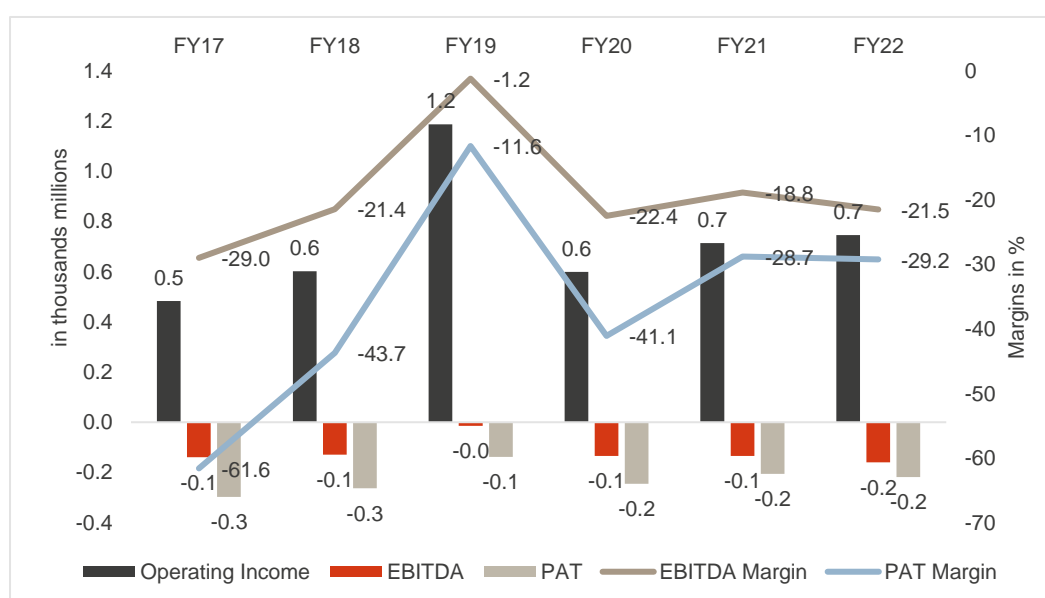
It specialises in the following goods: Telecom Integrated Power Unit, DC-DG Hybrid Power System, Polymer/Prismatic Lithium-ion Battery, Lithium Solutions, VRLA Battery. Their areas of expertise include the production of lithium batteries, lithium-ion batteries, advanced VRLA batteries, high voltage energy storage, energy storage solutions, AGM 12V/2V VRLA batteries, grid connected energy storage, and high-capacity systems for data centre applications.

Table 32: Key financial indicators

(In Millions)	FY17	FY18	FY19	FY20	FY21	FY22
Operating Income	483.4	602.0	1187.9	598.8	714.4	746.2
EBITDA	-140.0	-129.0	-14.0	-134.3	-134.5	-160.2
PAT	-297.8	-262.9	-138.1	-246.0	-205.3	-217.9
EBITDA Margin (%)	-29.0	-21.4	-1.2	-22.4	-18.8	-21.5
PAT Margin (%)	-61.6	-43.7	-11.6	-41.1	-28.7	-29.2

Source: Company annual reports, CRISIL MI&A

Figure 66: Key financial indicators – Coslight



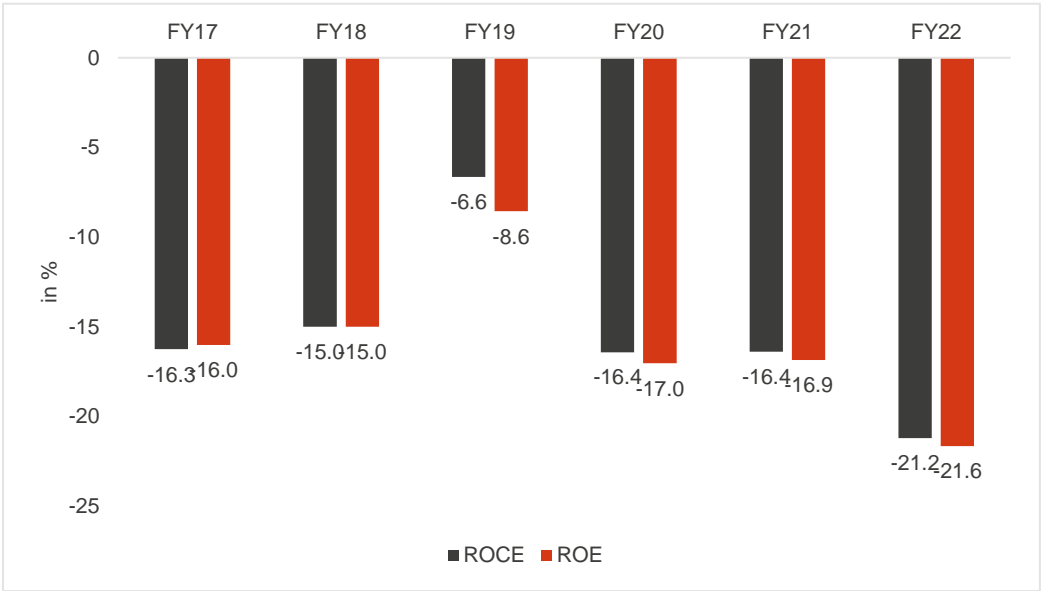
Source: Company annual reports, CRISIL MI&A

Table 33: Key return ratios

(In %)	FY17	FY18	FY19	FY20	FY21	FY22
ROCE	-16.3	-15.0	-6.6	-16.4	-16.4	-21.2
ROE	-16.0	-15.0	-8.6	-17.0	-16.9	-21.6

Source: Company annual reports, CRISIL MI&A

Figure 67: Key return ratios – Coslight



Source: Company annual reports, CRISIL MI&A

Exide India Limited

Exide India Limited is the biggest storage battery manufacturer in India, offering the broadest selection of both conventional flooded and modern VRLA batteries. They have been providing a wide selection of packaged power solutions across the nation, including high-quality automobile batteries for both private and commercial use. They offer a wide variety of automotive batteries for e-rickshaws, commercial vehicles, two-wheelers, and four-wheelers.

Exide is the leading automobile battery maker in India and South Asia due to its nine strategically placed factories, seven of which are devoted to batteries while the other two produce home UPS systems. The demand is expected to have a 70:30 split between the automobile and industrial sectors, respectively.

On the industrial side, 70% of the business, including industrial UPS, traction, telecom and solar have grown at an inspiring rate of 20% to 30% in the previous year, as per the company annual reports, Exide designs, manufactures, markets, and offers the biggest selection of lead acid storage batteries in the world, ranging in capacity from 2.5Ah to 20,600Ah, to accommodate the widest range of applications. Exide's manufacturing capabilities now have a global scope due to partnerships with East Penn Manufacturing in the US, Oldham in the UK, and Furukawa in Japan.

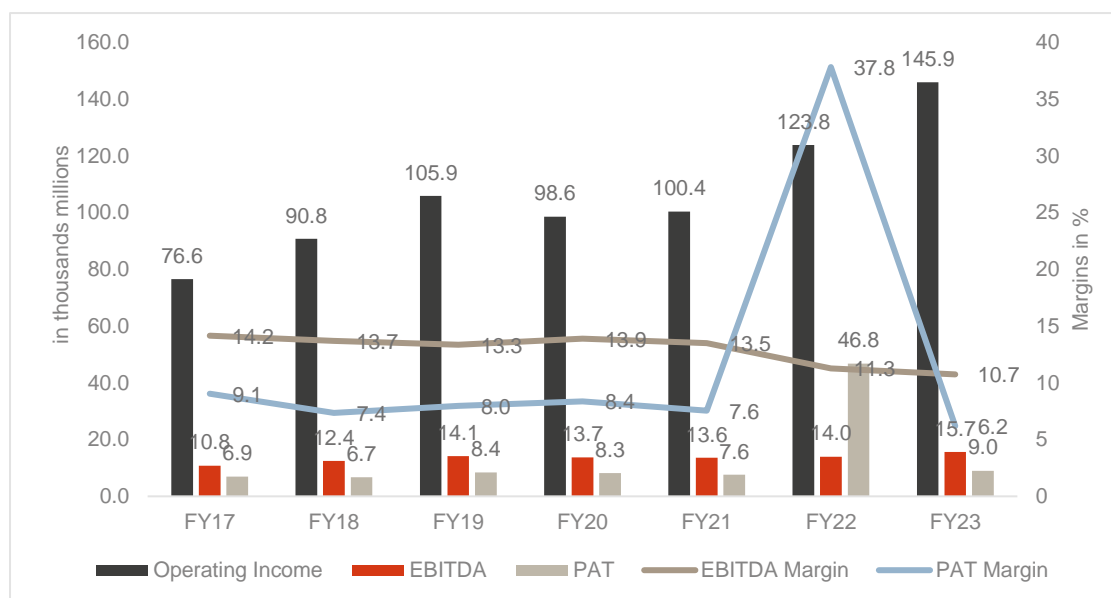
Their research and development (R&D) center, set up in 1976 in Kolkata is considered one of the premier battery research facilities in the world and is recognized by the department of Scientific & Industrial Research under Ministry of Science & Technology, Government of India.

Table 34: Key financial indicators

(In Millions)	FY17	FY18	FY19	FY20	FY21	FY22	FY23
Operating Income	76575.5	90764.5	105883.1	98566.6	100408.4	123816.9	145919.3
EBITDA	10839.9	12442.9	14131.1	13687.2	13567.5	13963.2	15680.1
PAT	6936.4	6683.5	8440.5	8255.1	7582.8	46835.3	9036.3
EBITDA Margin (%)	14.2	13.7	13.3	13.9	13.5	11.3	10.7
PAT Margin (%)	9.1	7.4	8.0	8.4	7.6	37.8	6.2

Source: Company annual reports, CRISIL MI&A

Figure 68: Key financial indicators – Exide



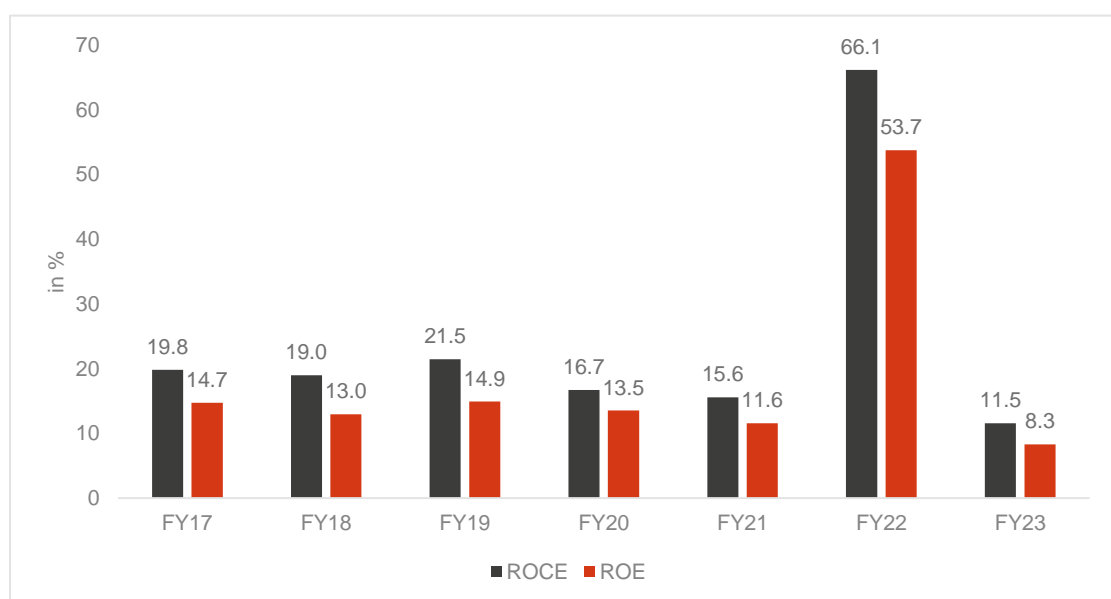
Source: Company annual reports, CRISIL MI&A

Table 35: Key return ratios

(In %)	FY17	FY18	FY19	FY20	FY21	FY22	FY23
ROCE	19.8	19.0	21.5	16.7	15.6	66.1	11.5
ROE	14.7	13.0	14.9	13.5	11.6	53.7	8.3

Source: Company annual reports, CRISIL MI&A

Figure 69: Key return ratios – Exide



Source: Company annual reports, CRISIL MI&A

Amara Raja Batteries Limited (ARBL)

Amara Raja Batteries Limited (ARBL) is the company of the Amara Raja Group and is one of the largest manufacturers of lead-acid batteries for both automotive applications and industrial and in the Indian storage battery industry.

The company's portfolio encompasses a wide range of batteries designed for various applications, including automotive, industrial, and home use. Amara Raja Batteries is known for its superior automotive batteries, catering to both original equipment manufacturers (OEMs) and aftermarket customers. The company has two main strategic business units: the automobile battery division and the industrial battery division.

ARBL supplies automotive batteries under OE relationships to Ford India, Honda, Hyundai, Mahindra & Mahindra, Maruti Suzuki, Ashok Leyland, and Tata Motors, Honda Motorcycles & Scooters India Private Ltd, Royal Enfield, Bajaj Auto Ltd among others. ARBL is also the leading private label supplier for prominent brands. ARBL had capacity to manufacture 12.75 million four-wheeler batteries, 15.0 million two-wheeler batteries and 2.3 billion AH VRLA batteries per annum as on March 31, 2019.

In India, ARBL is the preferred supplier to major telecom service providers, telecom equipment manufacturers, the UPS sector (OEM & Replacement), Indian Railways and to the Power, Oil & Gas,

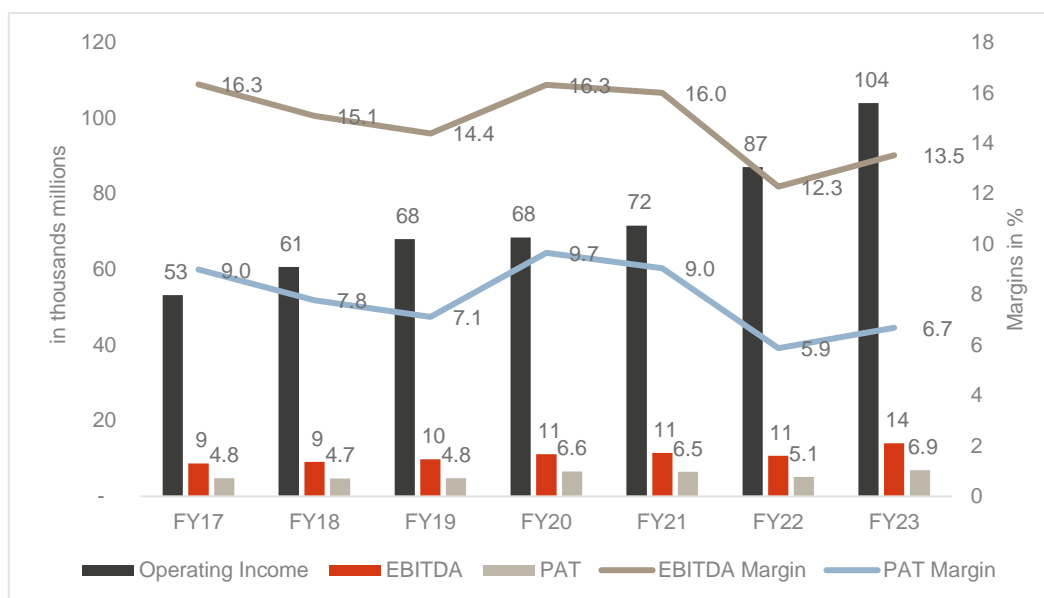
Amara Raja Batteries Ltd, a market leader in UPS segment for about 15+ years aims to provide an uninterrupted and reliable battery performance for a long-lasting period and as they are the largest manufacturer of SMF VRLA batteries in India they are designed for high quality performance to achieve zero down time.

Table 36: Key financial indicators

(In Millions)	FY17	FY18	FY19	FY20	FY21	FY22	FY23
Operating Income	53,199	60,634	67,991	68,442	71,546	87,020	1,03,959
EBITDA	8,690	9,145	9,786	11,167	11,446	10,686	14,058
PAT	4784.9	4713.2	4834.9	6608.2	6468.1	5112.5	6,944.1
EBITDA Margin (%)	16.3	15.1	14.4	16.3	16.0	12.3	13.5
PAT Margin (%)	9.0	7.8	7.1	9.7	9.0	5.9	6.7

Source: Company annual reports, CRISIL MI&A

Figure 70: Key financial indicators – ARBL



Source: Company annual reports, CRISIL MI&A

Table 37: Key return ratios

(In %)	FY17	FY18	FY19	FY20	FY21	FY22	FY23
ROCE	28.9	24.7	22.7	24.3	22.5	16.2	19.7
ROE	20.4	17.1	15.6	19.4	16.9	11.9	14.3

Source: Company annual reports, CRISIL MI&A

Figure 71: Key return ratios – ARBL



Source: Company annual reports, CRISIL MI&A

Aptiv Components India Private Limited

Aptiv Components India Private Limited is a leading global technology company that specializes in developing and manufacturing advanced automotive components and systems. As a subsidiary of Aptiv PLC, Aptiv Components India plays a crucial role in the automotive industry by providing cutting-edge solutions that enhance safety, connectivity, and sustainability in vehicles.

Aptiv offers its services in Advanced Safety and User Experience, signal and power solutions, safety and autonomous driving solutions, smart vehicle architecture, and connected services. Aptiv Components India provides signal and power distribution solutions to ensure efficient and reliable flow of electrical signals and power within vehicles. This helps optimize vehicle performance and energy management. The business produces and distributes parts for cars and trucks, including as pin headers, safety restraint systems, connection wires, and underwater towed arrays. Worldwide, Aptiv provides original equipment manufacturers.

It employs over 200,000 people across 131 production plants and 11 key technological centres. They have presence in 48 nations and are committed to providing its clients with solutions that are appropriate for the market.

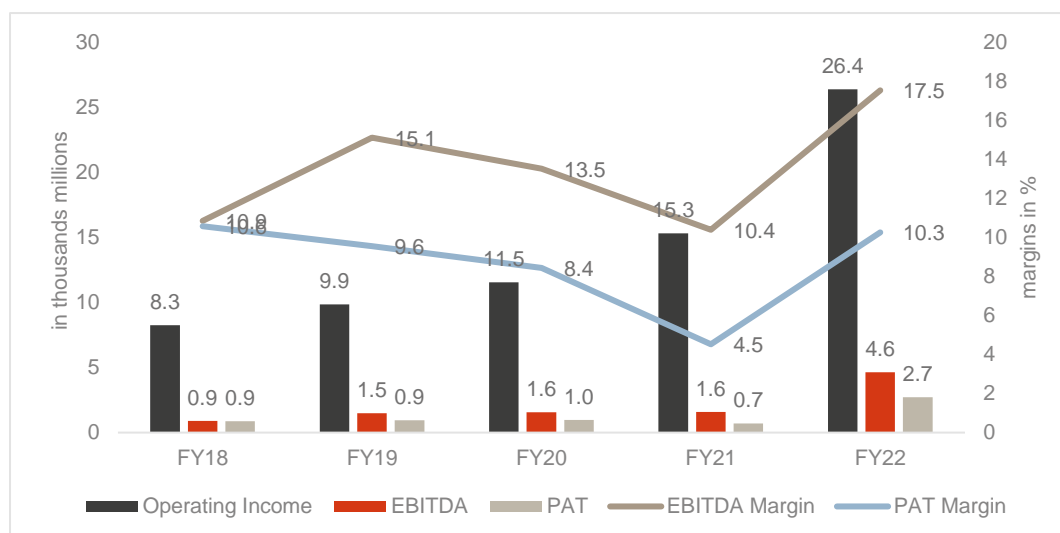
The distribution systems, including hybrid high voltage systems, are integrated into one optimized vehicle electrical system that can utilize smaller cable and gauge sizes and ultra-thin wall insulation (which product line makes up approximately 44% of our total revenue for the year ended December 31, 2022, and 42% for each of the years ended December 31, 2021, and 2020).

Table 38: Key financial indicators

(In Millions)	FY18	FY19	FY20	FY21	FY22
Operating Income	8254.3	9864.5	11544.0	15321.3	26392.6
EBITDA	896.2	1490.5	1561.6	1592.8	4629.7
PAT	873.1	943.4	973.6	693.5	2707.4
EBITDA Margin (%)	10.9	15.1	13.5	10.4	17.5
PAT Margin (%)	10.6	9.6	8.4	4.5	10.3

Source: Company annual reports, CRISIL MI&A

Figure 72: Key financial indicators – Aptiv Components



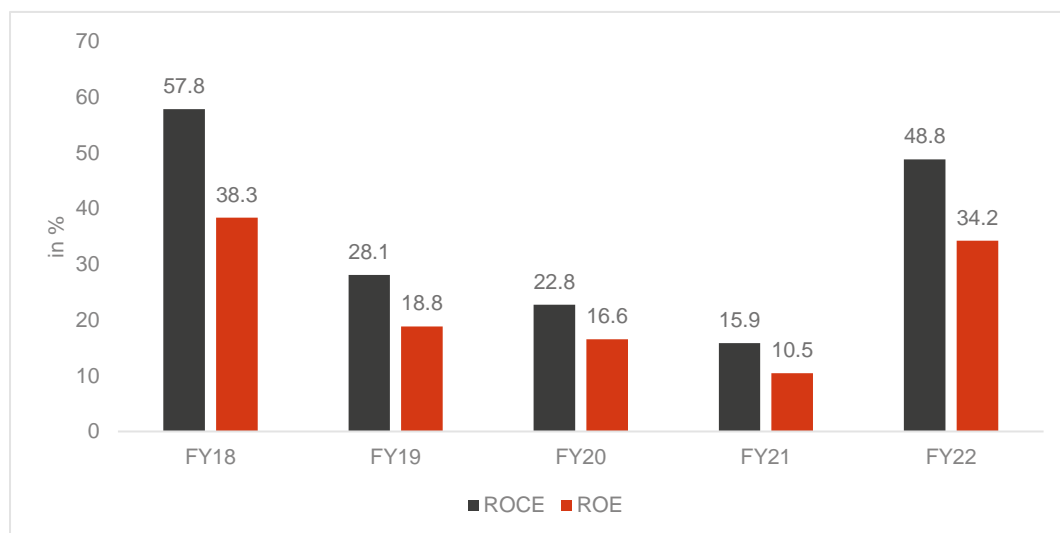
Source: Company annual reports, CRISIL MI&A

Table 39: Key return ratios

(In %)	FY18	FY19	FY20	FY21	FY22
ROCE	57.8	28.1	22.8	15.9	48.8
ROE	38.3	18.8	16.6	10.5	34.2

Source: Company annual reports, CRISIL MI&A

Figure 73: Key return ratios – Aptiv Components



Source: Company annual reports, CRISIL MI&A

Statiq (Sharify Services Private Limited)

Statiq is a smart public charging ecosystem. The company was founded in the year 2020 and is based in Gurgaon, Haryana. The users can locate and book EV chargers through their mobile app which also facilitates remote and seamless payment for the usage.

Statiq manufactures its proprietary smart EV chargers and aggregates other public EV chargers. They provide complete EV charging solutions for Home, Public & Commercial charging. They provide complete EV charging solutions for Home, Public & Commercial charging.

The products offered by them are Statiq Circle, CCS Charger, Statiq DC (DC Charger), AdWall (AC Charger), Statiq Pillar (AC Charger), AdWall (AC Charger).

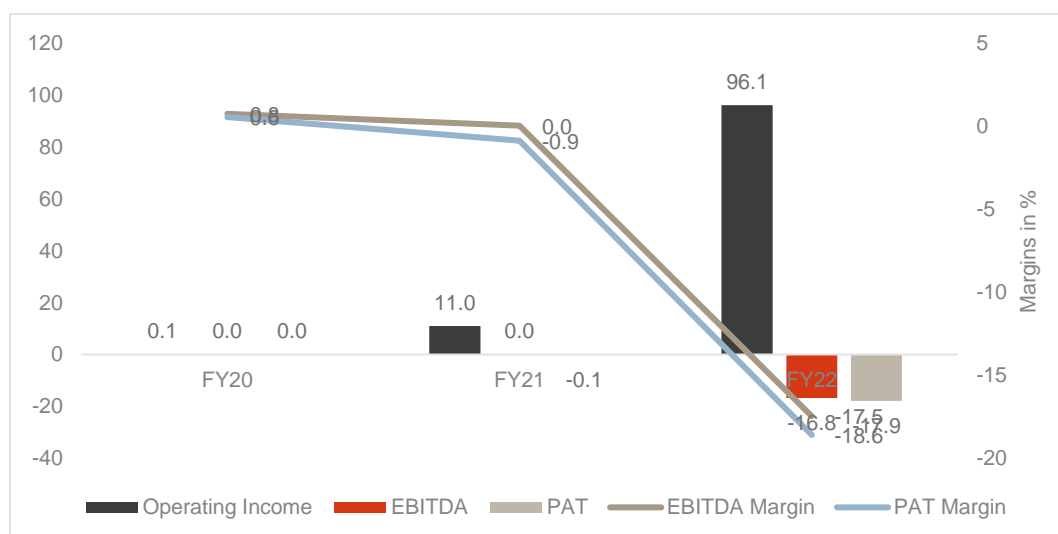
The Statiq DC (CCS) Charger is powerful DC charger generating an output of 60 KW. It is equipped with a CCS2 connector, and it ensures the fastest charging for your EV.

Table 40: Key financial indicators

(In Millions)	FY20	FY21	FY22
Operating Income	0.1	11.0	96.1
EBITDA	0.0	0.0	-16.8
PAT	0.0	-0.1	-17.9
EBITDA Margin (%)	0.8	0.0	-17.5
PAT Margin (%)	0.6	-0.9	-18.6

Source: Company annual reports, CRISIL MI&A

Figure 74: Key financial indicators – Statiq



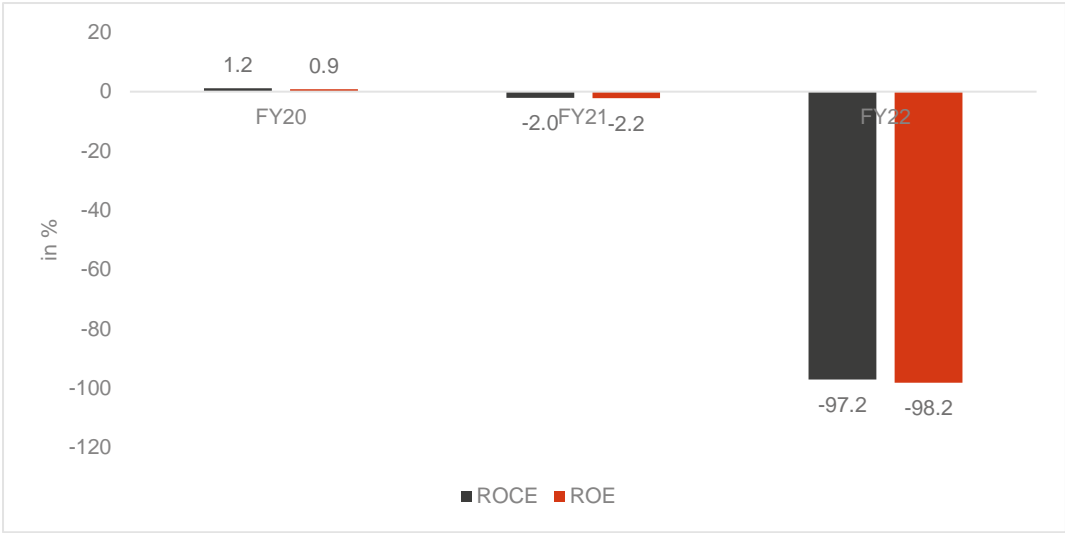
Source: Company annual reports, CRISIL MI&A

Table 41: Key return ratios

(In %)	FY20	FY21	FY22
ROCE	1.2	-2.0	-97.2
ROE	0.9	-2.2	-98.2

Source: Company annual reports, CRISIL MI&A

Figure 75: Key return ratios – Statiq



Source: Company annual reports, CRISIL MI&A

HBL Power Systems Limited

HBL is one of the major players in Lithium Batteries and Energy Storage systems manufacturing for diverse applications including aircraft engine starting, railroads, utilities, telecoms, data centers, UPS and switchgear. It offers several battery chemistries – lead acid, nickel cadmium, silver-zinc, thermal batteries, and primary lithium. In addition, it supplies ancillary equipment and industrial battery chargers and associated Power Electronics and Battery Management Systems. As an integrated player, HBL has five vertically integrated manufacturing units and a full-fledged Research & Development center.

Table 42: Key financial indicators

(In Millions)	FY17	FY18	FY19	FY20	FY21	FY22	FY23
Operating Income	14,144.6	16,104.1	12,658.8	10,917.8	9,120.4	12,381.4	13,718.8
EBITDA	1,286.0	1,333.3	971.9	805.4	673.7	1,466.4	1,635.0
PAT	383.9	317.0	277.3	262.2	137.3	939.0	984.5
EBITDA Margin (%)	9.1	8.3	7.7	7.4	7.4	11.8	11.9
PAT Margin (%)	2.7	2.0	2.2	2.4	1.5	7.6	7.2

Source: Company annual reports, CRISIL MI&A

Figure 76: Key financial indicators – HBL Power Systems

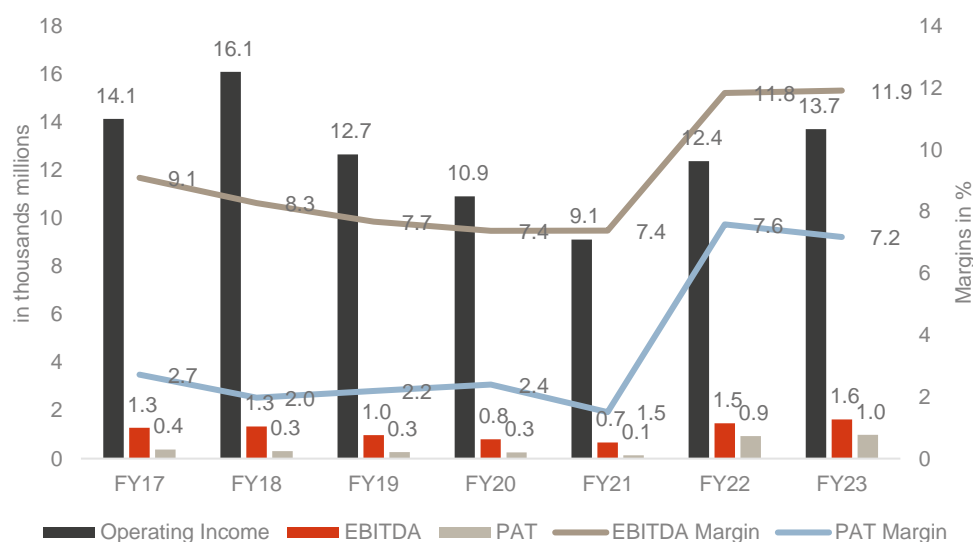
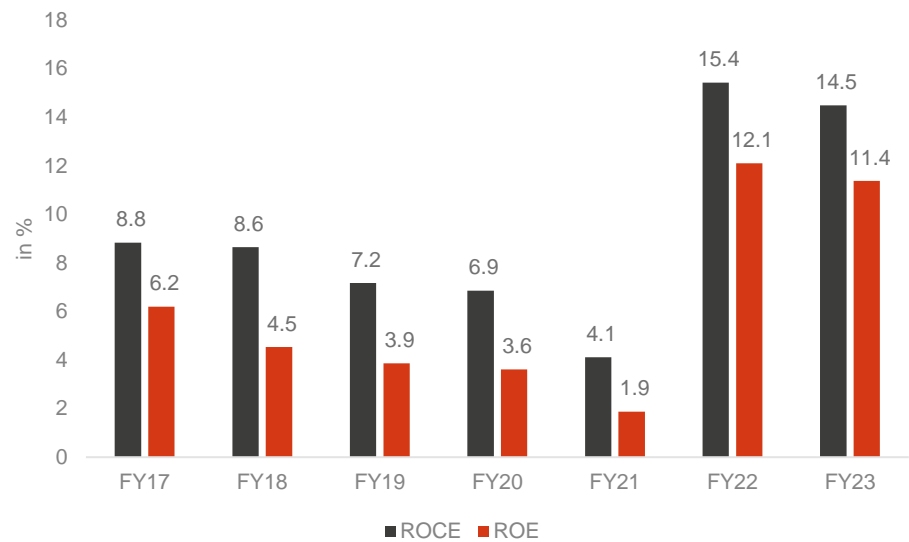


Table 43: Key return ratios

(In %)	FY17	FY18	FY19	FY20	FY21	FY22	FY23
ROCE	8.8	8.6	7.2	6.9	4.1	15.4	14.5
ROE	6.2	4.5	3.9	3.6	1.9	12.1	11.4

Source: Company annual reports, CRISIL MI&A

Figure 77: Key return ratios - HBL Power Systems



Servotech Power Systems Ltd

Having forayed into the industry in 2004 with the introduction of Sine-Wave inverters for domestic and commercial use, Servotech Power Systems Ltd. has grown over the subsequent years since inception while launching a series of LED lighting solutions, Solar Street lights, Solar-Hybrid Inverters, LED solar lighting solutions. It is engaged in the end-to-end manufacturing, procurement and distribution of a range of solar products, medical devices as well as energy-efficient lighting solutions. With a legacy of over two decades in establishing solar-powered infrastructure and commissioning projects pan India level, The company intends to establish EV charging tech infrastructure pan India.

Table 44: Key financial indicators

(In Millions)	FY17	FY18	FY19	FY20	FY21	FY22
Operating Income	792.2	1124.8	860.9	874.4	880.0	1495.1
EBITDA	65.1	63.4	45.4	43.5	42.8	243.8
PAT	50.0	39.5	30.0	8.1	9.2	36.6
EBITDA Margin (%)	8.2	5.6	5.3	5.0	4.9	16.3
PAT Margin (%)	6.3	3.5	3.5	0.9	1.0	2.5

Source: Company annual reports, CRISIL MI&A

Figure 78: Key financial indicators - Servotech Power Systems

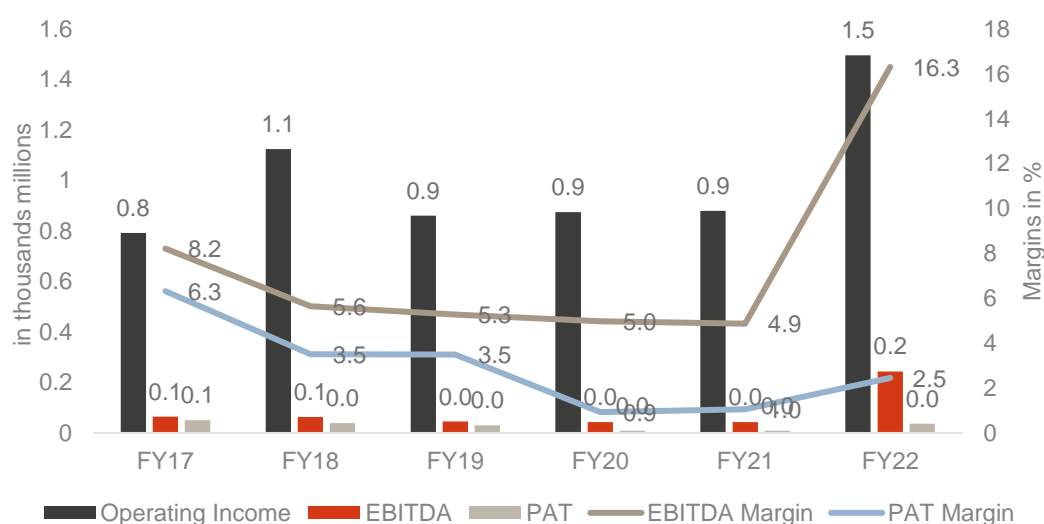
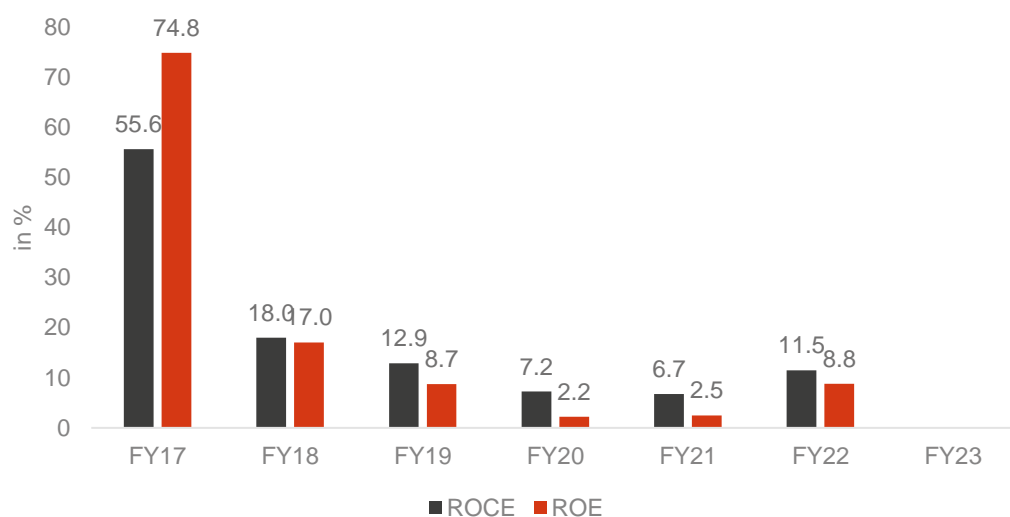


Table 45: Key return ratios

(In %)	FY17	FY18	FY19	FY20	FY21	FY22
ROCE	55.6	18.0	12.9	7.2	6.7	11.5
ROE	74.8	17.0	8.7	2.2	2.5	8.8

Source: Company annual reports, CRISIL MI&A

Figure 79: Key return ratios - Servotech Power Systems



Financial snapshot

Table 46: Key financial metrics – fiscal 2023

Companies/ Particulars	Operating income (Rs million)	Operating EBITDA (Rs million)	PAT (Rs million)	Operating EBITDA margin (%)	PAT margin (%)	ROCE (%)	ROE (%)	Gearing ratio	Inventory (days)	Debtors (days)	Creditors (days)
Amara Raja batteries	1,03,959	14,058	6,944	13.5%	6.7%	19.7%	14.3%	-	66	27	38
Exide batteries	1,45,919	15,680	9,036	10.7%	6.2%	11.5%	8.3%	-	83	31	55
Coslight India*	746	-160	-217	-21.0%	-29.0%	-21.0%	-22.0%	-	49	57	460
Delta Electronics India*	15,847	590	11	4.0%	1.0%	1.0%	1.0%	0.5	128	62	111
Exicom Tele-Systems*	3,792	-77	40	-2.0%	1.0%	13.0%	3.0%	0.8	119	118	217
Vertiv Energy*	22,594	2,594	180	11.0%	8.0%	56.0%	41.0%	-	53	78	132
Greenpole Power Solutions*	310	12	7	3.7%	2.2%	131.0%	100.0%	-	51	56	132
Vrinda Nano Technologies*	1408	54	27	4.0%	2.0%	17.0%	22.0%	1.4	68	84	59
Aptiv Power*	26,392	4,629	2,707	18.0%	10.0%	49.0%	34.0%	-	42	90	139
Statiq (Sharify Services) *	96	-16	-18	-17.0%	-19.0%	-97.0%	-98.0%	-	57	68	358
HBL Power Systems Ltd	13,718	1,635	984	11.9%	7.1%	14.4%	11.3%	-	104	80	43
Servotech Power Systems*	1,495	243	36	16.3%	2.4%	11.5%	8.7%	0.4	35	86	38

Source: Company annual reports, CRISIL MI&A

* Fiscal 2022

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