CRISIL
An S&P Global Company

# Assessment of cryogenic equipment industry

December 2022

# Table of contents

# 1 Overview of global economy

## 1.1 Review and outlook of economic growth and inflation in key global economies

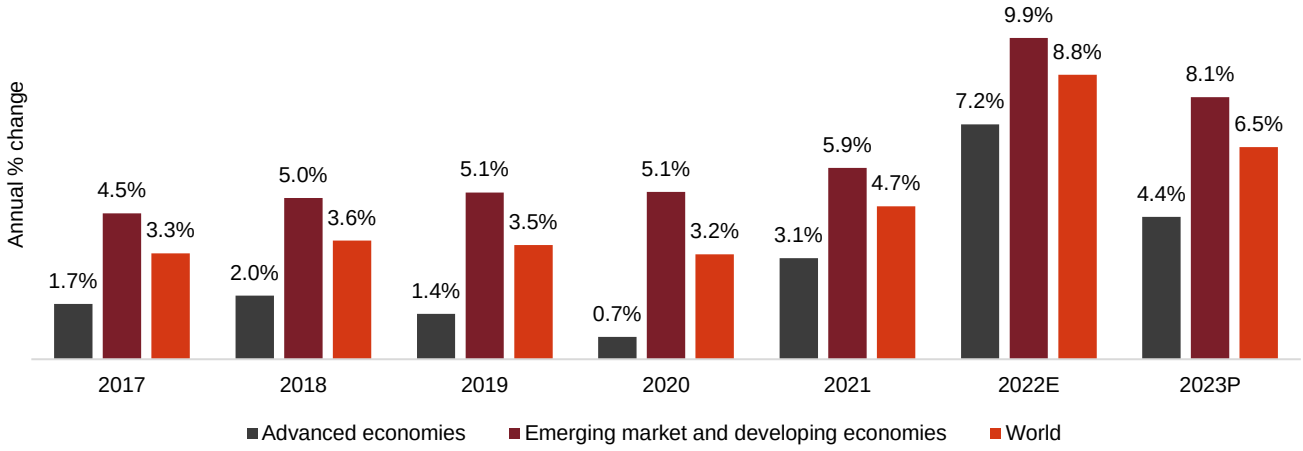
In 2022, world came out of the clutches of COVID and was gradually shedding the impact of the pandemic and was on the way to recovery. However, Russia's invasion of Ukraine and rise in energy and commodity prices have raised concerns on the strong recovery expected coming out of COVID. After the initial shock, there was some improvement witnessed in global economic indicators during the second half of 2022. Still the global outlook remains sluggish in the medium term.

Global central banks have sprung into action as strong demand and high commodity prices were fuelling inflation world over. Concerted effort across major central banks over the year have seemed to have stemmed inflation to some extent while preventing any major economic slowdown.

**Global Inflation**

The geopolitical shock arising from the Russia-Ukraine crisis has had ripple effects, most visibly seen in energy and commodity prices. Prices increased drastically over fears of supply disruptions from Russia given its status as the second largest exporter of oil globally. Prices surged after the conflict escalated on February 24 and continued climbing as advanced economies imposed economic sanctions on Russia. Brent crude oil briefly crossed the $130/barrel mark in early March. Base metal prices (particularly of non-ferrous metals such as aluminium and nickel) also jumped, owing to Russia's position as a significant producer.

**Trend in inflation, average consumer prices (CY2017-CY2023)**




*Advanced economies – US, Japan, Euro area*
*Emerging market and developing economies – China, India, Russia, Brazil, Mexico, South Africa*
*Source: IMF (World Economic Outlook – October 2022 update), CRISIL MI&A*

The third quarter of this year saw growth slowing down in many economies, suggesting that global growth slowdown is intensifying as central banks continue to hike rates aggressively to curb demand impulse, and thereby tame inflation. Additionally, energy supply shortages are creating headwinds to growth, especially in European economies.

Ahead of the G20 summit in Indonesia, the International Monetary Fund (IMF) said in its report that slowing global economic growth is increasingly evident in the high frequency indicators. The purchasing managers' indices (survey-based measures that gauge the momentum of manufacturing and services activities), which track several G20 economies, have steadily worsened in recent months. According to the IMF, "Global economic growth prospects are confronting a unique mix of headwinds, including from Russia's invasion of Ukraine, interest rate increases to contain inflation, and lingering pandemic effects such as China's lockdowns and disruptions in supply chains."

After shrinking in the first half of the year, the US economy bounced back to register positive growth in the third quarter (July-September), but there are indications that private consumption, one of the largest components of the economy, is starting to soften. Real gross domestic product (GDP) grew an annualized 2.6% on-quarter in the third quarter, after recording -0.6% and -1.6% growth in the second and first quarters, respectively. Positive growth in the third quarter is partly because of lower goods imports during the quarter. Growth in private consumption demand slowed to 1.4% from 2.0% in the previous quarter.

However, positive growth momentum may be difficult to sustain as exports could fall due to slowing global demand, and high interest rates will start weighing on private consumption demand. Slowing activity in residential sales and construction is already reflective of the latter. The latest US inflation rate suggests some easing in price pressure in the economy. In October, inflation based on the consumer price index (CPI) slowed to 7.7% on-year, below market expectation of 8.0% and down from 8.2% in September. Core inflation measured 6.3% on-year, was also lower than expectation. Though inflation has eased, it is still way above the target, and it remains to be seen if the US Federal Reserve (Fed) will go slow in its rate hike spree from hereon as growth tanks.

The eurozone economy registered a growth of 0.2% on-quarter (in seasonally adjusted terms) in the third quarter vs 0.8% in the previous quarter, confirming that growth momentum is slowing down as the Russia-Ukraine conflict-triggered energy crisis continues to weigh on the economy. Third quarter growth in some of the key economies was as follows: Germany (0.3%), France (0.2%), Spain (0.2%), and Italy (0.5%). Commensurate with slower GDP growth, employment growth in the eurozone fell to 0.2% from 0.4% in the second quarter.

Meanwhile, CPI inflation continued to rise in the region; it reached 10.6% on-year in October, up from 9.9% in September and markedly above 4.1% in October last year. It was largely driven by 41.5% jump in energy prices in October (vs 40.7% in September). That said, the rise in inflation was pretty much broad-based with inflation ex-energy also rising to 6.9% from 6.4%; and inflation ex-energy, food, alcohol and tobacco to 5.0% from 4.8%. Latvia, Lithuania and Estonia recorded 20%-plus inflation. While in some of the bigger economies inflation was: Germany (11.6%), France (7.1%), Spain (7.3%), and Italy (10.6%). To tame inflation, the European Central Bank has been raising rates (like its global counterparts). It hiked the key policy rates by 75 basis points (bps) in its policy meet on October 27, 2022. Accordingly, interest rate on the main refinancing operations, and rates on the marginal lending facility and the deposit facility increased to 2.00%, 2.25% and 1.50%, respectively.

In signs of what could be the beginning of a recession in the UK economy, its GDP contracted 0.2% sequentially in the third quarter, after growing by the same magnitude in the previous quarter. This marks the first contraction since the first quarter of 2021, when the economy recorded 1.2% decline. GDP growth had slowed from 0.7% in the first quarter to 0.2% in the second before finally entering contractionary zone in the third.

CPI inflation jumped to a 41-year high of 11.1% in October, much above the expectation of 10.7% and 10.1% recorded in September. This largely reflects higher price of energy (electricity, gas and other fuels). The housing

and household services inflation, which includes energy, reached an all-time high of 11.7% on-year in October, up from 9.3% in September.

Japan's GDP contracted an annualised 1.2% on-quarter in the third quarter in contrast to an expectation of positive growth and down from 4.6% growth in the second quarter. It is the first contraction in four quarters, and largely a result of inflated import bill because of 20%+ depreciation in the yen against the US dollar. Imports registered a growth of 22.6%, way above 7.9% growth in exports. Domestically, growth in private consumption, a large component of the economy, slowed down to 1.1% in the third quarter from 5.1% in the previous one, reflecting negative impact of inflation on consumption demand.

To support the economy, last month the government announced a stimulus package worth ¥29.1 trillion (~$207 billion) to keep tabs on energy prices for households and businesses.

Annual consumer price inflation reached 3.7% in October – the highest print since January 1991 – up from 3.0% in September, as weakening yen continued to inflate imported energy costs. The rise in inflation was broad-based. Core inflation, which excludes volatile categories of food and fuel, rose to a 40-year high of 3.6%. With this, inflation has remained above the Bank of Japan's 2% target for the seventh consecutive month.

The GDP data, release of which was delayed by a week to avoid clashing with the Communist Party Congress, showed that the Chinese economy grew 3.9% on-year in the third quarter, beating the forecast of ~3.4% growth. Still, GDP data underscored the nation's ongoing growth challenges as reflected in the poor performance of the real estate market and weak retail data. To be sure, China's official growth target for 2022 was pegged at 5.5%. In contrast, the economy grew 3.0% in the first nine months of the year.

Inflation, meanwhile, fell to 2.1% on-year in October from 2.8% in September. This is the lowest inflation print since May and was helped by slowdown in the prices of food and non-food products. Food inflation softened to 7.0% from 8.8% in September. Non-food inflation fell to 1.1% from 1.5%. Core inflation, which excludes volatile categories such as food and fuel, however, remained stable at 0.6%.

**Global growth outlook**

The global economy continues to face turbulent challenges, shaped by the lingering effects of the Russia Ukraine crisis, energy crisis caused by persistent and broadening inflation pressures, and the slowdown of economy in China.

The channels of transmission of the conflict to the wider global economy occur through:

- Direct impact of sanctions on the Russian economy, lowering its economic growth outlook
- Elevated energy and commodity (metals, food) prices and their impact on the inflation of various countries and consumer confidence (both affecting private consumption)
- Decade high inflation levels and tightening financial conditions in most regions
- Policy response to the conflict (in terms of monetary and fiscal policy to support consumption and tackle inflation)
- Rising share of economies in growth slowdown or outright contraction
- Impact on global trade flows owing to supply chain disruptions and higher international shipping costs

- Impact on capital flows as financing moves to lower-risk assets (particularly affecting emerging markets as capital flows out due to risk-off sentiment)

As a result of these shocks, IMF estimates global growth will slow to 3.2% in 2022, compared with 6.0% growth witnessed in 2021. World growth is expected to slow down to 2.7% in 2023.

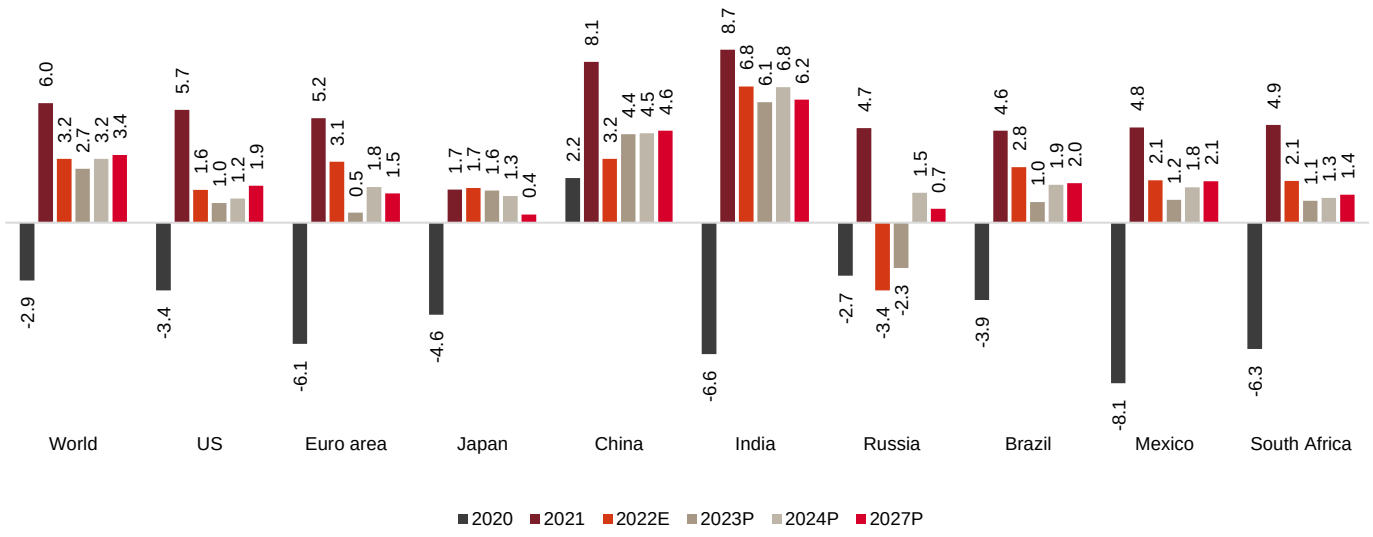
This is primarily attributed to the contraction in Russia's economic growth, and the negative impact of energy prices. The hit to other economies is a function of their exposure to Russia, and their dependence on energy imports. Accordingly, Europe is expected to be significantly hit. The US will see a nominal impact from lower growth in Russia, but a slowdown in growth comes from higher energy prices.

Asia-Pacific economies are relatively insulated, since they have "little direct exposure to Russia or Ukraine in terms of revenue, assets, investments, or supply chains". However, the trajectory of their currencies and capital flows/contagion risk will be determined based on whether they are net energy importers.

The current crisis comes with a high degree of uncertainty. Irrespective of the duration of conflict, the disruptions caused in commodity prices, supply chains, inflationary impulse and consumer confidence may persist for some time.

The pandemic has abated, but a new black cloud hovers over the global economy.

**IMF estimates of GDP growth for key economies**




**Euro area includes 19 countries of the European union*
*Source: IMF (World Economic Outlook – October 2022 update), CRISIL MI&A*

**Brent crude on a high**

Oil prices increased in 2022 due to the demand-supply tightness. The current geopolitical tensions between Russia and Ukraine would likely have wider implications on the energy prices. This, coupled with unrest in Kazakhstan and outages and ability of OPEC members to increase output would be the key determinants of oil prices in 2022. Furthermore, increase in alternate fuel prices would also keep oil prices elevated.

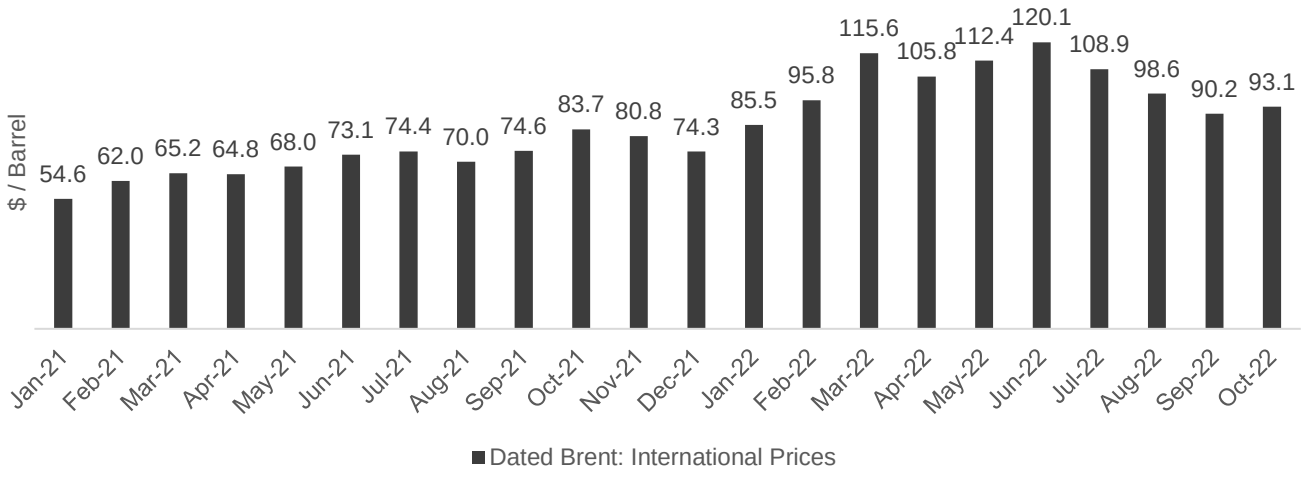
Volatility in crude oil prices is primarily attributable to uncertainty with regard to the Russia-Ukraine war. And while we expect prices to cool down in the first half of 2023, if the war esclates, crude oil prices could see a further upside from our projection.

Indeed, on the supply front, failure to achieve a ceasefire in Ukraine along with resurgence in the conflict have heightened volatility in crude oil prices. In fact, Ban on Russian crude oil by the end of 2022 will create structiral shift in the oil basket globally. Any such sanctions could have a wider impact on energy supply as well as prices of alternate fuel such as natural gas and coal. This has already increased the volatility in crude oil prices.

Also putting upward pressure on prices has been the rise in tensions in Libya, with the declaration of force majeure in the Sharara and Al-Feel oil fields, which have a production capacity of over 450,000 barrels per day (bpd), and closure of operations at the Zueitina port, considerably affecting production and export operations across Libya's Oil Crescent region. This is a crucial factor restricting the achievment of incremental production from the Organisation of Petroleum Exporting Countries (OPEC)+ states, a key cog in the global oil price machinery.

CRISIL projects the price of crude oil at $100.0-105.0 per barrel in 2022 vis-a-vis $70.4 per barrel in 2021, which is an increase of 33-38% on-year. Even in CY2023, CRISIL expects the prices to remain elevated in $90-95/barrel range.

**Brent crude oil price**




*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*

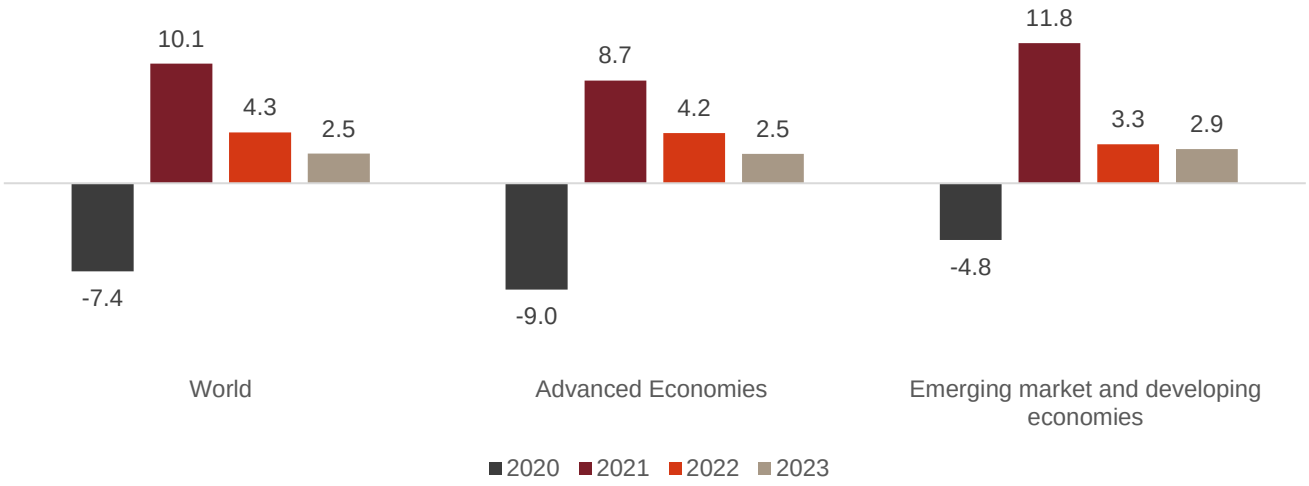
## 1.2 Global trade environment

Amidst the worsened global economic condition, global trade growth pace is expected to taper: from 10.1% in 2021 to an estimated 4.3% in 2022 and 2.5 % in 2023. IMF has toned down its forecast during October update mainly due to the decline in global output growth and supply chain constraints.

Appreciation in dollar value during 2022 also impacted world trade growth, considering the dollar's dominant role in trade and its trickle-down effect on other economies.

Trade disruptions are expected amidst various factors including Russia Ukraine conflict, high energy prices, record high inflation levels and the tighter monitory measures undertaken to control the same. In line with the decelaration in the global GDP growth, global trade is also expected to be under pressure in the short term.

**IMF estimates of world trade growth**




*Note: Volumes of exports of goods and services have been considered for the calculations*
*Source: IMF (World Economic Outlook – October 2022 update), CRISIL*
*Advanced economies – US, Japan, Euro area*
*Emerging market and developing economies – China, India, Russia, Brazil, Mexico, South Afric*

Russia Ukraine conflict is expected to weigh on Eurozone trade, Covid restrictions to impact China trade while the strict monetary measures are expected to limit household consumption globally. Import demand is estimated to soften amid pressured household spending and rising manufacturing costs in Europe. While in US, debt distress will limit spending on capital expenditure, vehicles as well as housing. Covid outbreaks, restrictions and the impending production disruptions will impact China trade.

While high import bill and monetary tightening is expected to limit consumption in emerging and developing countries.

# 2 Overview of the Indian economy

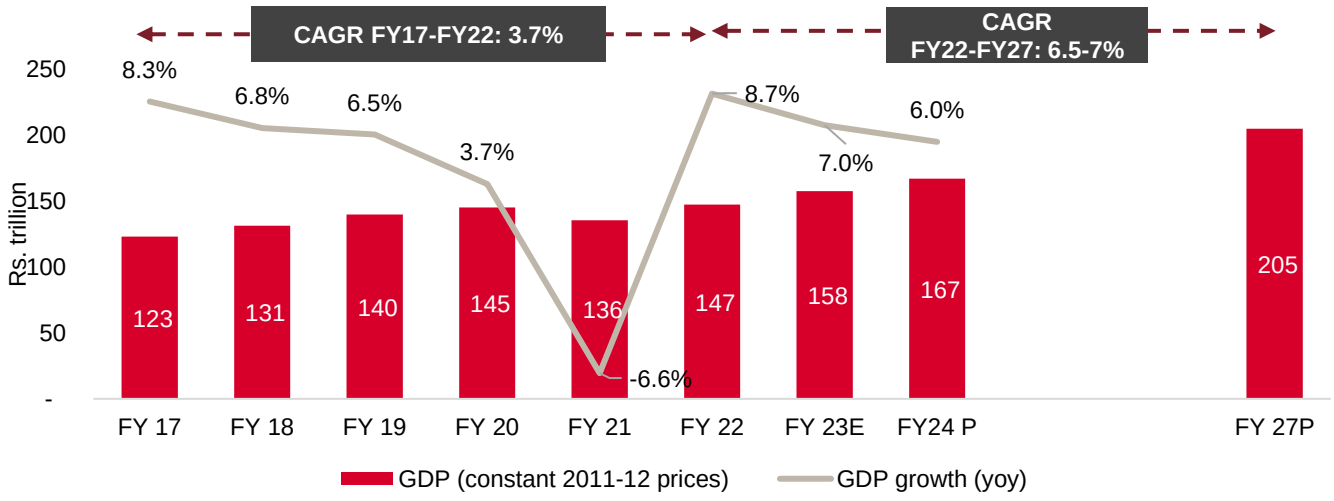
## 2.1 Review of real GDP growth over fiscals 2017-22 and outlook for fiscals 2022-27

The Indian economy logged a 3.7% CAGR over fiscals 2017-22. Economy contracted 6.6% during fiscal 21 due to impact of COVID-19 in third quarter of fiscal 2020 and fiscal 2021.

GDP growth between fiscal 2017 and fiscal 2019 grew robustly at a CAGR of 6.6% driven by rising consumer aspirations, rapid urbanisation, the government's focus on infrastructure investment and growth of the domestic manufacturing sector. The economic growth was supported by benign crude oil prices, softer interest rates and lower 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 (IBC); 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).

India's economic growth was led by services, followed by the industrial sector, over fiscals 2017-22. Growth over fiscals 2017-22 was, however, impacted by demonetisation, the non-banking financial company (NBFC) crisis, slower global economic growth, and COVID-19.

**GDP growth pace to slow down to 7% in FY23, long term growth expected at 6.5-7% CAGR**




*Note: P – Projected; E – Estimated, FY22 – Second advance estimate*
*Source: National Statistical Office (NSO), CRISIL Research estimates*

Growing restrictions on the movement of people and lockdowns in the affected countries led to demand, supply and liquidity shocks, which resulted in major financial losses and bankruptcies of several players in different industries. India saw one of the world's most stringent lockdowns in March 2020. Impact of Covid-19 was more pronounced on contact sensitive services as social distancing norms impacted many services such as entertainment, travel and tourism sector. While many industries in the manufacturing sector also faced issues with shortage of raw materials/components as lockdown in various parts of the world wrecked havoc on their supply chains. 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 the rising number of Covid-19 cases, GDP growth moved into positive territory towards the end of fiscal 2021. India's real GDP grew 8.7% in fiscal 2022 from the low base of fiscal 2021.

According to the National Statistical Office estimates released on November 30, 2022, India's real gross domestic product (GDP) growth slowed down to 6.3% on-year in the second quarter (Jul-Sep) of fiscal 2023. During the first quarter of the fiscal, GDP had grown at 13.5%.

The economy was first hit by the pandemic during the first quarter of fiscal 2021 and again affected in the second wave by the delta variant in the first quarter of fiscal 2022. In contrast, there was no pandemic-led disruption in the first quarter of this fiscal. Hence, first quarter data of this 2023 continues to be statistically boosted by the favourable base effect.  Despite headwinds due to the Russia-Ukraine conflict, the growth momentum (in seasonally adjusted terms) improved sequentially during the quarter.

India's real gross domestic product (GDP) rose 6.3% on-year in the second quarter of fiscal 2023 vis-a-vis 13.5% in the previous quarter. The sharp deceleration was partly because of a high base effect, as GDP had printed 8.4% in the second quarter of fiscal 2022. That said, GDP was dragged down by weakening industrial growth as well, particularly in the manufacturing sector that was hit by slowing global growth and compressed margins.

On the supply side, gross value added (GVA) grew 5.6% on-year in the second quarter of fiscal 2023, much slower than the 6.3% growth in GDP during the period. The reason for the slowdown was industry, with improving agriculture and services arresting a further slowing

Within the industry basket:

- Manufacturing GVA turned negative 4.3% in the second quarter vs. 4.8% in the previous quarter, as weakening global growth hit export demand. Narrowing margins added pressure, as cost pressures for producers rose at a faster pace than retail prices. This was indicated by Wholesale Price Index-linked inflation averaging 12.4% on-year in the quarter compared with 7.0% for Consumer Price Index (CPI). But the slide in manufacturing growth was at odds with Purchasing Managers' Index manufacturing, which was in the expansion zone in the July-September quarter, at ~55. Historical data further shows the first estimates of GVA based on Index of Industrial Production underestimate the actual manufacturing growth. Hence, there is a possibility of an upside to manufacturing as more data becomes available over the next few quarters

- Construction GVA also slowed to 6.6% from 16.8% in the previous quarter, suggesting that the overall investment environment remained subdued, despite the central government's capex push

- Other industrial sectors too saw declines, such as mining (-2.8% vs. 6.5%) and electricity (5.6% vs. 14.7%). In fact, core sector output growth slowed to 0.1% in October, implying that industrial weakness is spilling over to the current quarter

In contrast, agriculture GVA growth rose to 4.6% in the second quarter vis-à-vis 4.5% in the first quarter. A normal monsoon for the fourth year in a row appears to have supported production, despite uneven temporal and spatial distribution and a heatwave.

While services posted slowing on-year growth, it was primarily the result of an unfavourable base. In fact, activity continued to improve sequentially across all major components.

Private final consumption expenditure (PFCE) increased 9.7% in the second quarter compared with 25.9% in the previous quarter. It continued to contribute positively to growth.

Fixed investment, as measured by gross fixed capital formation (GFCF), slowed to 10.4% in the second quarter vs. 20.1% in the previous corresponding quarter. This suggests that private sector investment activity was yet to pick up materially, with the Centre driving the capex agenda. Also, while the Centre's capex growth was robust at 42.4% on-year in the second quarter, it was lower than the 57.0% increase in the previous quarter. That said, state capex could accelerate in the second half of this fiscal, thereby supporting overall capex growth.

Meanwhile, the government's consumption spending, as measured by government final consumption expenditure (GFCE), turned negative 4.4% on-year in the second quarter vs. 1.3% in the previous quarter, reflecting ebbing of Covid-19-related spending • Also, real export growth of goods and services slowed sharply to 11.5% in the second quarter from 14.7% in the previous quarter. Exports slowed considerably to major destinations – the US and the EU – as tightening financial conditions weighed on growth of these economies. In contrast, imports were strong at 25.7% in the second quarter (although lower than 37.2% in the first quarter) on relatively resilient domestic demand. Taken together, net exports continued to subtract from overall GDP growth.

Share in GDP expanded materially for PFCE (58.4% in the second quarter of fiscal 2023 vs. 56.6% in the second quarter of fiscal 2022) and imports (31.9% vs. 27%), while it fell for GFCE (8.8% vs. 9.8%), and was stable for GFCF (34.6% vs. 33.4%) and exports (23.3% vs. 22.2%).

Nominal GDP was much higher at 16.2% in the second quarter compared with real GDP. Also, while the GDP deflator moderated to 9.3% on-year in the second quarter from 11.6% in the previous quarter, it was higher than the pre-pandemic level (0.2% in the second quarter of fiscal 2020)

**Domestic macroeconomic outlook for fiscal 2023**

| Macro variables | FY22 | FY23E | FY24P | Rationale for outlook |
|---|---|---|---|---|
| GDP (%, on-year) | 8.7% | 7.0% | 6.0% | CRISIL has revised down forecast for India's real gross domestic product (GDP) growth to 7.0% for the current fiscal (2022-23) from 7.3% estimated previously. This is primarily because the slowdown in global growth has started to impact India's exports and industrial activity.<br>However, domestic demand remains supportive this fiscal, helped by a catch-up in contact-based services, government capital expenditure (capex), relatively accommodative financial conditions, and overall normal monsoon for the fourth time in a row.<br>The impact is expected to be more next fiscal (2023-24) as global growth decelerates faster. Additionally, domestic demand could come under pressure as interest rate hikes gets transmitted more to consumers, and the catch-up in contact-based services fades.<br>Consequently, we expect India's GDP growth to slow to 6.0% in fiscal 2024, down from 6.5% estimated previously. The risks to the forecast remain tilted downwards. |

| Macro variables | FY22 | FY23E | FY24P | Rationale for outlook |
|---|---|---|---|---|
| CPI-linked inflation (%, on-year) | 5.5% | 6.8% | 5.0% | High crude prices pushed the commodity prices during fiscal 2023 traslating into record high inflation during the year. CPI inflation may moderate in the coming few months as base effect comes into play and with the expectation of a healthy rabi crop. Yet, inflation will remain elevated above the RBI's upper tolerance band of 6%, with pressure from both, food and core. Even during the next year, inflation is expected to remain sticky. |
| 10-year government security yield (%, March-end) | 6.8% | 7.5% | 7.0% | Yields on 10-year G-Secs are inching up at a moderate pace, in comparison with lower-tenure rates or money-market rates, which have seen faster transmission.<br>The pressure on yields to harden further will likely remain: hopes of a slower pace of rate hikes from the US Fed came to a nought, as the Fed, in its November meeting, outlined that terminal policy rate may be higher than expected. Crude oil prices are again climbing up on prospects of supply cuts, even though demand is cooling down.<br>Domestically, we expect that another rate hike is in the offing in December. We expect the MPC to raise rates by another 25 bps. After that, monetary policy actions will follow the trajectory of domestic inflation and external developments.<br>The combination of tightening global financial conditions and continued stance of monetary tightening domestically implies yields will remain under pressure.<br>We thus expect yields on 10-year G-sec to average 7.5% in March 2023, compared with 6.8% in March 2022. As inflation cools down next fiscal, and as the RBI takes a pause in its rate hike cycle, yields are expected to come down to 7% by March 2024 |
| CAD/GDP (%) | -1.2 | -3.2 | -2.4 | The rise in international commodity prices, exacerbated by the Russia-Ukraine crisis, is expected to soften with the slowdown in global growth. Several key economies are on the brink of recession. Crude prices have already eased to below $85/barrel after remaining above $120/barrel in June.<br>At the same time, India's exports face further headwinds, given the moderation in global growth. A greater slowdown in exports vis-à-vis imports, with services trade surplus too coming under mild pressure, will widen the CAD some more in the second quarter. But financing of CAD has not posed a challenge so far, with FPI flows showing a reversal since July.<br>Overall, CRISIL projects India's CAD at 3.2% of GDP in the current fiscal, with risks tilted to the downside. |

| Macro variables | FY22 | FY23E | FY24P | Rationale for outlook |
|---|---|---|---|---|
| Rs/$ (year-end) | 76.2 | 79.5 | NA | 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. That said, a similar story is playing out across most other economies, with their currencies falling for the same reasons.<br>The rupee is also facing domestic pressure from elevated inflation and deteriorating outlook on the current account deficit (CAD). The CAD is expected to widen to 3.2% of gross domestic product as against 1.2% in the previous fiscal.<br>Some support for the rupee, though, can be expected from the Reserve Bank of India, which remains committed towards preventing large bouts of volatility in the currency. CRISIL expects the rupee to average 79.5 against the dollar in March 2023 compared with 76.2 in March 2022. |

*Note: E: Estimated, P - Projected*
*Source: Reserve Bank of India (RBI), NSO, CRISIL*

CRISIL has revised down the forecast for India's real gross domestic product (GDP) growth to 7.0% for the current fiscal (2022-23) from 7.3% estimated previously. This is primarily because the slowdown in global growth has started to impact India's exports and industrial activity.

However, domestic demand remains supportive this fiscal, helped by a catch-up in contact-based services, government capital expenditure (capex), relatively accommodative financial conditions, and overall normal monsoon for the fourth time in a row.

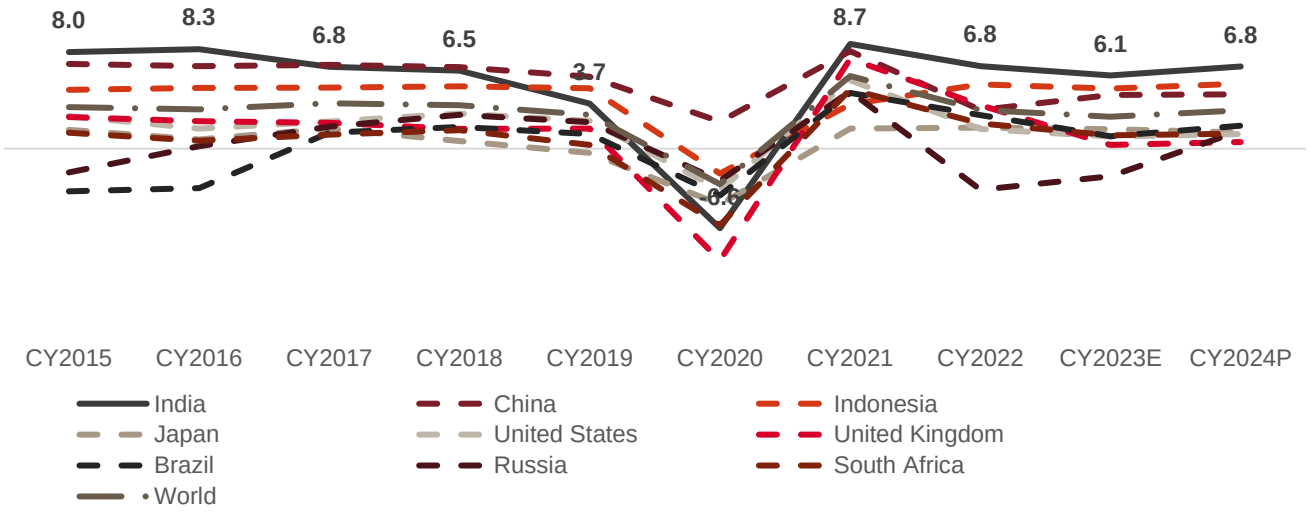
The impact is expected to be more next fiscal (2023-24) as global growth decelerates faster. Additionally, domestic demand could come under pressure as interest rate hikes gets transmitted more to consumers, and the catch-up in contact-based services fades.

The second quarter fiscal 2023 data reflected how global slowdown had begun to spill over to the Indian economy. Long-term growth movements suggest that despite diverging now, India's growth cycles have been remarkably synchronised with that of advanced economies since the 2000s. Major developed economies are expected to fall into a shallow recession by next year. S&P Global expects US GDP to swerve from a growth of 1.8% in 2022 to negative 0.1% in 2023, and the EU from 3.3% to 0%. This will weaken the export prospects for India, thereby weighing on domestic industrial activity. And while domestic demand has stayed relatively resilient so far, it would be tested next year by weakening industrial activity. It will feel the pressure from increasing transmission of interest rate hikes to consumers as well, and as the catch-up in contact-based services fades. Also, rural income prospects remain dependent on the vagaries of the weather. Therefore, increasing frequency of extreme weather events remain a key monitorable. While lowering demand for Mahatma Gandhi National Rural Employment Guarantee Act jobs is an encouraging sign for the rural economy from a job perspective, depressed wages are a matter of concern for rural demand. Because of these factors, CRISIL projects GDP growth to slow to 6% in fiscal 2024 from 7% in fiscal 2023, with risks to the downside.

**India to remain a growth outperformer globally**

Despite the markdown in near-term growth, India is expected to remain a growth outperformer over the medium run. We expect India's GDP growth to average 6.6% between fiscals 2024 and 2026, compared with 3.1% globally — as estimated by the International Monetary Fund (IMF). India would also outgrow emerging market peers such as China (4.5% growth estimated in calendar years 2023-2025), Indonesia (5.2%), Turkey (3.0%) and Brazil (1.6%). Stronger domestic demand is expected to drive India's growth premium over peers in the medium run. 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 China-plus-one policy as global supply chains get reconfigured with shifting focus from efficiency towards resilience and friend shoring. Private consumption (~57% of GDP) will play a supportive role in raising GDP growth over the medium run.

**India is one of the fastest-growing major economies (GDP growth, % on-year)**




*E: Estimated; P: Projected*
*Note: GDP growth is based on constant prices*
*Source: IMF (World Economic Outlook – October 2022 update), CRISIL*

**Factors that will shape growth in fiscals 2023 and 2024**

Three factors will play a prominent role:

1. Global slowdown to impact domestic industrial activity via the exports channel
2. The one-time lift to contact-based services from domestic demand will abate next fiscal, but government capex will stay supportive
3. Tightening domestic financial conditions will hurt growth next fiscal

**Impact of global slowdown**

**Increased synchronisation of global and domestic growth cycles:** Long-term growth movements suggest that despite being on divergent trends, India's growth cycles have been remarkably synchronised with those of advanced economies since the 2000s (see chart below). Put another way, there is no escaping the short-term

demand fluctuations around the trend and this time will be no different. The deceleration of major developed economies underway will create downside risks for India's growth outlook

**Gloomier global outlook will spill over to India:** As central banks aggressively raise rates to fight inflation, advanced countries will find it hard to stave off a sharp downturn in activity. According to S&P Global, global growth is set to decline from 3.1% this year to 2.4% in 2023, led by slower growth in advanced economies, especially eurozone and the United States (US).

In the base case, S&P Global expects a shallow recession in the US in early 2023, but the economy is expected to grow 0.2% for the full year, following a modest 1.4% growth in 2022. In the downside scenario, where high inflation persists and the US Federal Reserve (Fed) is forced to tighten policy even more aggressively (to at least 5-5.25% by mid-2023, and rates remain higher for longer), the US economy could contract 0.3% in 2023.

Eurozone is expected to grow a mild 0.3% in 2023, markedly down from the 3.1% forecast for 2022. In the downside scenario, eurozone would see high prices and rationing of energy, leading to GDP contraction of 1.3% in 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. The impact of tightening will be more pronounced next fiscal because monetary policy actions manifest with a lag. India's core (non-oil, non-gold) exports declined by a massive 16.9% on-year in October; core exports have declined for three consecutive months now, with an average decline of 7.8% between August and October. The economy also witnessed net FPI outflow averaging $0.4 billion in September and October after an average inflow of $3.7 billion in the previous two months.

**Household demand is holding up this fiscal, helped by services catch-up and government capex, but will moderate next fiscal:** Consumer spending is growing in pockets for some goods and services. Among goods, passenger vehicle sales have been recording double-digit growth since May 2022. The ongoing festive season especially augurs well for consumer spending after two pandemic years of subdued celebrations

Services is sustaining a strong pick-up, with PMI services in expansionary zone since August 2021, rising to 55.1 in October from 54.3 in September. Passenger traffic is logging double-digit growth for both rail and air traffic, reflecting the broad nature of recovery in travel services. However, a lot of the robust pick-up in services can be explained by the pending catch-up to pre-pandemic levels. Passenger rail and air traffic remains below that mark till date.

Signs of slowdown are emerging for some demand segments. Core imports have been on a slowing trend in September-October 2022. IIP has also been declining for consumer durables and non-durables, possibly reflecting weakening demand conditions

Demand recovery remains uneven, with consumption for lower value goods continuing to trail higher-ticket items. While passenger vehicle sales have crossed pre-pandemic levels, two-wheeler sales continue to wallow below corresponding levels. Further, consumer non-durables have been recording their sharpest decline in growth among major IIP components since March 2022

Rural income prospects remain dependent on the vagaries of weather. Increasing frequency of extreme weather events, therefore, remain a key monitorable. While lowering of demand for MGNREGA jobs is an encouraging sign for rural economy from a job perspective, depressed wages are a matter of concern for rural demand

**Tighter financial conditions could test resilience of domestic demand next year**

So far, the Reserve Bank of India (RBI) has raised the policy repo rate by 190 basis points (bps). While the repo rate is higher than the pre-pandemic level of 5.15%, it remains lower than 6.50% peak reached in 2018 during the last rate hike cycle. Similarly, bank lending rates remain lower than the pre-pandemic five-year average so far. The impact on domestic demand and lending activity, therefore, is still not adverse

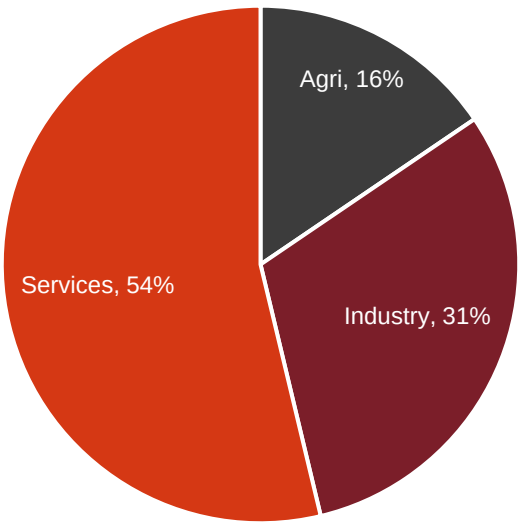
For instance, bank credit is still supporting demand recovery, growing to a decadal high of 17.9% in October 2022, and is forecast at 15% for this fiscal. The offtake is strongest to retail loans. Besides, given cleaner balance sheets, banks are more willing to lend to corporates and households.

However, some of this is expected to change soon with the transmission of rate hikes and lower liquidity to the system picking up. As transmission increases, higher borrowing costs could take some steam off from the current strength in domestic demand.

## Government policies to boost manufacturing in India

Indian economic output is majorly driven by the high productivity services sector which contributes 54% of the economic output. The share of industry is a distant second at 31% of which manufacturing account nearly 60%. Manufacturing sector growth can not only increase job in the sector but also reduce forex outgo on imported goods. Hence the government has introduced several incentives in the past decade in order to boost the manufacturing sector in India.

**Sectoral GDP share FY2022**




*Source: CRISIL*

## Construction capex to rise 12-16% on a high base in fiscal 2023, post a 35-40% rise in fiscal 2022

The growth in capex for fiscal 2023 is in continuing momentum from FY2022 where despite challenges due to coronavirus variant, the sector showed an estimated rise of 35-40% on a low base in FY21. In FY22 the sector returned to normalcy and challenges faced during the lockdown. Growth in FY23 is attributable to rise in state and

central government expenditures in various sectors such as roads, railways, urban infra, water supply and sanitation etc.

Construction capex is projected to rise 12-16% on year in fiscal 2023 led by infrastructure segment to Rs. 10.6 to 10.8 trillion. 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. Although FY2022 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 9.3-9.5 trillion over a low base of FY21. The low base of FY21 is attributable to the 6 to 9 month delay granted by the RERA due to the breakout of the pandemic which led to a decline in the building and construction sector as builders deferred completions while investments in the industrial sector too were deferred beating down investments for fiscal 2021 to Rs. 6.9-7.1 trillion from a high of Rs 8.1 trillion in fiscal 2020.

**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 the past five years, as 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.

| Sector | *FY16-FY20 CAGR* | *FY21E (Rs. trillion)* | *FY22E (Rs. trillion)* | *FY23P y-o-y growth* | *FY23P (Rs. trillion)* | *FY23-27P to FY18-22E ratio* |
|---|---|---|---|---|---|---|
| **Infrastructure (A)** | **12%** | 4.9-5.1 | 5.9-6.1 | 20-25% | 6.9-7.1 | **1.4x** |
| *Roads* | 16% | 2.6-2.7 | 2.9-3 | 12-16% | 3.3-3.4 | 1.8x |
| *Power* | 7% | 0.3-0.4 | 0.4-0.5 | 25-28% | 0.5-0.6 | 1.4x |
| *Railways* | 16% | 0.6-0.7 | 0.9-1 | 8-12% | 1-1.1 | 1.8x |
| *Urban Infra* | 11% | 0.4-0.5 | 0.6-0.7 | 20-25% | 1.1-1.2 | 2.4x |
| *Irrigation* | <1% | 0.6-0.7 | 0.6-0.7 | 6-8% | 0.7-0.8 | 1.3x |
| *Other Infra* | 12% | 0.1-0.2 | 0.1-0.2 | 20-25% | 0.2-0.3 | 1.4x |
| **Industrial (B)** | **11%** | **0.4-0.5** | **0.5-0.6** | **6-10%*** | **0.6-0.7** | **1.2x** |

*Note: E-estimated, P- Projected;*
*Source: CRISIL Research*

Center's capex is only one third of the total capex while two third are expected to be state capex. However, actual state capex is lagging budgeted estimated. Private companies are primed and getting ready however they remain cautious in the current uncertain environment. Private consumption remains the weak link owing to reduced direct fiscal policy support. PLI scheme is expected to trigger faster growth in capex. It is expected to generate a capex of Rs. 2.2-2.5 trillion between FY23 to FY26 estimated at 14% of total capex during the period.

## 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 manufacturing share in GDP to 25% by 2020 by boosting investment, foster innovation, and intellectual property, and build 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 setup 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 disseminate 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.

FDI inflows have seen a leg up, as India jumped to the 8th position in the list of world's largest FDI recipients in 2020compared to the 12th position in 2018, according to the World Investment Report 2022. FDI to India almost doubled to $83.6 billion in 2021-22 from $ 45.15 billion in fiscal 2015.  India is on track to attract $100 billion FDI during fiscal 2023 according to Ministry of Commerce and Industry.

However, the share of manufacturing in GDP had not make a meaningful move since the introduction of the programme. 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 were announcement of National Infrastructure Pipeline, reduction in corporate tax, various sectors such as defence manufacturing, railways, space, and single brand retail have been opened up for FDI. Measures to boost domestic manufacturing were also taken through Public Procurement Orders (PPO), Phased Manufacturing Programme (PMP) and Production Linked Incentives (PLI) schemes etc. Many states also launched their own initiatives on similar like to boost manufacturing their respective states.

### 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 business and 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 resource and a strong financial system.

### Production Linked Incentive (PLI) scheme

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 India 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 2022-29.

Construction spends across Industrial investments in fiscal 2023 are seen rising 6-10% due to high base in FY22 where the sector grew due to deferred investments from FY21 and capex investments from PLI scheme coming online. The PLI scheme is a time bound incentive scheme by the Government of India which rewards companies in the range on 5-15% of their annual revenues based on the companies meeting pre-decided targets for incremental production and/or exports and capex over a base year. The stronger than expected pickup in demand and larger companies gaining share from smaller companies has also led to revival of capex in FY22. The rise in fiscal 2023 is on account of the expansion plans underway by India Inc.

**Budgeted incentives for each sector under the PLI scheme**

| Sector | *Segment* | *Budgeted (Rs bn)** | |
|---|---|---|---|
| Automobile | Advance chemistry cell (ACC) battery | 181 | 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 | |
| | Pharmaceuticals drugs | 150 | |
| Telecom | Telecom and networking products | 122 | 122 |
| Food | Food products | 109 | 109 |
| 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 | 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*

### Increasing 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 by 9.7% owing to GDP contraction amid the pandemic's impact on this lower base of fiscal 2021, per capita income rose 7.5% in fiscal 2022.

However, per-capita income is forecast to improve in line with GDP growth. This will be an enabler for domestic consumption. According to IMF estimates, India's per-capita income (at current prices) is expected to increase at a 10.5% CAGR over calendar years 2022-27.

## 2.2 Near-term outlook on agriculture, industrial and services GDP

### The services sector is the main 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 due to the pandemic. Fiscal 2022 witnessed marginal improvement in its share with gradual normalization of market operations.

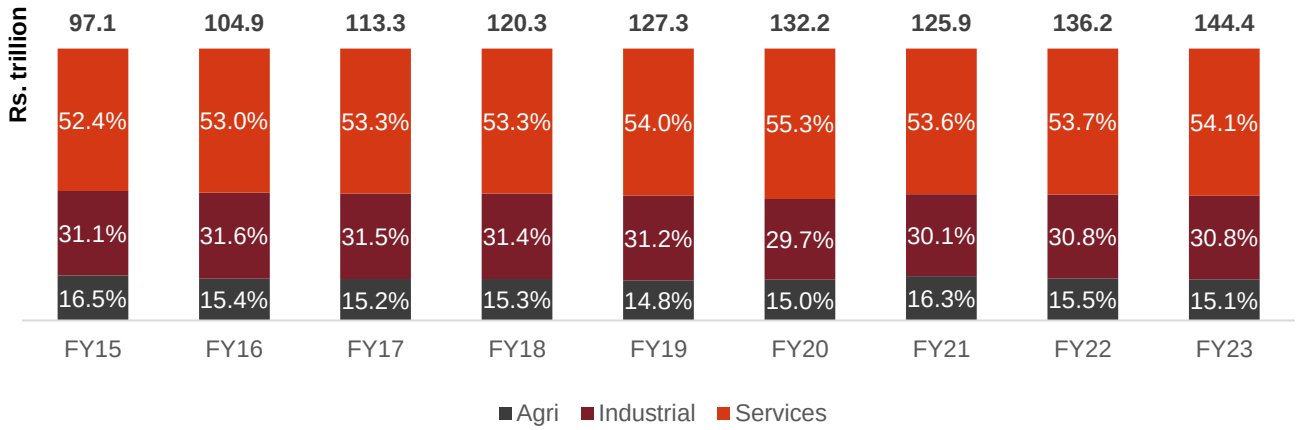
The industrial sector, which is the second-largest contributor, maintained its share in GDP, as the sector logged a 7.1% CAGR over fiscals 2015-19. Industrial contribution declined in fiscal 2020 with the slowdown in economic development. Before overall economic activity slowed down in fiscal 2020, India's 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 Covid-19 pandemic and subsequent lockdowns 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 GVA at constant prices expanded, while the share of services and industrial contracted.

Agriculture GVA continued to growth at a steady 3.0% in FY22. Faster GDP growth in FY22 saw share of agriculture decline in FY22 in contrast to FY21 when agriculture sector saw robust growth, a rare bright spot in a period when almost all sectors of the economy were impacted due to Covid-19 causing GDP to decline. Share of industrial sector in GDP grew marginally in FY22 dragged by utility services with a respectable 7.8% growth but below other industrial sectors of mining and manufacturing which grew strongly 12.6% and 10.5% in FY22 respectively. The lower base of FY21 supported the stronger growth of the industrial sector in FY22. Services sector lost share in in the GDP pie since the onset of Covid-19 in early 2020 due to 20% decline in the trade, hotel, transport and communication (THTC) in FY21. Covid restrictions had a more pronounced impact on THTC growth as the sector is more contact intenstive. Social distancing and travel restriction had a more pronounced impact on the sector. However, in FY22, supported by a low base, it saw growth bounce back to 8.4%.

**Share of sectors in GVA at constant prices**




*Source: RBI, CRISIL*

During fiscal 2023, agri sector is expected to continue its growth momentum of ~3% y-o-y. Services sector is expected to provide the thrust to the economy with 6.8% growth while industry sector growth is estimated to decelerate to ~6.4% during fiscal 2023 helping it maintain its contribution in fiscal 2023.

CRISIL expects further expansion in services contribution while agri sector to lose some ground during the year.

## 2.3 Review and outlook on inflation

**CPI inflation high on base effect**

Inflation, as measured by the Consumer Price Index (CPI), moderated to 6.8% on-year in October, down from 7.4% in September. This was expected due to the base effect from last fiscal. There was some easing in sequential momentum in cereal inflation, but it was offset by acceleration in vegetable inflation. Core inflation continues to remain sticky, exerting pressure on headline inflation.

The biggest takeaway from October CPI print seems to be the persistent stickiness in core inflation, which remains elevated at 6% in October and same as September, led by an increase in prices of pretty much the same components: clothing and footwear, housing, and household goods and services, personal care and effects, etc

Services inflation was at (5.6% in October — same as September), driven by housing, medical and transport costs (particularly in airfare, where prices jumped 14.7% on-year in October compared with 0.7% in September).

Steady inflation in services contrasts with moderation in inflation for ‘core goods’ (goods excluding food, fuel and services), which slowed for the third month in a row to 5.3% in October vs 6.8% in September

Moderation in food inflation on-year brought down the headline inflation in October: the drivers may seem difficult to disentangle as both base effect and momentum effect played opposing roles for major commodities. On the contrary, vegetable inflation slowed down sharply on-year to 7.8% (from 18.1% previous month) but prices jumped month-on-month to 4.1% (vs 2.7% in September). The seasonality effect in vegetable prices usually peaks around October-November, which explains the sequential rise in vegetable inflation on-month (prices of tomato rose 14% on-month, while that of onions rose more than 10%)

Inflation for milk and milk products continued to climb, reaching 7.7% in October from 7.1% in September and 6.4% in August, as hike in prices of retail packaged milk seeps through milk products as well.

**WPI-linked inflation single again**

Wholesale Price Index (WPI) inflation slipped into single digits for the first time since April 2021, to 8.4% in October from 10.7% the previous month.

Inflation across all major sub-groups eased in October. Fuel and power inflation dived by almost 10 percentage points (pp) to 23.2% from 32.6% in September, owing to a combination of base effect, decline in prices of kerosene on-month, and flat liquefied petroleum gas prices.

Core WPI inflation slowed to 6.4% (vs 7.8% in September) as cost pressures eased for producers of metals, textiles, chemicals, and others.

WPI inflation for food too rose at a slower pace, at 6.5% (vs 8.1%). However, its two components — primary food articles (8.3% vs 11%) and 'manufacture of food products' (3.1% vs 3%) — showed divergent trends.

Inflation in primary food articles eased on base effects and sequential easing in inflation momentum. Inflation rose in the latter owing to higher prices in the manufacture of milk products and derivatives of cereals (i.e., grain mill products). This could be the result of the hike in prices in both primary articles (wheat and milk) last quarter now being passed on to manufactured products.

**Inflation outlook**

CPI inflation may moderate in the coming few months as base effect comes into play and with the expectation of a healthy rabi crop. Further, seasonal effect for vegetable inflation comes down after November following fresh harvest. Yet, inflation will remain elevated above the RBI's upper tolerance band of 6%, with pressure from both, food and core.

On food, lower rice sowing in the kharif season could continue to impart pricing pressures. Core inflation is now becoming more dominated by services inflation, indicating recovery in demand and greater pricing power for producers to pass on costs. Last, for fuel inflation, volatility in international crude oil prices owing to geopolitical tensions implies we are not out of the woods yet.

Considering these factors, we retain our CPI inflation forecast at 6.8% for this fiscal FY23, with the upcoming last quarter inflation likely printing below 6% while for FY24 we expect CPI to be lower around 5.5%.

# 3 Global cryogenic equipment industry

## 3.1 Overview of cryogenic gases

Industrial gases are used in industrial processes for manufacturing products in a wide range of industries, including oil and gas, petrochemicals, chemicals, power, mining, metals, pharmaceuticals, electronics, glass and aerospace. Nitrogen, oxygen and natural gas are the major gases which would account for almost 80% of the cryogenic equipment demand. Other gases would include argon, helium, nitrous oxide, ethylene, and carbon dioxide.

These gases are produced by a gas production plant called an air separation unit (ASU), which filters and cools the atmospheric air to very low temperatures. As gases are cooled, they turn into liquids. However, each gas liquefies at a different temperature. This property enables the separation of gases by distillation with very high purity levels. The output of this process is available as a liquid at a very low temperature (below -150°C) and is called cryogenic gas.

Another major segment of cryogenic gases is the energy segment, which consists majorly of natural gas and, to a smaller extent, hydrogen. Liquefied natural gas (LNG) is produced by the oil and gas industry though exploration and extraction of underground gas reserves and cooling it to about -162°C which liquefies it making it convenient for storage and transportation. Hydrogen can be produced in many ways, including from fossil fuel sources such as LNG and from renewable sources though electrolysis of water.

As long as cryogenic gases are kept cool, they stay in liquid form and can be held at a lower pressure. Very large quantities can be contained in a smaller tank compared to their gaseous form, which requires high-pressure tanks that hold a lower amount of gases by weight. If the temperature of a cryogenic liquid increases by absorbing heat from its surroundings, it turns into gas, increasing the pressure inside the equipment. To prevent this, the equipment has to be properly insulated and it also requires to sustain some pressure build up based on its design. There are regulations developed and maintained as per the application and product to ensure the safety of people working with or around these gases, and the environment into which these gases might escape.

The equipment used to store, transport and handle the cooled gases in liquid form is collectively called cryogenic equipment. ASU's form about 58-62% of the demand for total global cryogenic equipment consumption in CY2021. The major cryogenic equipment includes tanks, valves, vaporisers and pumps. The other equipment includes pipes, regulators, freezers, storage dewars, strainers, samplers, heat exchangers, leak detection equipment, dispensers, and accessories (manifolds, fittings, vacuum jacketed/insulated piping, hoses, and connections). The market sizing of cryogenic equipment included below includes all cryogenic equipment use for storage, handling and distribution of industrial gases as well as gases used for energy such as a LNG and hydrogen and includes air separation units, liquefiers and LNG bulk carriers.

Not all gases require cryogenic equipment for storage and handling. The output of an ASU are gases in cryogenic state which also makes them convenient to transport as they take us less volume. LNG is also cooled to its liquid state as it allows for separation of impurities and unwanted gases. This process also reduces the volume required to 1/600$^{th}$ the volume compared to the gaseous form at atmospheric pressure which makes it convenient for transportation. For overseas transportation, LNG bulk tankers are used to transport LNG to an LNG terminal at the destination port. Distribution of cryogenic liquids needs to be done in special insulated tankers which keep the cryogenic liquids from boiling and escaping into the atmosphere. However, when these gases are to be put to use, they may be required to be converted to their gaseous form either due to the end-use requirement or lack of

cryogenic equipment at the end use location. For e.g., medical oxygen is required to be converted to a gas from its liquid form at a hospital where it might be stored in a cryogenic tank. However, in locations where cryogenic tank storage is not available, the gas is also distributed and stored in high pressure cylinders. This is usually the case at end use locations where the gas requirement is lower. High pressure cylinders are not included in market sizing of cryogenic equipment.

## 3.2 Cryogenic industry supply chain

There are four major groups in the cryogenic industry:

- Raw material manufacturers: They include metal and metal part manufacturers that produce large quantities of steel and steel products, which are the major raw materials for cryogenic equipment, along with other metals such as copper and nickel alloys, chromium, and titanium.
- Cryogenic equipment manufacturers: They manufacture equipment such as tanks, valves, and vaporisers, which enable storage and handling of cryogenic gases. The equipment is supplied to gas companies for manufacture, storage, and transportation of industrial or energy gases such as LNG or hydrogen. It is also supplied to end-users of such gases.
- Gas suppliers: They include industrial gas manufacturers operating air separation units, or oil and gas companies producing LNG.
- End-users: They are industries where such gases are used, e.g., steel, glass, semiconductor, and hospitals.

## 3.3 Regulations governing cryogenic gas equipment

Because of risks involved with malfunctioning cryogenic equipment, there are stringent regulations with regard to design, manufacture and operation of such equipment. These regulations vary based on type of equipment and area of operation, and also across regions to some extent.

Certification standards for each category of equipment is developed or maintained by an organisation with expertise in the area, such as American Society of Mechanical Engineers (ASME) and International Organization for Standardization (ISO), which specify specification/procedures for the manufacture of cryogenic equipment. These standards are usually required to be adopted by law in a country, and are enforced by one or more government bodies, based on the application of the equipment. Some standards could be accepted by a large number of countries, which allows for the equipment to be quickly imported and put into service, while some countries may provide expedited approvals of the equipment that already has approvals based on globally accepted standards.

Nevertheless, local laws could require additional approval for import, installation and use of cryogenic equipment from the local authority governing the application or industry. For e.g., in India, Petroleum and Explosive Safety Organisation is authorised to approve vessels to transport hazardous material, while US Department of Transport's approval is required for the transport of hazardous material in the US. The stringency related to design and manufacture and number of regulations in the segment is an additional barrier to entry for new players in the segment.

The major global organisations that specify and maintain standards related to cryogenic equipment across geopgraphies are:

- USA: American Society of Mechanical Engineers (ASME) provides the public and private sectors with a wide range of safety codes and standards. These are managed by the Board on Safety Codes and Standards (BSCS). In fact, the BSCS is responsible for the management of all ASME activities related to codes, standards, and accreditation and certification programmes directly applicable to safety codes, safety standards, and related accreditation and certification. For e.g., it develops and maintains eight major codes addressing safety. Of these, ASME Boiler & Pressure Vessel Code Section VIII details requirements applicable to the design, fabrication, inspection, testing, and certification of pressure vessels operating at internal or external pressures exceeding 15 pounds per sq inch, while ASME B31 is related to piping. Similar standards are present for other types of cryogenic equipment.
- EU: European Standards, which includes over 20 publishers of standards, including ISO and BS (British Standards) from the British Standards Institution, specify requirements for cryogenic equipment for use in the EU. For e.g., BS EN 1626:2008 specifies the requirement for cryogenic valves.
- Global: International Organization for Standardization (ISO) also maintains globally accepted standards. ISO21011:2008 is required for cryogenic valves, while ISO3834 specifies requirements for fusion welding of metallic materials that are part of a process in the manufacturing cryogenic equipment, such as tanks.
- Global: For devices running in enviornments with there could be a potential explosion possibility, additional certifications may be required such as ATEX/IECEx/PESO etc. ATEX, an initialization of the French term Appareils destinés à être utilisés en ATmosphères EXplosibles (French for "Equipment intended for use in explosive atmospheres"), is a set of European Union regulations that ensure products used in explosive environments are safe. Enviornments with flammable gases, mists or vapours or combustible dusts along with air and an ignition source could be a potential explosion hazard and are required to be tested and certified by the ATEX certification based on the categories of equipment and zones of operation. Simiar to ATEX, IECEx (International Electrotechnical Commission Explosive Atmospheres) another certification is an internationally accepted method based on standards developed by IEC (International Electrotechnical Commission) in the field of electrotechnology. For e.g., these certifications are required for equipment used in auto fuelling stations since automobiles used electrical systems and can be an additional risk factor. In India the certification for equipment used in fuelling stations would fall under PESO.

Adhering to these standards are required to ensure that the certified equipment is fit to be used in a particular application from a safety point of view. The certification of the equipment in done by a qualified inspector authorised by a reputed organisation, such as National Board of Boiler and Pressure Vessel Inspectors (NBBI), ASME, etc. Equipment meeting all requirements can be stamped with a mark from the standards organisations. For e.g., ASME U stamped equipment may be a requirement when installed in an area where people are present. It could also be an essential requirement by insurance companies incase the facility needs.to be insured.

Similarly, cryogenic equipment manufacturers could secure other accreditations based on quality and expertise of their plants for specific activities, such as design only, metallic or non-metallic repairs, and/or alterations, either only in the shop, only in the field, or in the shop as well as the field. For instance, NBBI provides certificates of authorisation to use the ‘R’ symbol stamp for repair or alteration of equipment.

Other institutions with specialised expertise may provide their own certification to suppliers that can meet their quality standards. For e.g, International Institute of Welding, which is a premier welding R&D and educational institute, provides certification on specific techniques that are used in the manufacture of cryogenic equipment.

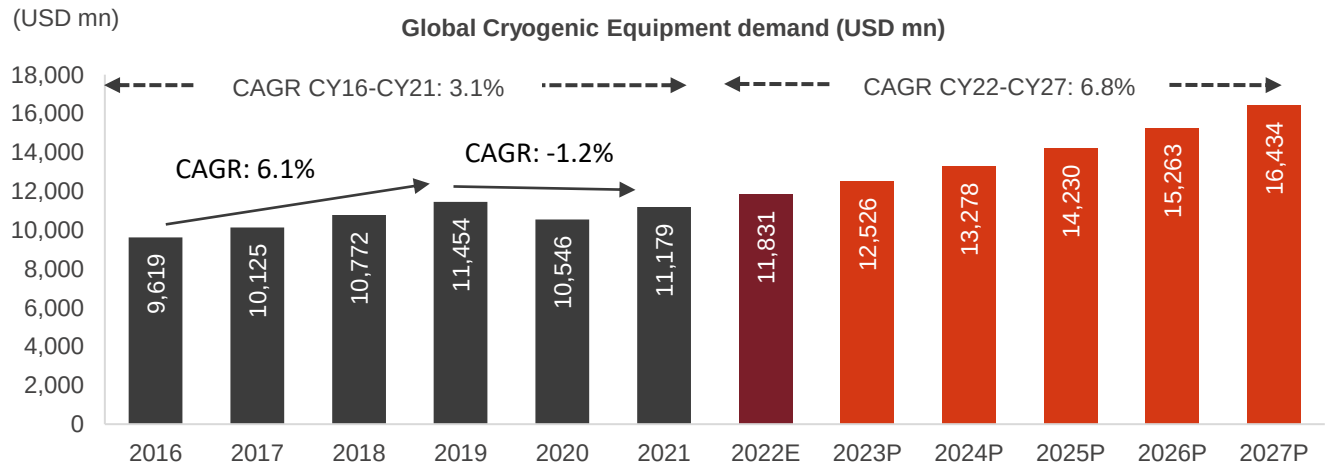
Many of the certifications are provided for a limited duration and need to be renewed periodically to ensure that the quality of the product / process is maintained.

## 3.4 Market size of global cryogenic equipment industry

The global cryogenic equipment market was valued at $11.2 billion in CY2021. Global cryogenic equipment demand clocked 3.1% compound annual growth rate (CAGR) between CY2016 and CY2021. Demand saw a dip during the Covid-19 period of CY2020 and CY2021, declining at 1.2% CAGR between CY2019 and CY2021, as economic activity slowed down.

Global cryogenic equipment demand is projected to reach $16.4 billion by CY2027, logging 6.8% CAGR between CY2022 and CY2027. Demand for cleaner fuels such as LNG and hydrogen due to focus on reducing carbon emissions from conventional energy sources will drive the uptake of cryogenic equipment across geographies. Additionally, the increase in industrialisation in developing nations in Asia Pacific is expected to boost demand for industrial gases in segments such as electronics, space and satellite and in turn, increase demand for cryogenic equipment.

**Global cryogenic equipment demand**




*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

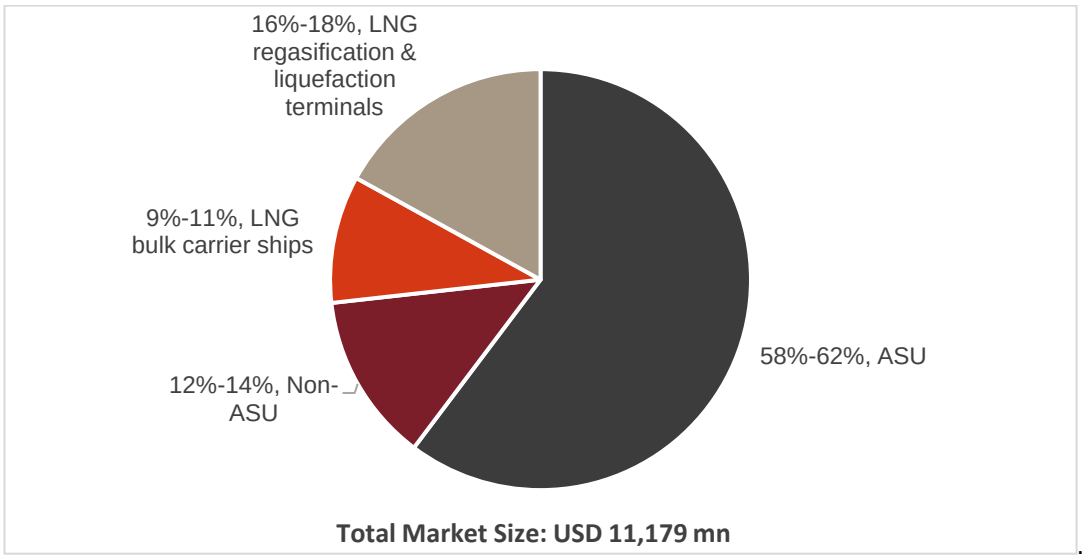
### Key applications of cryogenic equipment

The equipment used to store, transport and handle the cooled gases in liquid form is collectively called cryogenic equipment. ASU's form about 58-62% of the demand for total global cryogenic equipment consumption in CY2021. The major cryogenic equipment includes tanks, valves, vaporisers and pumps. The other equipment includes pipes, regulators, freezers, dewars, strainers, samplers, heat exchangers, leak detection equipment, dispensers, and accessories (manifolds, fittings, vacuum jacketed/insulated piping, hoses, and connections).

LNG applications form another major market for cryogenic equipment due to the large volume of natural gas demand and the subsequent need for its transport, storage and distribution. Of these application LNG bulk carrier ships and LNG terminals for liquefaction and regasifications are the major demand segments. LNG bulk carrier ships are marine vessels that enable the transportation of large quantities of liquified industrial gas which accounts for 9-11% of the total global cryogenic equipment demand while LNG liquefaction and regasification terminals are facilities that convert the industrial gas into its liquid and gaseous states, respectively, to facilitate storage and transporation of large volumes of natural gas economically over long distances. This segment accounted for 16-18% of the total cryogenic equipment demand in CY2021.

All other applications of cryogenic equipment are grouped under non-ASU segment, which includes rail and road transport, small-scale/temporary storage, cryopreservation, research studies, satellite launch facilities, cryogenic process technologies and cryogenic electronics, such as superconducting magnet systems, low-temperature detector systemsand infrared array systems, among others.

**Share of applications for cryogenic equipment CY2021**

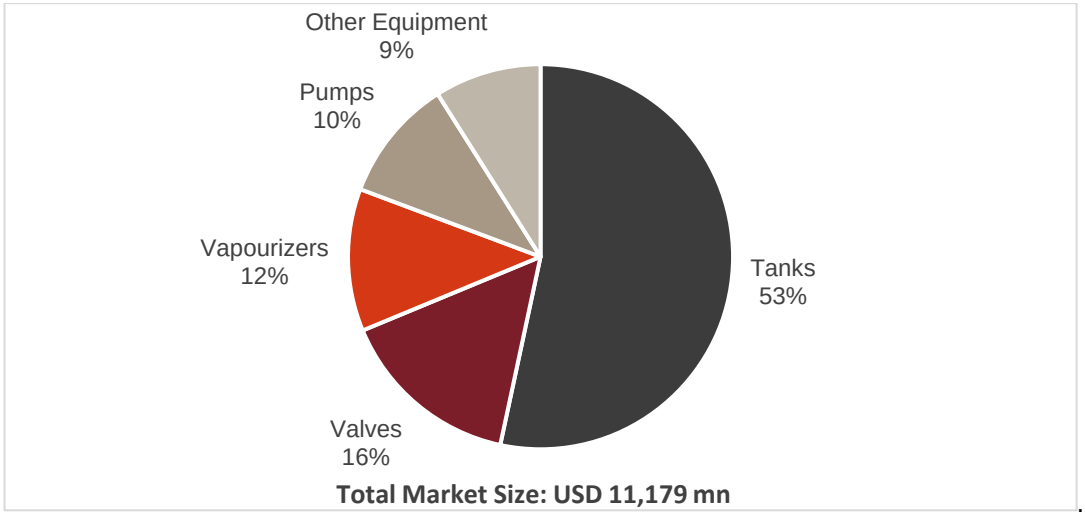



*Source: Markets and Markets, CRISIL Research*

## Types of cryogenic equipment

Of the types of equipment used, tanks used for storage and transportation form a major share with over half of the total cryogenic equipment demand. The other major types of equipment are valves which are used to control flow and for safety at 16%, vapourisers which convert cryogenic liquids to gaseous form at 12% and pumps at 10%. The other equipment accounting for 9% includes pipes, regulators, freezers, dewars, strainers, samplers, heat exchangers, leak detection equipment, dispensers, and manifolds, fittings, vacuum jacketed / insulated piping, hoses, connections etc.

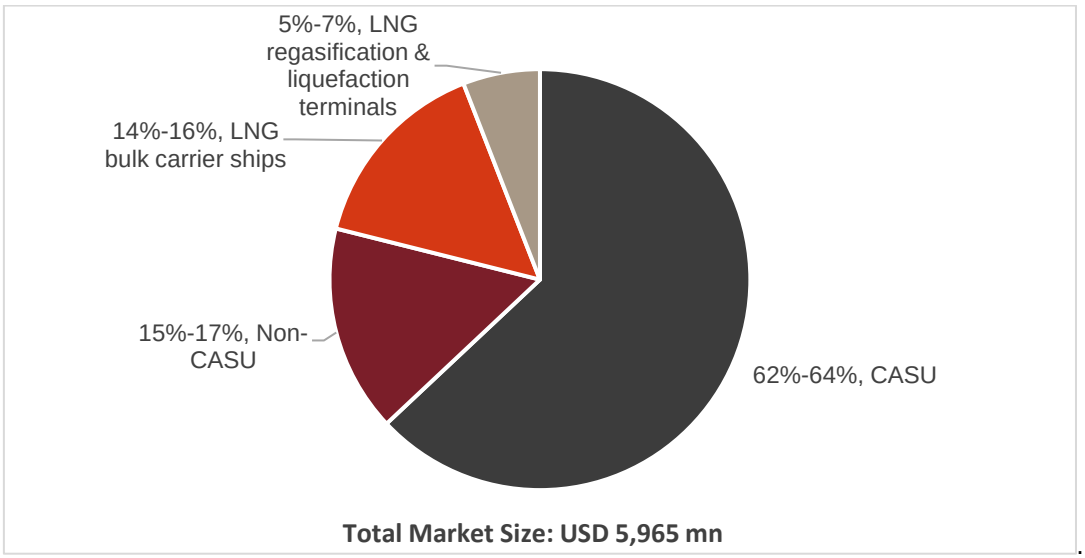
**Share of type of cryogenic equipment CY2021**




*Source: Markets and Markets, CRISIL Research*

At 53%, tanks account for an estimated $5,965 mn of the total global cryogenic equipment demand out of which ASU's for a major share of demand account for a little under 2/3rds of the demand. LNG bulk carrier ships account for 14-16% of the demand while LNG terminals accounted for 5-7% of the demand. The rest of the demand for tanks from transport and storage accounted for 15-17% of the demand.

**Share of applications for cryogenic tanks CY2021**




*Source: Markets and Markets, CRISIL Research*

## Impact of Covid-19 on the cryogenic gas equipment industry

The pandemic had an adverse impact on the cryogenic gas equipment industry as restrictions on travel and non-essential activity across many regions reduced the demand for goods and services. Demand for industrial gases and energy was also impacted. The industries most impacted were oil and gas owing to travel restrictions, while many industries slowed down because of lack of supply of parts.

However, demand for medical oxygen rose sharply during peak of the Covid-19 waves. During the peaks, demand for cryogenic equipment rose sharply, especially for tanks and oxygen production plants, such as pressure swing adsorption units that can be smaller and produce oxygen at required level of purity for supply to hospitals. Demand for oxygen containers such as tanks also rose to the extent that supply was not able to cater to demand during peak requirement in some countries such as India where equipment for use in other industries had to be converted to make it suitable for use in the healthcare industry and was used to supply oxygen to hospital.

Although demand for liquid oxygen equipment declined in CY 2020 and CY 2021 as Covid-19 impacted industrial demand, demand from medical use cushioned a sharper fall. Hence, cryogenic equipment demand from the oxygen segment was affected to a lower extent compared with other cryogens. However, as share of medical oxygen demand comprises a smaller share of overall oxygen demand, at 15-20%, overall demand for cryogenic equipment from oxygen segment declined during CY 2020 and CY 2021 at a CAGR of 0.9% over 2019 peak as compared to a growth of 6.6% CAGR between CY 2016 and CY 2019.

With the readiness of medical oxygen supply tested, there has been increase in interest to ensure that the situation does not arise again in case of another COVID-19 wave, leading to a rise in medical oxygen infrastructure. Although COVID-19 subdued industrial gas and in turn cryogenic equipment demand, it had the opposite effect on

semiconductor demand. As economies around the world went into lockdown with global air travel and local restrictions on non-essential travel came into force, people were reliant on digital and remote work techonlogies like never seen before. Demand for computing devices shot up while supply chains were clogged shooting up prices. People without access to fast internet and computing devices were at a huge disadvantage. The demand for routers, phones, tablets, laptops, desktops etc. drove demand for electronic chips. As people were locked down in their homes, home comfort became another essential increasing demand for consumer durables such as air conditioners, TV's etc. while post-COVID boom for personal transport increased demand for automobiles and electronic chips which are also used in these vehicles. All of this combined has caused shortage of semiconductor devices, thereby driving investments in the semiconductor sector for capacity expansion. Accompanied by increasing demand for digital technologies such as cloud, IoT, AI/ML etc, and improving productivity across industries, demand for cryogenic equipment from the electronics segment is expected to see the fastest growth across industries between 2022 and 2027.

## Key demand drivers

### High demand for gases from the metallurgy sector

The metallurgy industry uses industrial gases in processes such as metal forming, fabrication, welding and combustion — oxygen and nitrogen are the most commonly used industrial gases. Oxygen is an integral industrial gas used in the production of steel. According to the World Steel Association (WSA), ~73% of global steel production is done using the oxygen process (basic oxygen process). As demand for steel increases, demand for oxygen is likely to accelerate, creating demand for oxygen-related cryogenic equipment**.**

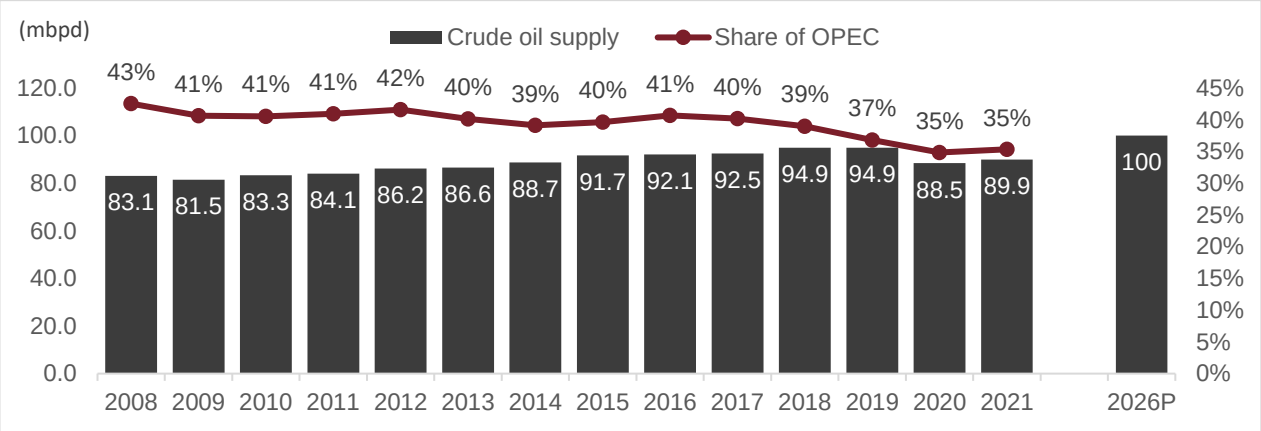
In the US, the Build Back Better Act has multiple provisions for public health, greenhouse gas reduction, and manufacturing. It also proposes building a supply chain for critical goods. The Act will increase spending on manufacturing plants, clean energy and green technologies, driving investments in electric vehicle production and charging infrastructure, along with hydrogen infrastructure and health infrastructure with a total outlay is estimated to be $1.64 trillion over 10 years. The demand for metals such as steel and aluminium and fabrication of metal products will support demand for cryogenic equipment required to handle gases such as oxygen, LNG etc.

China has been pushing its Belt and Road Initiative for improving connectivity from China to Europe, the Middle East and Africa, where up to $900 billion worth of projects are estimated to be under execution. In India, the National Infrastructure Pipeline (NIP), announced by the government to improve project preparation and attract investments into infrastructure, has up to $1.87 billion worth of projects in the pipeline as per the NIP portal on India Invest Grid. Such projects are expected to drive demand for metals, especially steel and aluminium supporting demand for cryogenic equipment.

Production of metals such as steel and aluminium is set to increase as infrastructure activity, automobile production (especially of electric vehicles) and consumer durables demand are expected to rise, driven by an increase in population, urbanisation, and rising consumption (especially in developing economies). Further, development of high-strength metal alloys with high rigidity and stiffness for emerging applications is expected to drive the growth of the metallurgy sector.

## Demand from the oil and gas sector to rise with recovery in global economy

### Global crude oil supply outlook




*Source: CRISIL Research*

In 2020, oil suppliers were forced to restrict production due to demand contraction on account of Covid-19. In 2021 and 2022, with expected recovery in demand, supply is also expected to increase. Going forward, the share of the Organization of Petroleum Exporting Countries (OPEC) in global crude oil production is expected to decline by 2025. OPEC countries met over 40% of the world's crude oil supply over the past few years. But the share has been declining gradually. The cartel contributed to ~35% of overall production in 2020, down from ~41% in 2016. Considering the resistance from OPEC to increase crude oil production to restrict decline in crude price, we expect its share to remain below 40% by 2026. Further, production from non-OPEC countries such as the US is expected to increase. Share of OPEC in total oil production has fallen due to supply disruptions and production cuts in line with the market sentiments. On the other hand, production from non-OPEC countries have also increased, especially from the US.

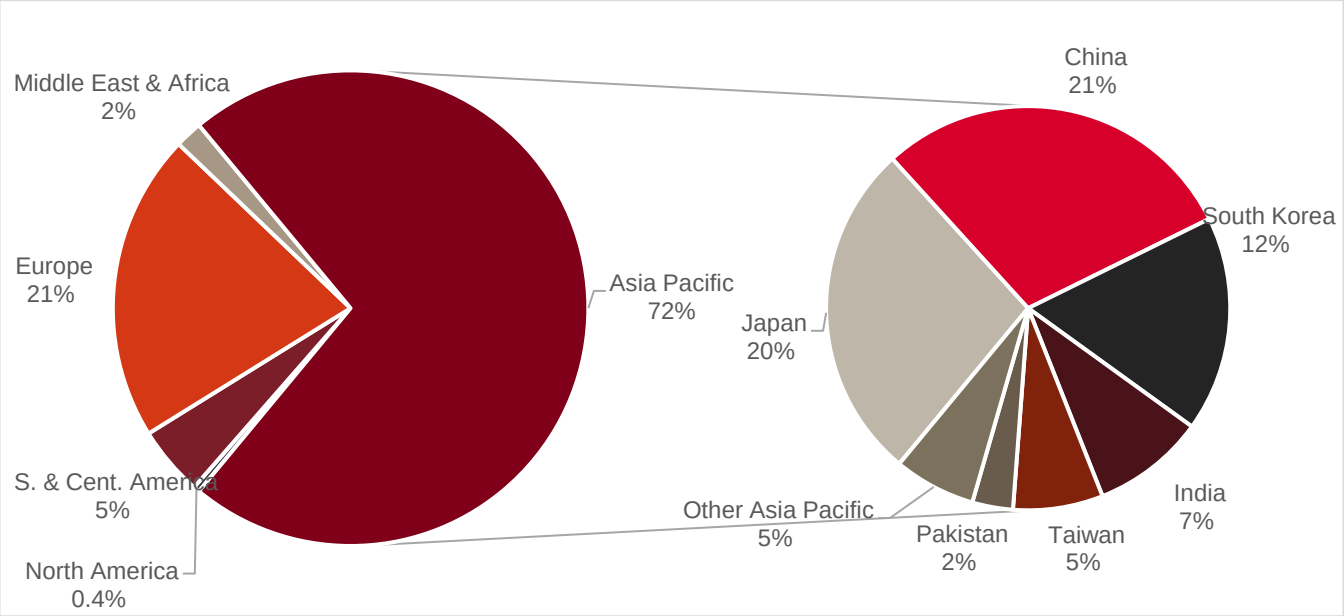
CRISIL Research projects global supply of crude oil rise to remain gradual and tepid during the five year forecast period. We expect supply to increase by 5-5.5 million barrels per day (mbpd) between calendar years 2019 and 2026. CRISIL Research believes the average price of crude oil will increase 25-30% on-year to $100-105 per barrel in 2022 from $70.4 per barrel in 2021, even after declining from a decadal high of $138.0 per barrel in March 2022, crude oil prices averaged $106.0 per barrel in April 2022. The increase in prices is primarily attributable to the ongoing geopolitical tensions between Russia and Ukraine. The prices have corrected in the past few months with increase in interest rates from central banks around the world and concern of slowing demand.

CRISIL Research expects oil supply from the Middle East to increase by about 3-4 mbpd (million barrels per day) during CY 2020 - CY 2026. Countries, such as Iraq and the UAE, are expected to keep the oil flow strong post oil production cut deal valid up to 2021 and would together account for slighly over 1 mbpd of the incremental production. Saudi Arabia and Kuwait will be the other major contributors.  Overall crude oil production in the US, including condensate production, decreased ~3% on-year to 16.48 mbpd in 2020 as it became economically unviable for certain unconventional oil assets to continue operating. The pace of production is expected to increase 1.4-1.6 mbpd between CY 2020 and CY 2026. As far as oil production from Canada is concerned, supply is expected to increase by 0.6-0.8 mbpd between 2020 and 2026. Over the next five years, North American oil production will likely see a marginal increase of 2.2 mbpd between 2020 and 2026 as against ~4.6 mbpd added between 2015 and 2019.

In the oil and gas industry, the downstream processes require use of industrial gases such as nitrogen, hydrogen, oxygen and carbon dioxide for chemical synthesis. Nitrogen and carbon dioxide are also used as injection fluids for enhanced oil recovery (EOR) and used widely for gas cycling, reservoir pressure maintenance and gas lift in the oilfield process. With increase in demand for oil and gas as global economic recovery gains steam from an extended COVID-19 slump, oilfield operators are also increasing production to meet rising demand. Cryogenic equipment is required in these oilfields for the storage and handling of liquefied industrial gases and for converting them into useful gaseous form. Thus, growing oil production from existing mature wells through EOR and from newly drilled wells across the world is expected to drive growth of the cryogenic equipment market.

## Shift to lower-carbon fuels to drive demand for LNG

**Share of Global LNG trade (CY2021)**



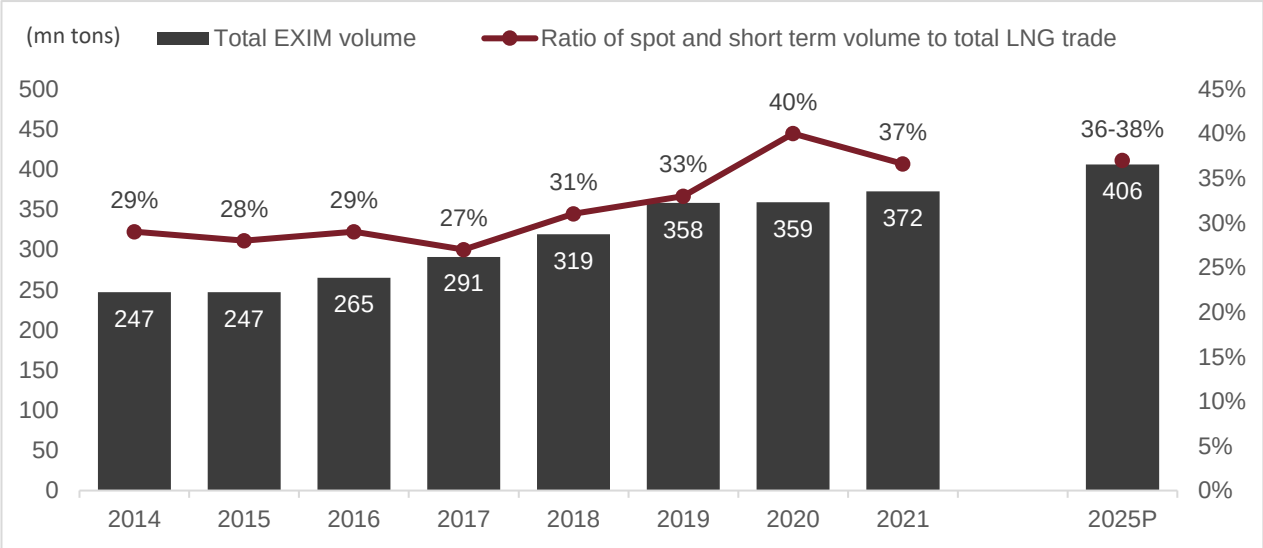

*Source: BP Stats, CRISIL Research*

Global LNG trade posted ~7.8% CAGR between CY2015 and CY2021, to reach ~372.3 million tonne (MT). Demand was driven by Asian nations such as China, India, Japan and South Korea, which increasingly shifted to gas from alternative energy sources such as coal, crude oil and nuclear power. LNG availability also improved because of large-scale capacity additions by Australia and the US, which accounted for the majority of new liquefaction capacities commissioned over the past five years. LNG liquefaction terminal capacity, also increased in 2021 with new capacities of 7.4 MTPA taking the total to 462 MTPA.

Asian economies account for over 70% of the total LNG trade. China and Japan are the largest markets for LNG trade accounting for about one fifth of the global LNG trade volume. China overtook Japan as the top LNG importer recoding a 15% increase imports driven by a shift to low carbon sources. Japan, though, is expected to remain the one of the largest importers of LNG, although the restart of the country's nuclear reactors would lower import volumes. Also, Chinese LNG demand is expected to grow significantly to over 110 MTPA by 2025, as the country aggressively shifts from coal to natural gas, in line with its long-term plan to combat rising pollution. China has aggressively replaced coal with gas in industries and households, which is evident from the shutdown of coal-based power plants and replacement of coal with gas for residential heating.

The below chart show the LNG trade volume which indicates the supply of natural gas, as generally, natural gas is liquefied to get LNG when it is required to be transporter overseas in LNG container ships while, domestic demand is met though pipelines in gaseous form. Whereas, the demand for LNG is indicated through the ratio of LNG procured in the spot market over and above the contracted LNG volumes which indicates the additional demand for LNG. The demand for LNG has increased with LNG trade volume increasing by ~4% in CY2021 of which the total volume of spot and short term demand reached 136.3 MT in CY2021 accounting for 36.6% of the total trade, lower than 40% seen in CY2020 as demand for spot LNG increasing caused the prices for LNG to increase impacting demad from cost sentitive enconomies.

**Global LNG demand versus supply**




*Source: CRISIL Research*

The procurement for LNG in spot market is expected to remain moderate through CY 2025 as higher prices dent the demand in the spot market however, overall LNG demand including contracted volumes are expected to continue to increase through CY 2025. In the long run, CRISIL Research projects global liquefied natural gas (LNG) demand to grow at a healthy pace of 5-6% CAGR up to 2025 to 480-500 million tonne per annum (MTPA). Demand would mainly be driven by Asian economies, such as China, India and South Korea, along with emerging demand centres, such as Bangladesh and Pakistan.CRISIL Research expects significant new LNG export capacity additions over the next five years, leading to a surge in global LNG supply. In CY 2021, LNG liquefaction terminal capacity, also increased in 2021 with new capacities of 7.4 MTPA taking the total to 462 MTPA. This included 1.5 MTPA Petronas Floating Liquified Natural Gas (PFLNG) Dua floating offshore liquefaction unit at Sabah, Malaysia, and a new large-scale, 5 MTPA capacity installed at Sabine Pass liquefaction train in the US. Between 2021 and 2025, we expect 7-8 MTPA of liquefaction terminals to be commissioned each year. These capacity additions will be led by the US. Owing to surging domestic gas production and low prices, the US started exporting LNG in 2016 - it began exports with the commissioning of the first train (4.5 MTPA) of the 18 MTPA Sabine Pass LNG terminal. Over the next five years, we expect new terminals of ~140 MTPA capacity to start operations across the globe, driven by the US.

The recent growth in the LNG market is proportionately boosting demand for cryogenic equipment in this industry. While renewable energy is cleaner, it does not produce power at a steady rate; in the case of solar, power is only produced during the day. LNG-based supplementary power producing systems aid in reducing emissions while

maintaining power supply during peak demand. These factors are driving demand for cryogenic equipment in the energy and power industry. Opportunities for cryogenic equipment in decarbonisation are expected to be significant as countries try to meet their decarbonisation goals. For example, to achieve the France 2030 plan, the government has allocated a total of ~$6.14 billion (EUR 5.6 billion) to decarbonise industrial sectors such as steel, cement, chemicals and metallurgy. Such efforts are likely to benefit LNG and hydrogen demand and, in turn, drive demand for cryogenic equipment.

### Chemicals industry's decarbonisation and transition to more sustainable process to fuel growth

In the chemicals industry, industrial gases such as nitrogen, argon, hydrogen and helium are used for various applications such as polymerisation, synthesis of intermediates, freeze drying, storing biological samples and drugs, and preparation of laboratory and pilot production-scale cold baths. The chemicals industry had been facing cyclical pressures before the COVID-19 pandemic began, and this scenario had become worse post the pandemic. Going forward, strong demand for both commodity and speciality chemicals is expected due to the recovery of many economies from the pandemic. One of the major areas of focus for chemical companies in the near future will likely be sustainability and decarbonisation. Many chemical companies are expected to increase investment in research and development (R&D) capabilities and leverage advances in decarbonisation and recycling technologies to lower their and their customers' carbon footprint, as well as reduce plastic waste. Further, the recovery in global economic growth coming out of the Covid-19 period with easing of restrictions will increase demand for industrial gases in the chemicals industry, consequently driving demand for cryogenic equipment.

## Opportunities in the cryogenic equipment market

### Hydrogen demand from multiple industries to surge as cost of green hydrogen falls driven by need to reduce carbon footprint

There has been increasing interest in hydrogen in recent years as it is considered to be a versatile green energy source when produced from renewable sources though electrolysis. The newest applications of hydrogen, such as fuel cells in the transportation and energy-related industries, are also gaining momentum. Several countries are beginning to experiment with hydrogen as a source of power for industries such as transportation, steel and fertilisers to reduce carbon emissions.

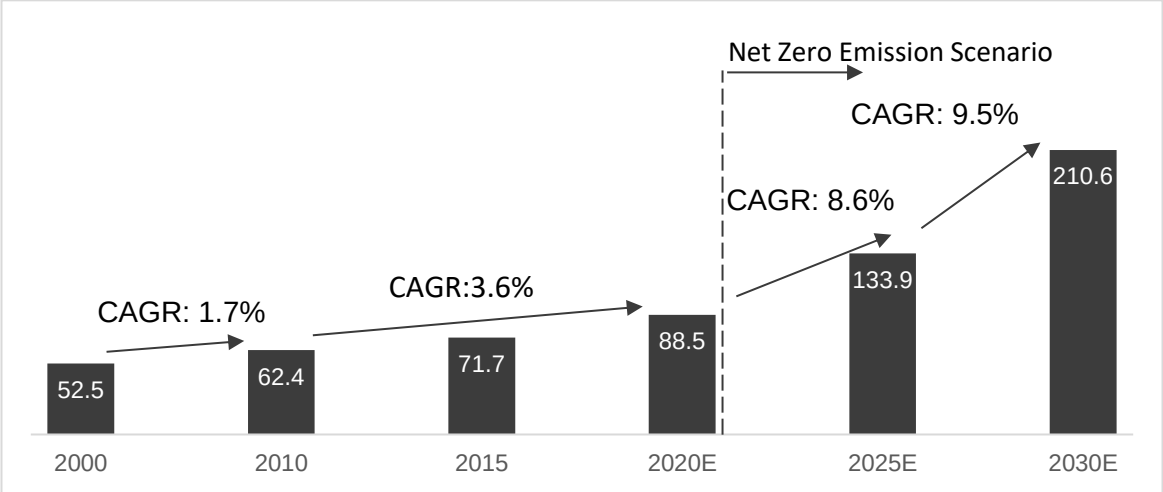
Steel is one of the most energy-intensive industries. According to a WSA study in CY 2020, every tonne of steel produced emits about 1.85 tonne of carbon dioxide into the atmosphere. In CY2020, 1,860 MT of steel was produced, which resulted in total direct emissions of 2.6 billion tonne, representing between 7% and 9% of global anthropogenic carbon dioxide emissions. The urgency to move to a lower carbon footprint by steel-consuming industries has resulted in steel manufacturers looking for alternatives such as 'green steel' made using 'green hydrogen', i.e., hydrogen produced from renewable energy sources.

In Sweden, steel giant SSAB and mining company LKAB have a joint venture named HYBRIT (Hydrogen Breakthrough Ironmaking Technology), which has already started commercial deliveries of steel made from green hydrogen. In India, Vedanta's Sesa Goa Iron Ore Business is seeking a tie-up with IIT Bombay to develop processes for manufacturing green steel.

However, the high cost of hydrogen and the equipment utilising hydrogen (such as fuel cells) poses challenges. Secondly, infrastructure for hydrogen distribution is almost nil. Hydrogen, especially green hydrogen, is prohibitively expensive to produce and distribute. These challenges are being worked on to make hydrogen economically and technologically viable.

Demand for hydrogen had been growing at a tepid 1.7% CAGR between CY2000 and CY2010 which has increased in the next decade to 3.6% CAGR between CY2010 and CY2020. As per International Energy Agency (IEA) estimates, in the next zero emission scenario the demand for hydrogen can increase at a rapid pace at a CAGR of 8.6% between CY2020 and CY2025 and even faster at a CAGR of 9.5% between CY2025 to CY2030. However, IEA estimates that even this pace is below what is required to meet the net zero emission scenario by CY2050.

**Hydrogen demand (MT)**




*Source: IEA (2021), Hydrogen, IEA, Paris https://www.iea.org/reports/hydrogen, CRISIL Research*

Hydrogen can be produced in multiple ways, including through fossil fuels such as natural gas, where hydrogen and carbon are separated through a process call steam methane reformations — this hydrogen is called 'grey hydrogen', while that produced from coal is called 'black hydrogen' or 'brown hydrogen'**.** However, when the carbon content produced during hydrogen production is captured and utilised or stored instead of being released into the environment, it is called 'blue hydrogen'. This can provide similar benefits as green hydrogen, which is the cleanest form of hydrogen, produced from electrolysis of water. The by-products of electrolysis are hydrogen and oxygen when produced using power from renewable sources such as wind, solar and hydro. However, the cost of producing green hydrogen is very high for it to be considered viable against currently used fossil fuels. Another challenge with hydrogen is the way it is utilised to produce electric power though fuel cells. These are also a nascent technology that needs to be further refined to improve its operating characteristics; moreover, they are expensive to operate.

Additional applications for hydrogen such as jet fuel, fuel for ICE vehicles, and use in industrial processes as an alternative to fossil fuel-based sources are likely to emerge in the long term as innovation in process and techonlogies take place driven by a need to achieve net zero emissions.

As per IEA the cost of production of hydrogen from natural gas ranges from $0.5 to $1.7 per kg and cost of blue hydrogen produced using carbon capture technologies is expected to range between $1 to $2 per kg while green hydrogen, produced from renewable sources to cost in the range of $3 - $8 per kg in CY2021 based on region.

Based on IEA's assessment, there is potential for green hydrogen cost to fall as low as $1.3 per kg in regions with excellent renewable resources which will be comparable to blue hydrogen by 2030. The reduction in cost of producing green hydrogen can significantly improve adoption of hydrogen across industries as hydrogen can

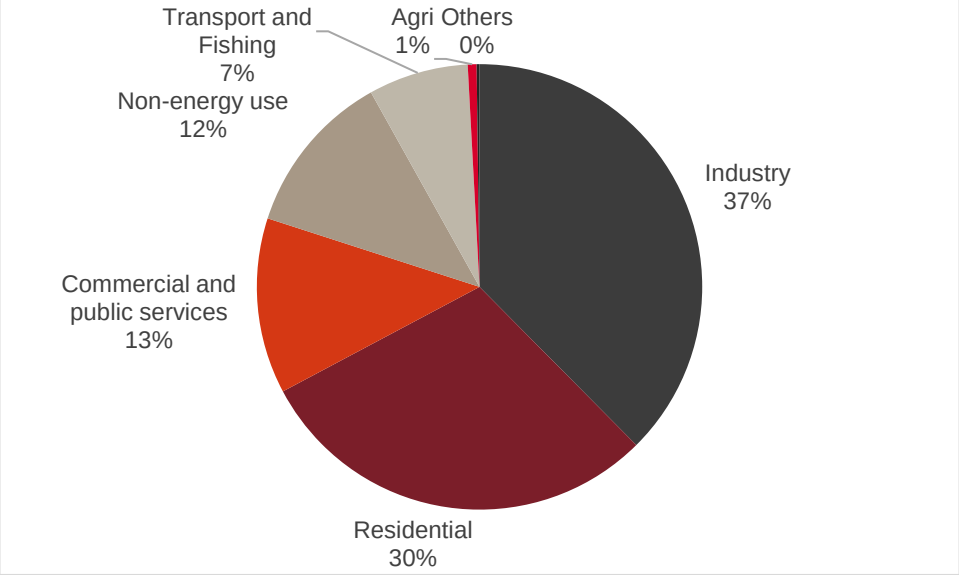
become more cost competetive w.r.t to fossil fuel while reducing the carbon footprint for organisations using green hydrogen.

### Development of alternative technologies to reduce transport emissions

The transportation industry is one of the largest sources of carbon emissions globally. To reduce emissions, both pollutants and greenhouse gases, there is a shift underway towards electric vehicles. However, for large power requirements, such as for heavy loads and long-distance transport, the size of batteries needed increases significantly. This affects the cost competitiveness of battery vehicles for such applications due to higher capital costs for larger batteries as well as loss in payload capacity due to additional weight of batteries.

The demand for natural gas is dominated by the industrial and residential sector with over 2/3rd of the demand.

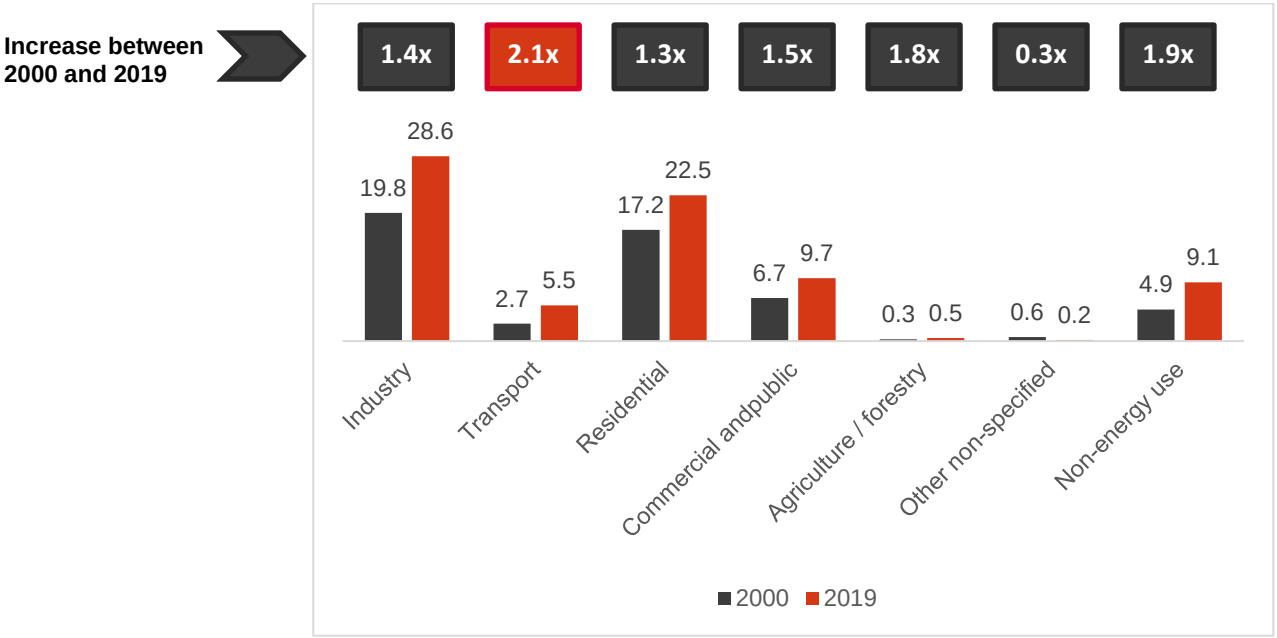
**Share of natural gas demand CY2019**




*Source: IEA, CRISIL Research*

However, with rising demand for cleaner fuels, the demand for natural gas has been steadility increasing. Over the last two decades the demand for natural gas from transport and fishing (including shipping vessels) has been the fastest growth end-use sector for natural gas.

**Natural gas demand (million terra joules)**




*Source: IEA, CRISIL Research*

Ships that burn highly polluting fuel oil face entry restrictions in some regional waters, which has caused an increase in demand for LNG for powering ships.

In the short term, LNG is expected to be the most technologically and economically viable option as it is a cleaner burning fuel with lower carbon emissions than crude derivatives. The lower volume occupied by LNG allows for a much larger volume of the fuel to be carried in a given size of fuel tank. This is beneficial for long-haul transportation allow for fewer fuel filling stops and they can also be refuelled relatively quickly. Lower need for fuelling infrastructure can also lower fuel costs. However, the infrastructure for LNG dispensation, especially for road transport, is still inadequate in most countries. Expansion of the LNG distribution network for transportation is expected to drive demand for cryogenic equipment from the transportation sector.

In the long term, there is a concerted effort by many leading companies to make products that can run on hydrogen, which can be produced from fully renewable sources. Toyota and Hyundai are two major automakers pioneering the use of fuel cells and have also launched commercial products in the passenger vehicle segment. They are also collaborating with companies and governments to bring their technology to other segments. For example, Toyota has collaborated with truck makers Hino and Kenworth for heavy-duty trucks such as Class 8 trucks (heaviest class of trucks) in the US. Airbus is testing hydrogen-powered planes with its ZEROe concept. Storage of breathing oxygen in liquid state for high-altitude military aircraft was one of the earliest of such use cases. Other aircraft applications include cabin pressurisation and cooling, along with the generation of auxiliary power. Liquid hydrogen is also being considered as a fuel for hypersonic aircraft.

Space propulsion depends on propellants that are normally gaseous in nature but are carried in the condensed form as liquids facilitated by the use of cryogenic systems. These applications of industrial gases in the aerospace industry are expected to drive demand for cryogenic equipment.

### Rise in space and satellite applications

Applications of liquid oxygen in the aerospace industry are increasing in the Asia Pacific region. In India and Russia, liquid oxygen demand is expected to get a boost from growth of cryogenic space engines. Cryogenic engines would usually use another gas along with oxygen such as LNG or hydrogen which are stored in their liquid state in cryogenic tanks. This allows the space vehicle to reduce the size of the fuel tanks required to be carried allowing for better efficiency of the cryogenic engine. When used with hydrogen, it doesn't create any pollution in the atmosphere unlike fossible fuel-based engines. Hydrogen sourced from renewable energy can further help greenify space activities. Increasing investment in space missions is the major driving factor for cryogenic gases and associated equipment demand in India. Further, the government set up a new body IN-SPACe (Indian National Space Promotion and Authorisation Centre) in June 2020 to regulate and promote private-sector participation in space activities. The government is also planning to revise the foreign investment policies in the space sector to facilitate foreign direct investment in the sector. In addition, Indian private players, along with foreign companies, have also shown interest in participating in the country's aerospace and defence sector. These developments across India's aerospace industry are expected to drive demand for cryogenic equipment in the country. Thus, increasing space missions are also likely to create opportunities for oxygen-related cryogenic equipment in the near future.

### Evolving electronics applications requiring cryogenic gases

Cryogenic gases cater to an array of applications in the electronics industry, such as fibre optics, flat panel displays, integrated circuit packaging, assembly and testing, LED technologies, photovoltaics, printed circuit board (PCB) assembly and testing, and semiconductors.

Manufacture of semiconductions require multiple types of cryogenic gases. Some of these gases used to create the chemical reactions to produce the electrical properties of the device are required to be produced at very high qualities with no impurities as even a small amount of impurities could reduce the output of the plant (due to defective products) which will cost a lot due to the chip making process being very capital intensive. Another purpose of gases in semiconductor manufacturing is the use of "purge" gases which are used to flush out other gases in the pipeline, containers etc. Nitrogen, oxygen, argon and hydrogen are some of the major gases used in the semiconductor manufacturing process.

Often electronic devices are required to be tested after production in varying climatic conditions as specified in the safe operating ranges for the devices — this also requires cooling with nitrogen. Demand for electronic chips for computing devices has increased due to remote work adoption. The increased demand has led to an increased demand for computing devices, increasing prices of devices and driving investments in the semiconductor sector. This has impacted other sectors as well such as consumer durables and automobiles as chip fabrication plants have been facing capacity constraints with a sudden rise in demand.

Digital technologies such as cloud, the internet of things (IoT), and artificial intelligence (AI)/ machine learning (ML) are improving productivity across industries, and the hybrid/ remote work culture is taking hold. Therefore, demand for cryogenic equipment from the electronics segment is expected to rise as many countries, including the US, China and India, are making efforts to ensure that supplies of components that are critical for productivity growth and technological advancement are available as per requirements.

### Cryogenics and its uses in cryo-scientific research

Crogenics is the production and behaviour of materials at vey low termperatures. The low temperatures modify the behaviour of materials to produce distinct effects which are find a range of applications in research and techonology. For e.g., one of the best known and used phenomenon - super conductivity has been put to use for production of powerful magnets which are used in varying fields such as electronics, medicine and biological research. In medicine, cryosurgery is performed to treat many types of diseases, such removal of tumours and other malignant skin conditions. Cryoelectronics is a field where electronics phenomena are studied at low temperatures where electrical resistance is next to negligible. Cryobiology involves the study of low temperatures on living organisms. Cryotheraphy for treatment of inflammation, managing pain etc. is also another new field under study whose benefits are yet to be fully understood.

Some of the most challenging problems in science are being tackled with the help of cryogenic phenomena which are not seen under normal conditions. Cryogenic fulids are used to cool magnets for the Large Hadron Collider which contains the world’s mot powerful particle accelerator. ITER project (“iter” meaning "The Way" in Latin), which is a collaboration of 35 nations, are building the world’s largest tokamak, a magnetic fusion decive which will be used to study nuclear fusion which can be a large source of clean energy. The ITER cryostat is a large stainless steel high-vacumm pressure chamber which provides high vacumm, ultra-cool environment for the ITER vacuum vessel and superconducting magnets.

The requirements for cryo-scientific research can be very demanding depending on the application. Requirements for extremely pure gases, clear environments and very low temperatures such as near absolute zero may be required which may not have commercial viability but could be essential in research.

## Challenges for cryogenic equipment

### Cryogen leakage from equipment leading to health hazards

Some gases can be dangerous when inhaled even at normal temperatures. Due to cryogenic gases being stored at very low temperatures, their leakage poses health hazards and has two major risks. First, prolonged exposure to cryogen can cause frostbite and damage to the lungs. Second, discharge of the cryogen into an enclosed area can lead to oxygen deficiency in the area, posing a health risk. These necessitate extra care in designing, testing and maintaining cryogenic equipment, which can be a hindrance to adoption of cryogenic equipment.

### Well-to-wheel emissions of LNG lower benefit of shifting from other fossil fuels

Well-to-wheel emissions are calculated by looking at emissions for the entire value chain, instead of just at the end-use locations. Some studies have pointed out that although replacing other fossil fuels with clean burning LNG can benefit at the location of use, there are potential emissions then negate some of the benefit elsewhere. The main reason being that LNG, which is basically liquefied methane, is a very potent greenhouse gas, estimated to be 34-40 times more greenhouse effect producing than carbon dioxide. Tiny amounts of fugitive emissions (unintentional emissions) can nullify the benefits at a value-chain level. This can happen during nozzle coupling, valve and pump leakage, etc. in industrial use. LNG vehicles that do not have their engine running will usually require venting of boil-off gases from the fuel tank if pressure increase beyond safe limits and it absorbs heat from its surroundings; lower efficiency engines also add to unburnt methane emissions. Pipeline/tank ruptures due to mechanical failure or accidents can also leak methane into the atmosphere are another source of emission. These require tight regulations and adherence to these regulations with proper controls to get the desired benefit of shifting to LNG.

### Electric vehicles could hurt LNG and hydrogen demand

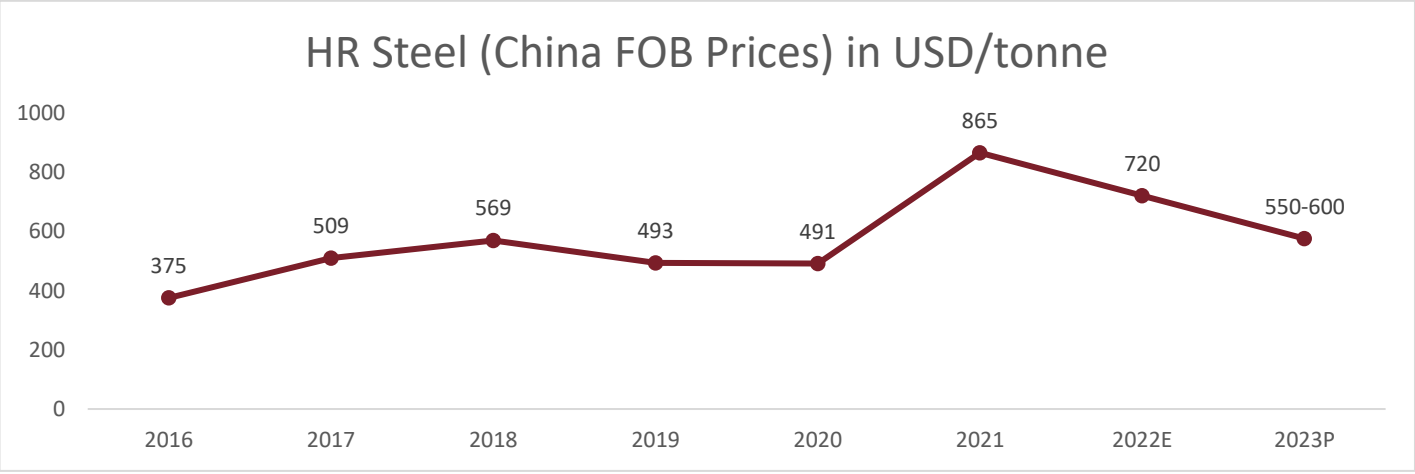
Long-haul transport of heavy goods via roads, ships and airlines requires significant amount of energy. To cater to these segments with batteries alone can be economically unviable due to the current high upfront costs of the batteries and lower energy density (amount of energy contained in a given size of battery). Hence, electric vehicles, at least in the present scenario, are mostly used in the short-haul or light-vehicle categories. However, efforts are underway to make battery vehicles more efficient, including the battery technology and the powertrain and physical characteristics of the vehicle. These improvements could enable battery vehicles to capture a larger share of the market, which would hurt LNG and hydrogen demand. The extent to which battery vehicles can compete with LNG and hydrogen-based vehicles will depend on technology breakthroughs. While there is no consensus on this topic, there are highly committed voices on both sides of the argument. Tesla, a pioneer in electric vehicle technology, believes hydrogen vehicles could be unviable and is solely focused on battery vehicles. Meanwhile, Toyota, a pioneer in fuel-cell technology, has largely abandoned battery technology and is primarily focused on fuel-cell vehicles.

### Volatility in raw material prices impact costs for cryogenic equipment suppliers

After an impressive rally last year, when global steel prices (China HR FOB) rose 76%, prices fell in January February 2022 on weak demand in China as it cut its manufacturing output in lieu of the Winter Olympics and Lunar New Year. However, the recent rise in raw material prices and the Russia-Ukraine war, rising covid-19 cases have again led to an upward rally in prices. However, since mid-May, coking coal prices have started to correct massively and panic procurement of steel in global market has subsided. Consequently, prices have seen a rapid downward trend. China HR FOB prices are already below $700 per tonne level. Even EU and US prices are hovering in the $800 per tonne level.

Recovery in demand on last year's low base, high input costs of iron ore, coal, ferro alloys, gas and other key raw materials, coupled with rising steel prices in both the global and domestic market, led to a significant rise in steel and other commodity prices. Therefore, we foresee continued volatility over the next quarter as global geo-political tensions, recent outbreaks of new Covid-19 variants in China, and disruptions in coking coal market keep prices elevated.

**Global Steel price trend**



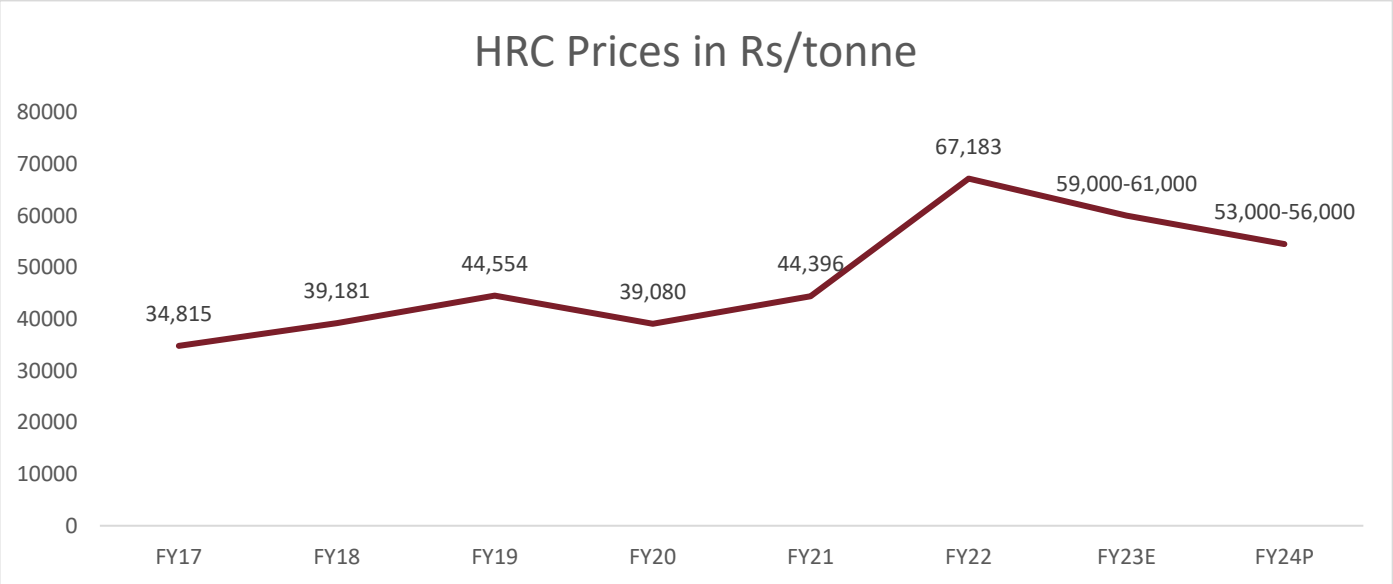

*Note: HRC – Hot Rolled Coil*
*Note: E: Estimate; P: Projected*
*Source: CRISIL Research*

Overall, China HR FOB is expected to average at $700-750 per tonne in 2022 in our base-case scenario. EU steel prices however will remain elevated and maintain a premium to China prices owing to higher energy costs that it is facing on restricting Russian supplies of coal, gas and steel. In CY 2023, while prices will correct further, they will continue to remain above the average of the last couple of years owing to a green cycle in play, and thereby, average at $550-650 per tonne. In fact, prices are currently hovering in the $550-600/ tonne range. We expect some correction going ahead before witnessing recovery in the second half of CY2023.

In fiscal 2019, domestic steel prices rose 13.7%, mirroring the trend in global steel prices, led by strong domestic demand and rupee depreciation. Domestic HRC prices surged 20% in the first half of fiscal 2019 owing to elevated global prices and weakening rupee. However, prices started moderating in the third quarter of fiscal 2019 due to trend reversal in the aforementioned factors. Flat steel prices rose 14% on-year in fiscal 2021 to average at Rs 44,396 per tonne. Long steel prices rose 12% on-year to average at Rs 45,175 per tonne in fiscal 2021. Fiscal 2022 saw steel prices surge on account of pent-up demand in global market paired with logistics and supply-chain challenges and rising input cost. Flat steel prices rose a whopping 51% on-year to average at Rs. 67,183. Meanwhile, long steel prices rose by 26% to average at Rs. 56,941. As global steel prices soar on rising raw material costs in the wake of coking coal disruptions in Australia, tightness in the export market owing to the Russia-Ukraine war prices are expected to remain high in the first quarter of fiscal 2023. Consequently, for fiscal 2023, average domestic flat steel prices are expected to drop by 11-13% on-year, post a 51% rise in fiscal 2022. Long steel prices to remain flat on-year on account of not seeing as stark a rally in prices as flat products. In fiscal 2024, prices are forecast to moderate as volatility in the global market subsides. That said, prices will not revert to pre-Covid-19 levels as costs are projected to remain high and green cycle comes into play.

Steel is a major raw material for cryogenic equipment. The changes in steel prices directly impact the gross margins of the cryogenic equipment suppliers. Rapid increase in steel prices will impact the ability of suppliers to complete projects undertaken profitably and increase the cost of new projects.

Domestic steel price trend

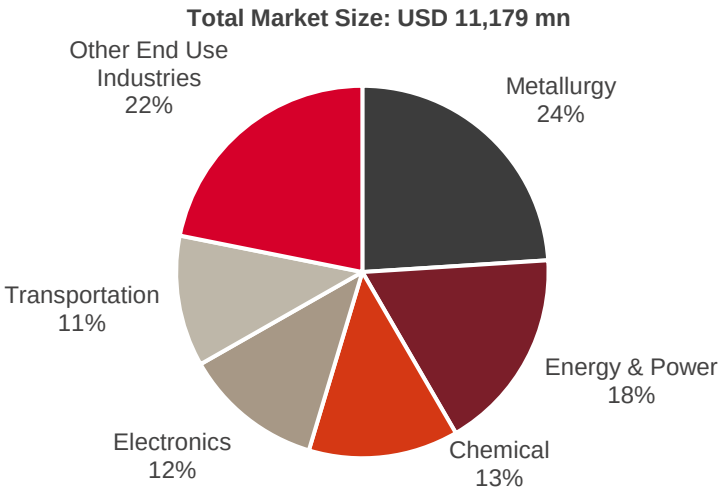



*Note: HRC – Hot Rolled Coil*
*Note: E: Estimate; P: Projected*
*Source: CRISIL Research*

## 3.5 Market size of global cryogenic equipment by end-use industry

Metallurgy is the largest demand segment for cryogenic equipment, with 24% share of overall demand in CY2021. During the year, demand from the segment was ~$2.7 billion. The large market share can be attributed to rapid industrialisation and favourable government policies globally benefitting the manufacturing and industrial sectors.

**Share of cryogenic equipment by end-use industry in CY2021**

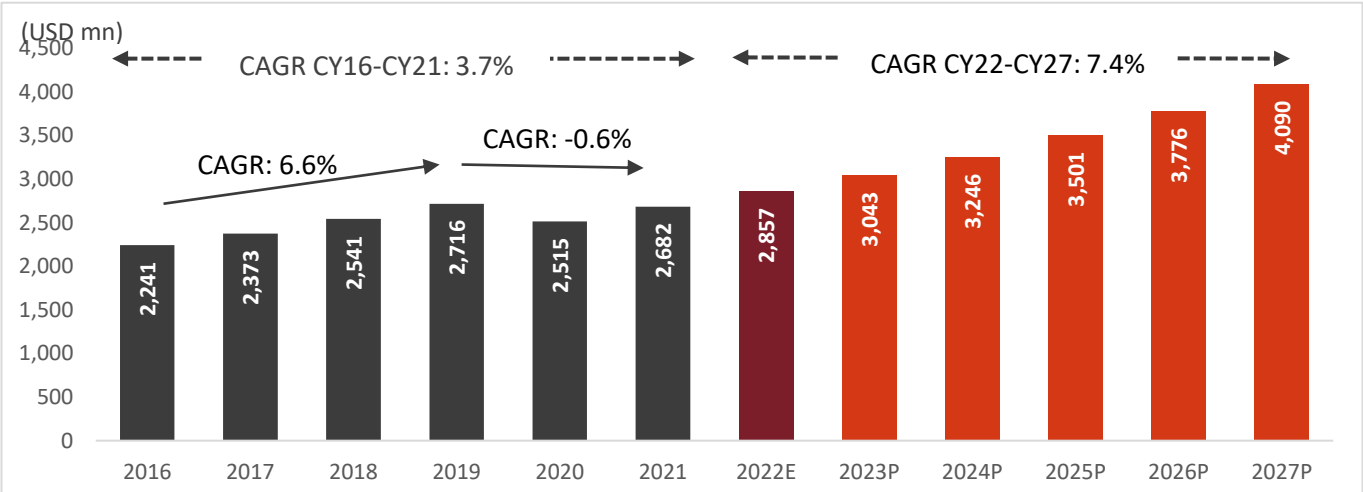



*Source: Markets and Markets, CRISIL Research*

Within the metallurgy industry, processes such as metal forming, fabrication, welding, and combustion require industrial gases, and therefore cryogenic equipment, with oxygen and nitrogen the most commonly used gases. Other gases such as argon and hydrogen are used to a lesser extent.

Between CY2022 and CY2027P, demand for cryogenic equipment from the metallurgy industry is expected to grow at 7.4% CAGR mainly driven by demand for steel and aluminium from infrastructure, automobile and consumer goods.

**Demand for cryogenic equipment from metallurgy industry**

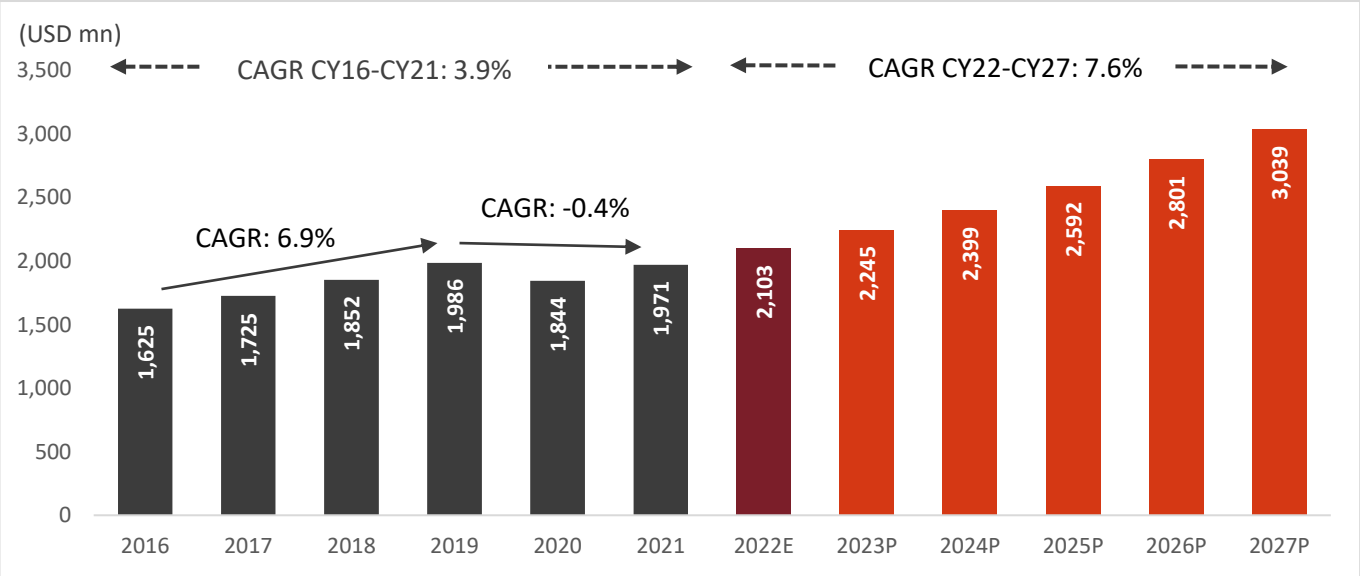



*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

Energy and power, which was the second-largest demand segment for cryogenic equipment in CY2021, is also projected to continue to rise, fuelled by rising population and economic expansion. Cryogenic equipment is used for various industrial gases across energy and power applications. Cryogenic equipment is also used by the energy and power industry for supply of some of its products (LNG and hydrogen) to other end-use industries.

Between CY2022 and CY2027P, demand for cryogenic equipment from the energy and power industry is expected to grow at 7.6% CAGR. Metullargy processes are typically energy intensive. As per World Steel Organisation, every tonne of steel produced leads to 1.85 tonnes of carbon dioxide emission which translated into 2.6 bn tonnes of carbon dioxide emission in 2020 for the 1.86 bn tonnes of steel produced in 2020. Demand for cryogenic equipment from the metullargy industry are expected to be driven by investments in R&D to make processes cleaner with climate change in focus and building of cleaner fuel capacities such as LNG and hydrogen while reducing the carbon footprint of existing processes.

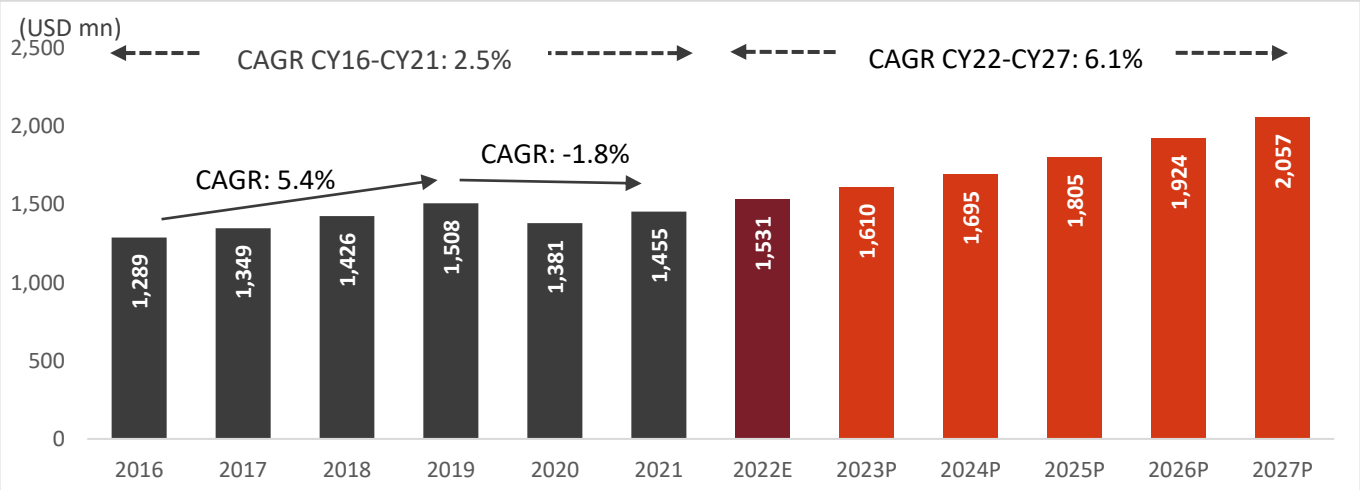
**Demand for cryogenic equipment from the energy and power industry**




*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

In the chemicals segment, industrial gases are used for polymerisation, synthesis of intermediates, systhetic gases, specialty chemicals etc. The cryogenic equipment demand from the segment has recovered from the low during the peak of the pandemic, with demand estimated to grow at 6.1% CAGR between CY2022 and CY2027 driven by increased consumption demand and a shift to lowering emissions by the sector.

**Demand for cryogenic equipment from the chemicals industry**



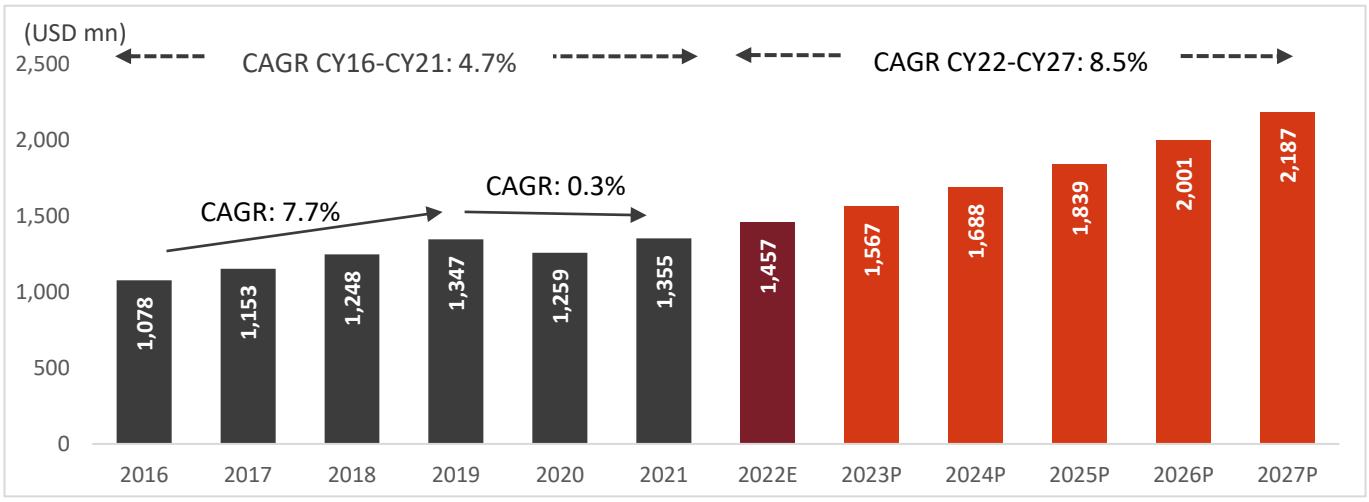

*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

While the electronics segment was the fourth-largest cryogenic equipment demand centre in CY2021, the semiconductors and consumer electronics sectors within the electronics segment are expected to post high growth. Cryogenic gases cater to an array of applications in the electronics industry, such as fibre optics, flat panel displays, integrated circuit manufacturing, packaging, assembly and testing, LED technologies, photovoltaics, printed circuit board (PCB) assembly and testing, and semiconductors.

Hence, the overall segment is expected to rise the sharpest in the cryogenic equipment basket at 8.5% CAGR over CY2022 and CY2027. Continued demand from remote working, technologies such as AI/ML, IoT, and cloud/edge computing will provide lift.

In fact, demand for cryogenic equipment from the electronics industry was not just the fastest during the pre-pandemic period, but the segment was also the least impacted during the peak of the pandemic in CY2020 and CY2021 as demand for computing devices rose sharply owing to companies shifting to work-from-home during the lockdowns. Even post lifting of restrictions, companies have continued to provide remote or hybrid work options, thereby requiring the use of multiple electronic devices, such as workstations as well as internet equipment, and for telephonic/video conferencing purposes.

**Demand for cryogenic equipment from the electronics industry**

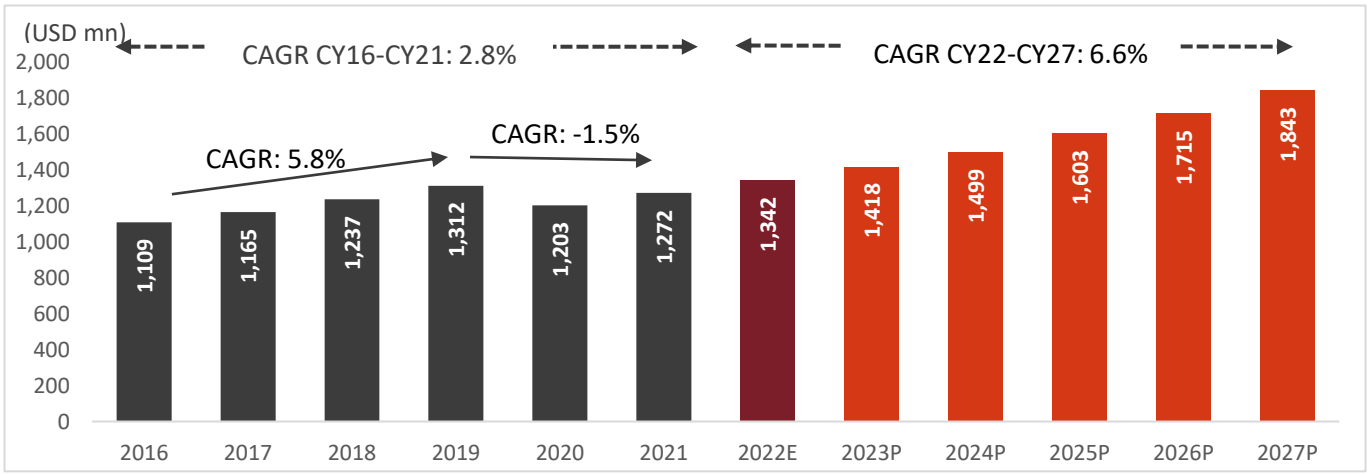



*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

Owing to large amount of emission of pollutants as well as greenhouse gases from trucks, buses, ships, and airplanes, the transport industry has come under increasing pressure to shift to low carbon alternatives. While for smaller vehicles such as two-wheelers and cars, electric or CNG are fast becoming alternative fuels, in the case of heavy transport, such as a long haul trucks, ships and airplanes, there are limitations due to the size of the batteries as well as the size/number of CNG tanks required, which increases costs and also takes up additional space and weight, leading to low utilisation. This is particularly pronounced in airplanes as weight is an important factor for efficiency. However, even for a low-margin business such as trucking, large batteries are financially prohibitive.

Hence, for long haul heavy transport fuel will need to be contained more densely (higher amount of fuel taking up less space) in smaller tanks such as LNG or hydrogen. Hence, demand for cryogenic equipment from the transportation industry is expected to grow at 6.6% CAGR between CY2022 and CY2027, with increasing shift to LNG and hydrogen fuel.

**Demand for cryogenic equipment from the transport industry**



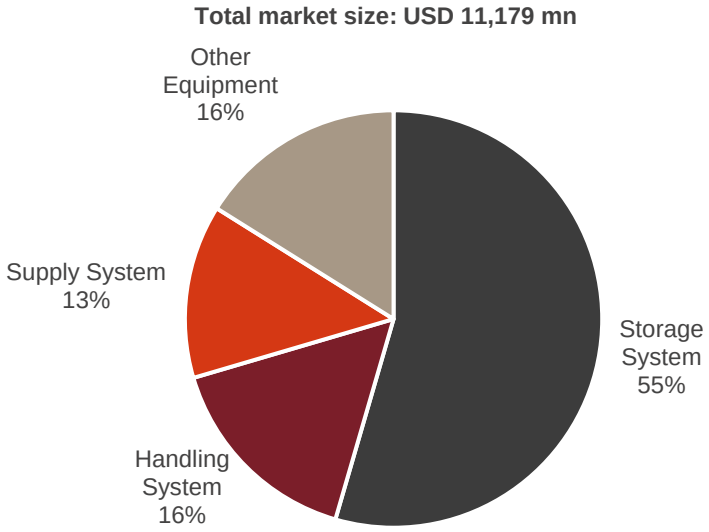

*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

## 3.6 Market size of global cryogenic equipment by type of system

The cryogenic equipment market can be segmented on the basis of storage system, handling system, supply system, and others.

Storage systems facilitate the preservation of industrial gases at cryogenic temperatures, either to be used on site or transported to the site of operation. Handling systems facilitate the movement and transfer of cryogenic fluids. A cryogenic supply system is cryogenic equipment used to feed, return, or deliver cryogenic fluids to be used in an application.

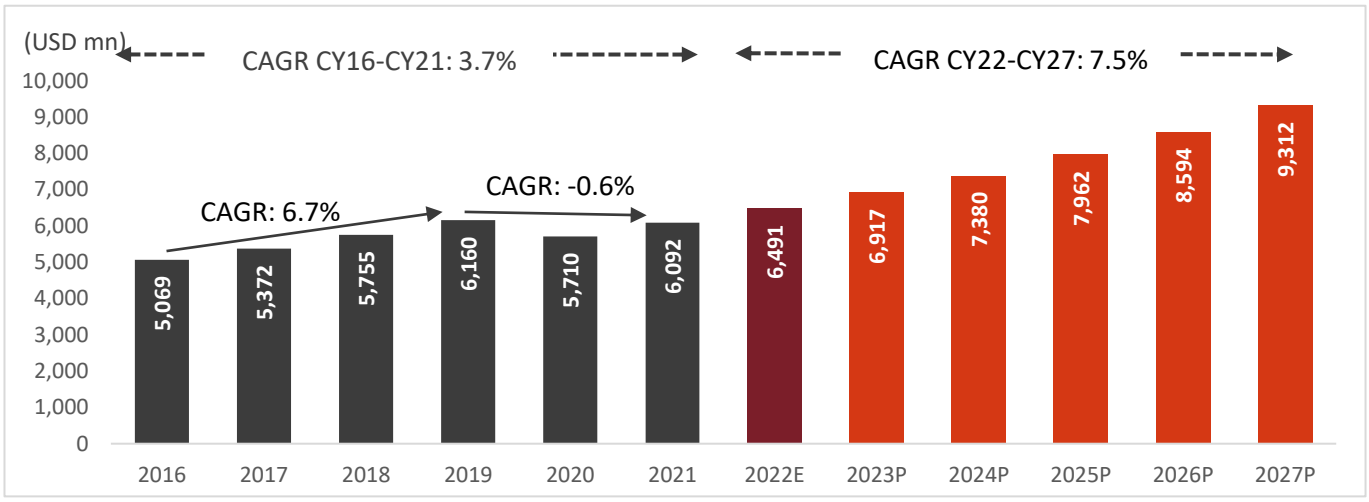
**Share of cryogenic equipment by type of system in CY2021**




*Note: Other Equipment includes: vaporizers, strainers, heat exchangers, samplers, leak detection equipment, tunnel freezers, and liquefiers*
*Source: Markets and Markets, CRISIL Research*

Storage system, which includes cryogenic tanks, dewars and pressure vessels, accounted for the largest share of cryogenic equipment market with 55% share in CY2021. Within the segment, while various types of cryogenic equipment are required for use with cryogenic gases, tanks are the primary component, wherein demand will increase proportionally with the increase in demand for cryogenic gases as tanks are used at both the production and end-use locations of cryogenic gases. Dewars facilitate dispensing or transporting cryogenic fluids in relatively small quantities with most of the applications in the healthcare industry and research and experimentation stages such as in superconductivity domain of the electronics industry. Going forward demand for cryogenic equipment from storage systems is expected to grow at a CAGR of 7.5% between CY2022 and CY2027.

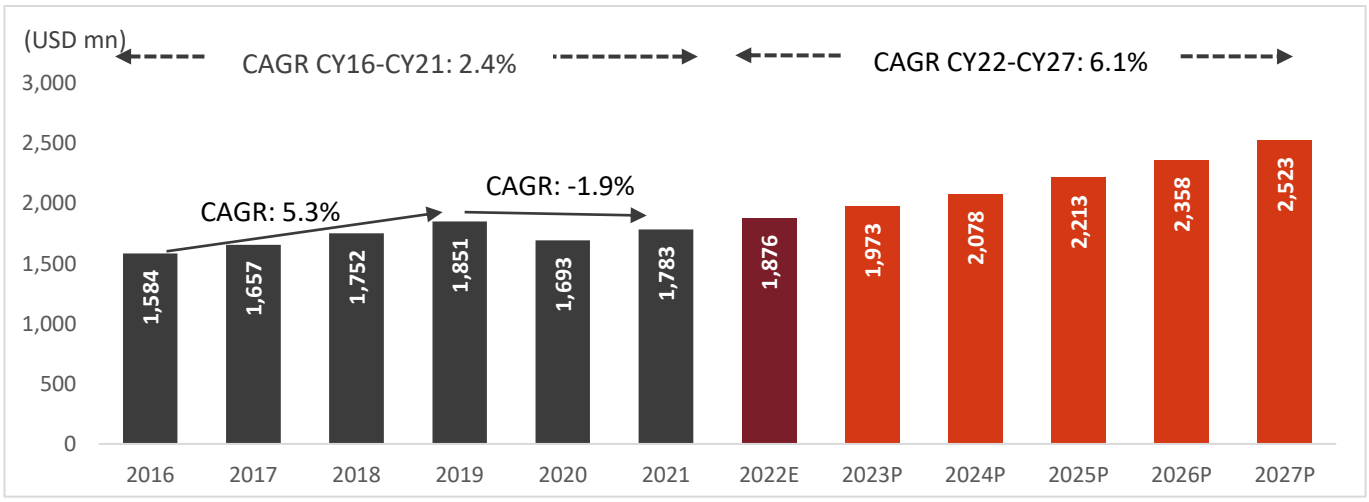
**Global demand for cryogenic storage equipment**




*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

The handling system segment accounted for 16% of the cryogenic equipment market in CY2021. Handling systems facilitate the movement and transfer of cryogenic fluids to cater to the respective application. These systems are primarily constituted by valves, regulators, and gauges, and are used in tandem with the other cryogenic systems. Going forward demand for cryogenic equipment from handling systems industry is expected to grow at a CAGR of 6.1% between CY2022 and CY2027P.

**Global demand for cryogenic handling equipment**

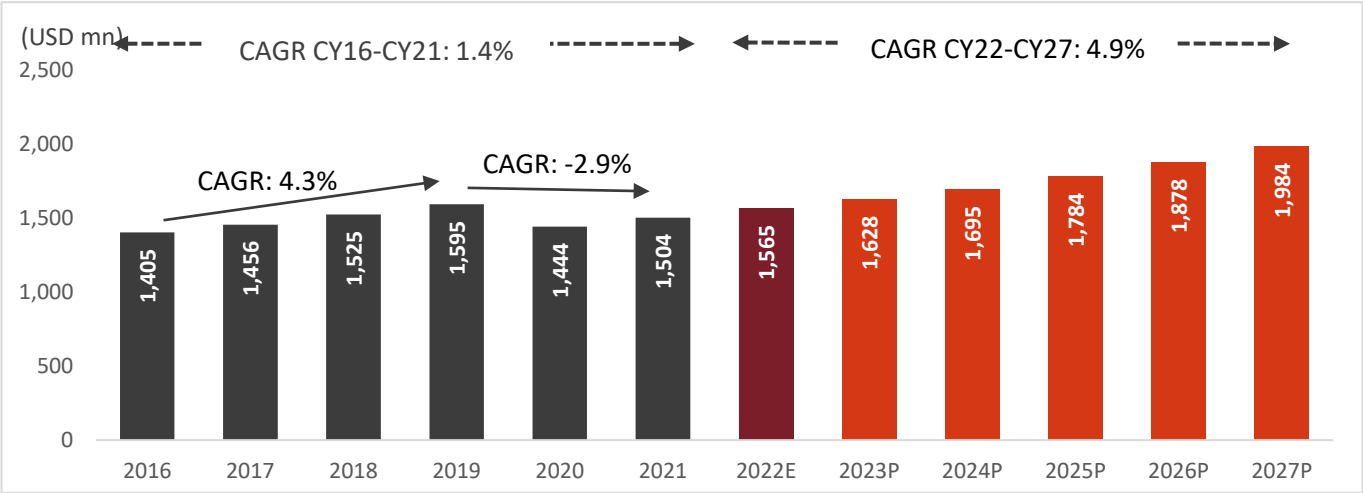



*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

The supply system segment accounted for 13% of the cryogenic equipment market in CY2021. A cryogenic supply system is a set of cryogenic equipment used to feed, return, or deliver the cryogenic fluids to be used in the respective application. These systems are composed of components/equipment such as pumps, pipes, hoses, and flanges. These components are designed and assembled to maintain consistent pressure, required flow, and purity

requirements. Going forward demand for cryogenic equipment from handling systems industry is expected to grow at a CAGR of 4.9% between CY2022 and CY2027P.

**Global demand for cryogenic supply equipment**



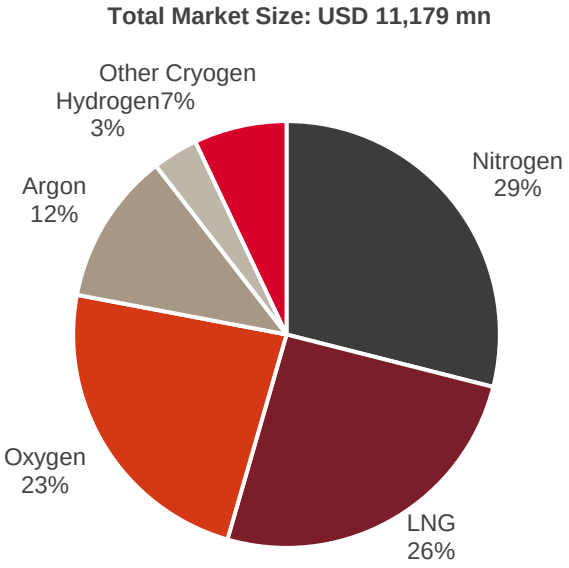

*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

## 3.7 Market size of global cryogenic equipment by cryogen

The major sources of cryogenic gases are atmospheric air, which is separated into its constituents such as nitrogen, oxygen, argon etc. by air separation units, and energy gases, such as LNG and hydrogen. While LNG, a fossil fuel, is extracted from drilling, hydrogen can be produced from renewable and non-renewable sources. While most of the hydrogen produced currently is from fossil fuels, in the long-term hydrogen produced from renewable sources i.e., “green hydrogen” is expected to increase as cost for producing green hydrogen declines. This is expected to drive demand for hydrogen as a source of clean fuel as it would be produced from fully renewable sources and also emits no pollutants during use.

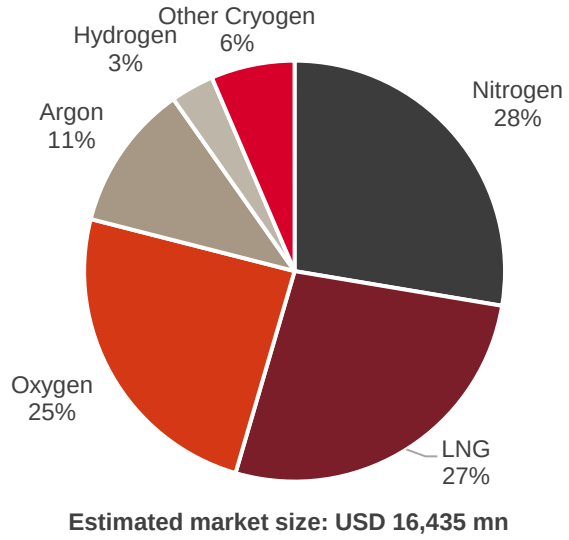
That said, nitrogen is the most widely used cryogen across industries. However, LNG, which is used as a fuel source, is seeing rising adoption as a cleaner fuel source in the global shift towards low carbon sources. Other gases that form 7% of the total demand for cryogenic equipment are helium, nitrous oxide, ethylene, and carbon dioxide.

**Share of cryogenic equipment by cryogen in CY2021**




*Source: Markets and Markets, CRISIL Research*

**Share of cryogenic equipment by cryogen in CY2027**



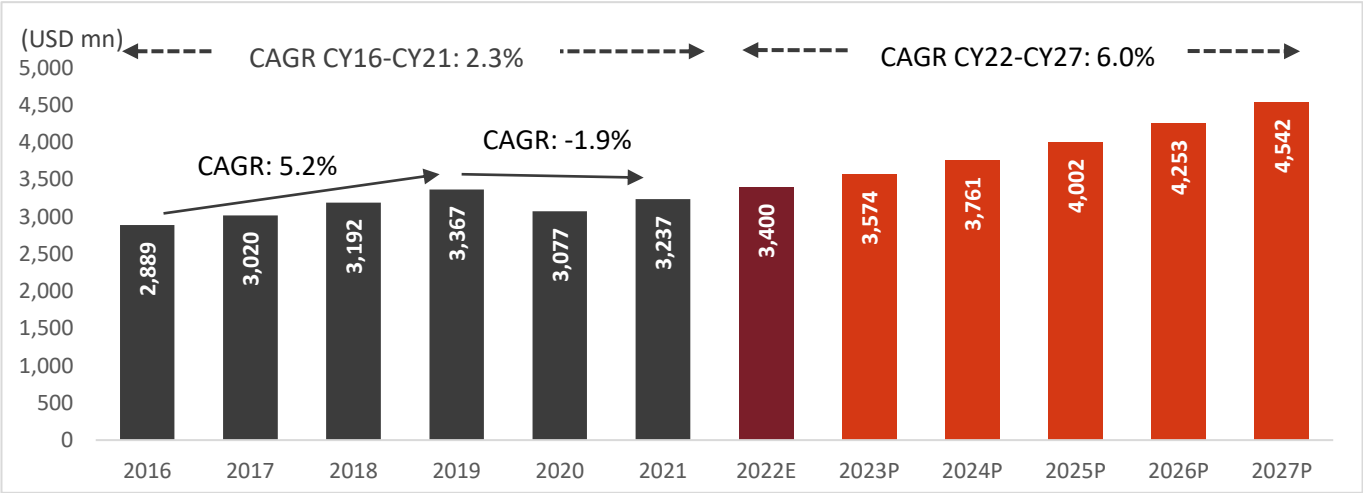

*Source: Markets and Markets, CRISIL Research*

Nitrogen, which comprised 29% share of the cryogenic equipment market in CY2021, has wide application in industries and for medical use owing to its high availability in the atmosphere and its inert nature. Nitrogen is used in the energy and power industry for enhanced oil recovery. It is also used in fertilisers as a feedstock and chemical industries. Demand for liquid nitrogen equipment, though, dipped during peak of the pandemic in CY2020 and CY2021 as industrial demand slowed.

However, between CY2022 and CY2027P, demand for cryogenic equipment from liquid nitrogen is expected to grow at 6% CAGR. Demand for liquid nitrogen equipment is expected to be driven by the electronics, energy and

power, and chemical industries. Regionally, growth is expected to be faster in the Asia-Pacific and North American regions.

**Global demand for cryogenic equipment from nitrogen segment**

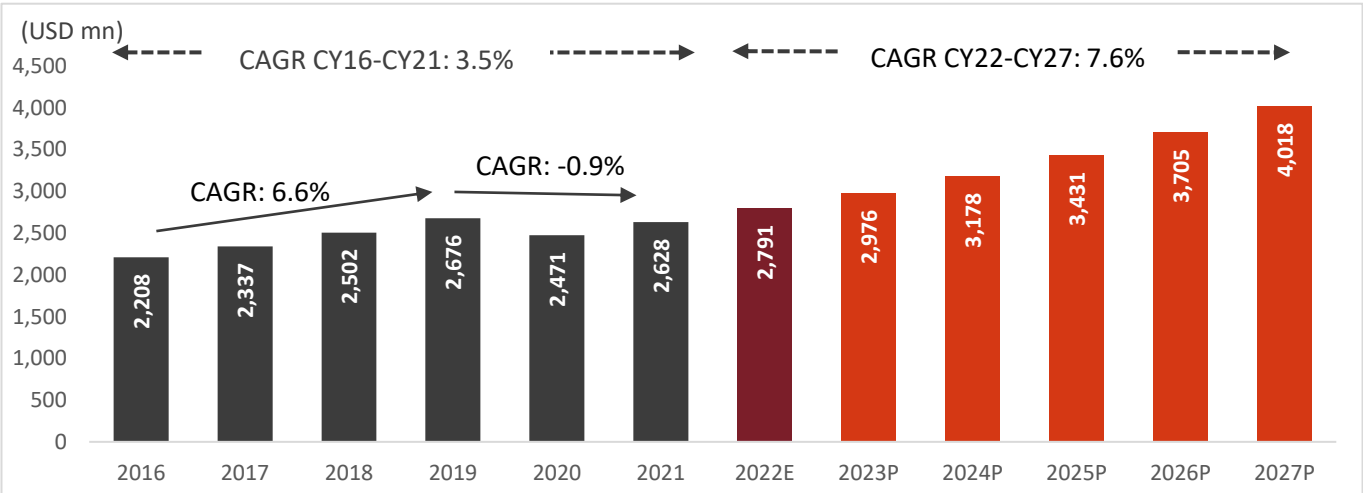



*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

Oxygen is also abundantly available in the atmosphere and has a key role in combustion and the oxidation processes in industries such as metallurgy. It also finds use in aerospace, petrochemical, and medical applications. In CY2021, the gas accounted for the third largest market share of the global cryogenic equipment market.

Between CY2022 and CY2027P, demand for cryogenic equipment of liquid oxygen is expected to grow the second-fastest, at 7.6% CAGR. Electronics and metallurgy industries are projected to be the key demand drivers for oxygen-related equipment.

**Demand for cryogenic equipment from oxygen segment**



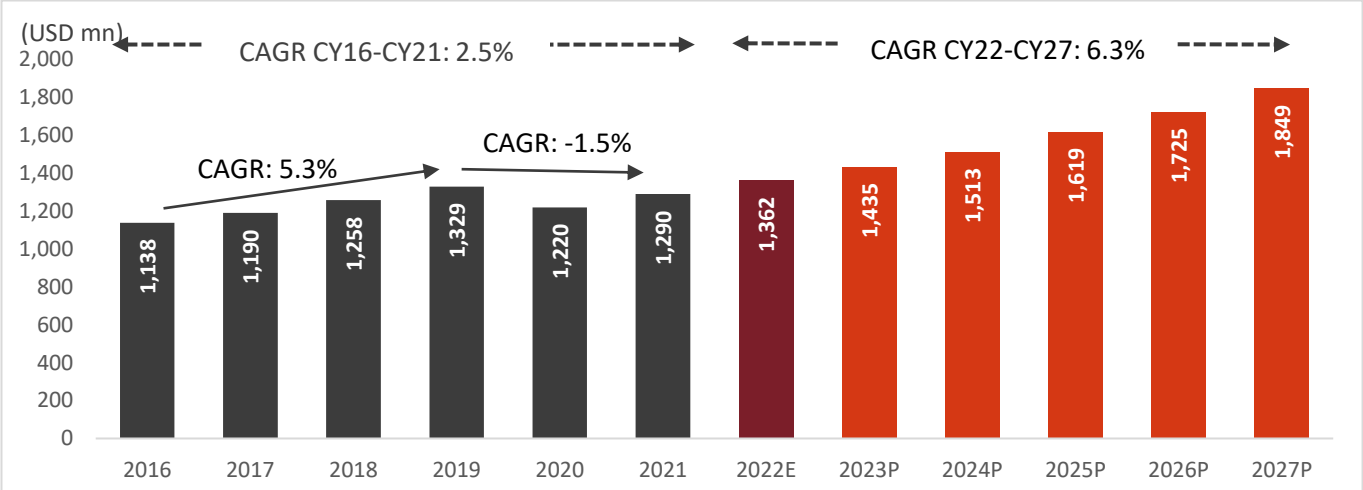

*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

Argon is an inert gas and is rarely found in the atmosphere, thus making it expensive to produce. Argon is used critical industrial processes, such as manufacturing of high-quality stainless steel and production of impurity-free

silicon crystals for manufacturing electronics. In fact, liquid argon is extensively used in the semiconductors industry. Other applications of liquid argon include fabrication of specialty alloys, lasers, and metals. It has medical applications as well, specifically in cryosurgery and situations that require an inert environment. The gas also provides an environment inert from oxygen and nitrogen for annealing processes.

From CY2022 to CY2027, demand for cryogenic equipment from the liquid argon segment is expected to grow at 6.3% CAGR. Rising demand for electronics will drive demand for argon and hence, demand for cryogenic equipment. Asia-Pacific and North America are expected to be key regions driving demand for liquid argon.

**Demand for cryogenic equipment from argon segment**



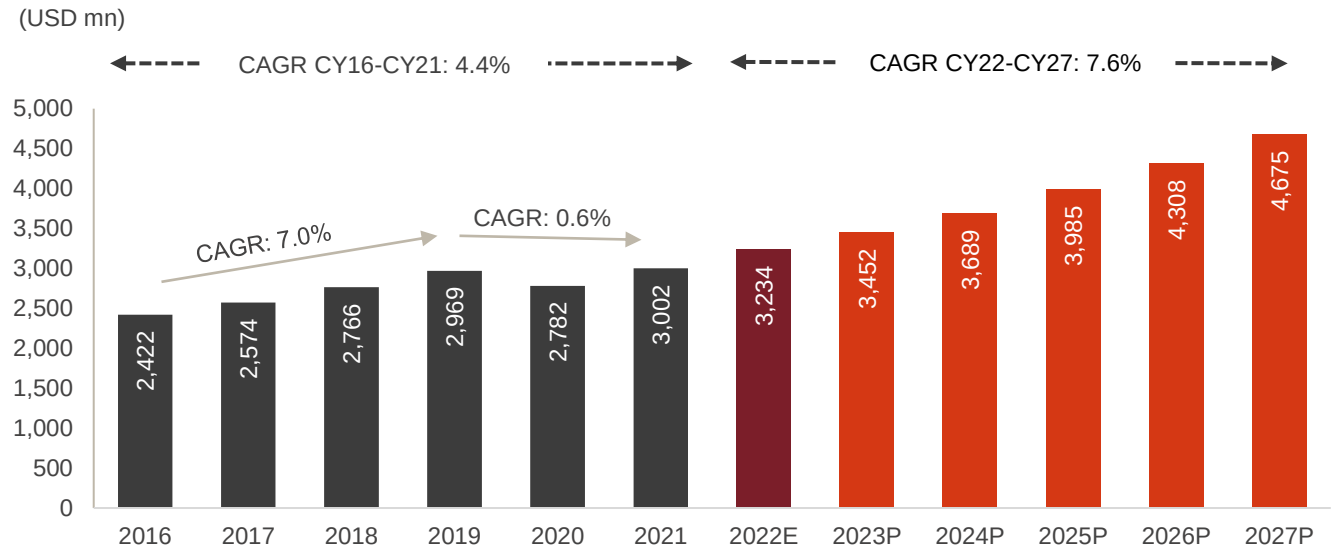

*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

Cryogenic equipment demand from the LNG segment was $3 billion in CY2021. Natural gas, which is largely methane, is cooled, thereby converting into a liquid, also known as LNG. The cooling reduces natural gas' volume by 600 times, thereby making it cheaper to transport. While LNG is reasonably costly to produce, advances in technology are reducing costs associated with liquefaction and regasification. LNG is primarily used as an energy source for heating and electricity generation. It also has other uses such as feedstock in fertilizer and hydrogen production.

But with rising investments in LNG infrastructure, both for use as a fuel and as a source of 'blue hydrogen' – hydrogen produced from fossil fuels, but with carbon produced in the process captured and stored instead of releasing it into the environment – the demand for cryogenic equipment from LNG is expected to post the fastest growth among cryogens over the long term.

Between CY2022 and CY2027, demand for cryogenic equipment from LNG is expected to grow at 7.6% CAGR. While shift to cleaner fuels is expected to drive demand in developed regions like the EU and the US, higher growth is expected from Asia-Pacific, in line with fast growing developing economies with rising need for electricity.

**Demand for cryogenic equipment from LNG segment**



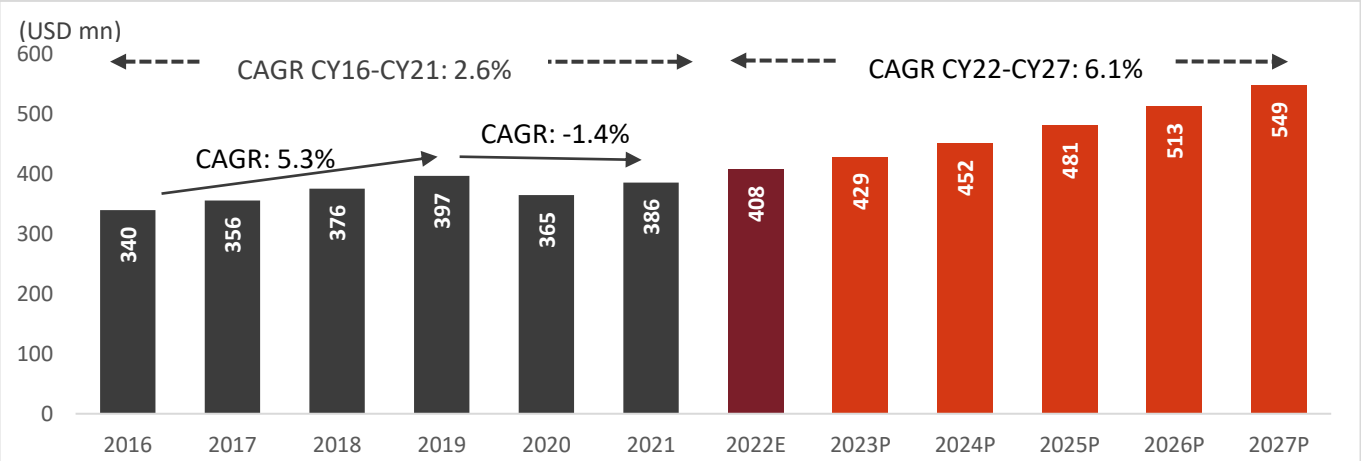

*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

Hydrogen is the lightest gas and, hence, occupies substantial volume under standard pressure conditions; liquefaction by cooling the gas can significantly reduce the volume. Storing in cryogenic tanks maintains the temperature of liquid hydrogen. Hydrogen is widely used in chemical and petroleum refining industries.

While demand for cryogenic equipment from the hydrogen segment accounted for 3.5% share of the global cryogenic equipment market in CY2021, given the potential for hydrogen applications and investments in R&D to reduce the cost of producing hydrogen as well as investments in processes to make use of greener sources of fuel, the share of demand for cryogenic equipment from the hydrogen segment is likely to continue to expand.

Between CY2022 and CY2027, cryogenic equipment from liquid hydrogen is expected to grow at 6.1% CAGR, driven by the electronics, metallurgy, and energy and power segments.

**Demand for cryogenic equipment from hydrogen segment**

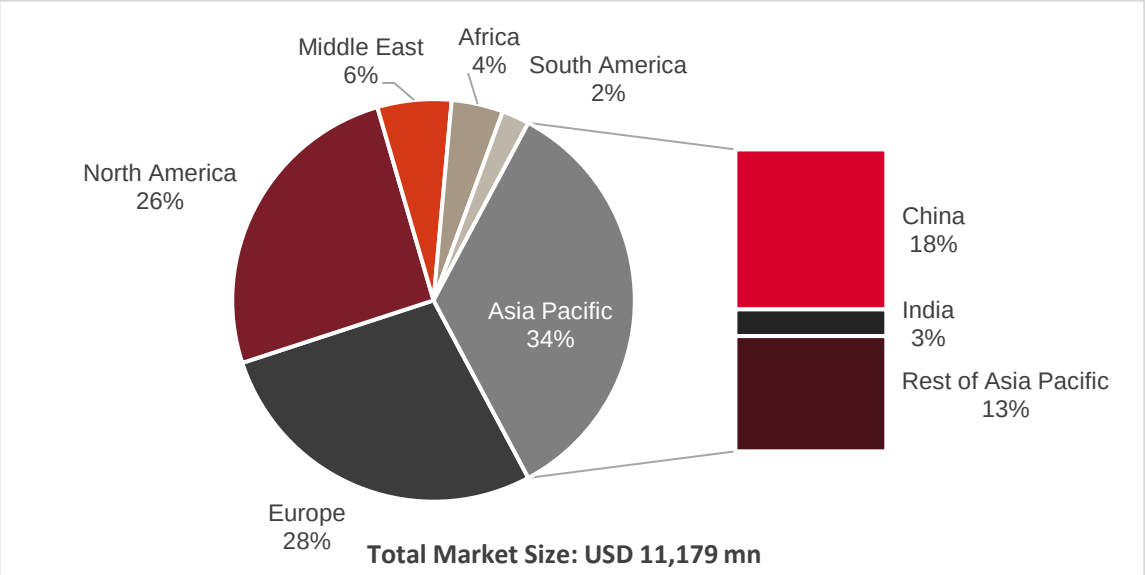



*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

## 3.8 Market size of global cryogenic equipment by region

Asia-Pacific is the largest market for cryogenic equipment, with 34% share. About half of this is from China owing to its large industrial sector, which requires considerable volume of industrial gases, as well as significant investments in LNG infrastructure.

**Share of demand for cryogenic equipment region-wise in CY2021**

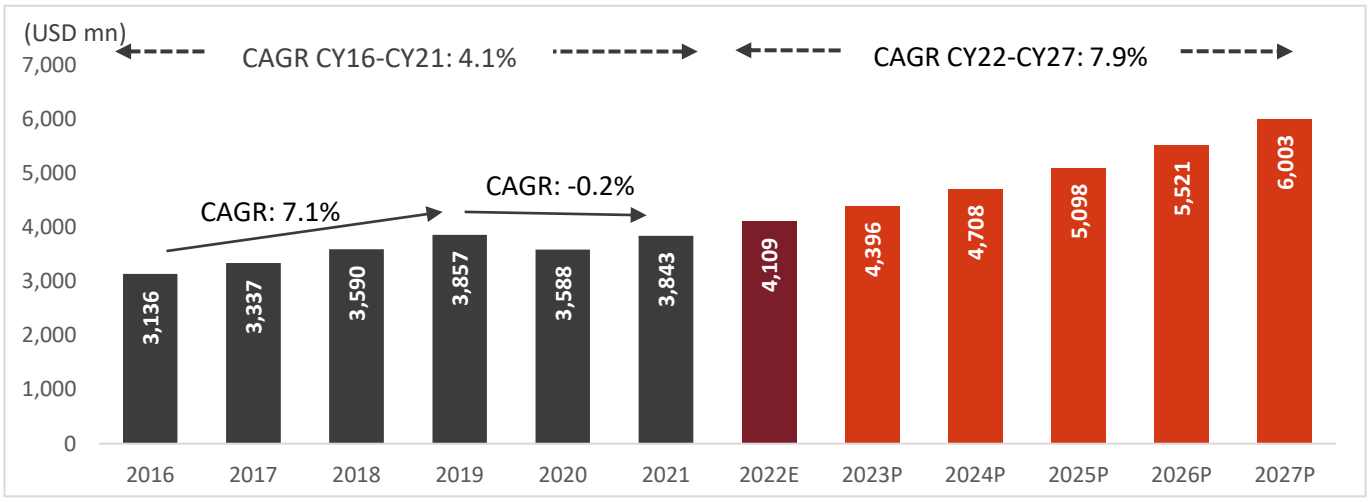



*Source: Markets and Markets, CRISIL Research*

The Asia-Pacific region is not only the largest market for cryogenic equipment, it is also projected to be the fastest growing between CY2022 and CY2027. Demand is expected to be driven by China and Japan, followed by India.

Demand for cryogenic equipment in the region is majorly driven by LNG demand with increasing focus on shift to low carbon techonologies in industry as well as transportation. The market in China is driven by development of LNG infrastructure projects, rising LNG demand in Japan and natural gas production operations in Australia. Increase in production of metals for infrastructure development is driving demand for gases such as oxygen in China and India. Rising demand for semiconductor manufacturing in China and India is expected to drive demand for nitrogen, oxygen, argon and hydrogen which are used in electronics manufacturing. Investments in space and satellite applications in India are expected to drive demand for oxygen, hydrogen and LNG. Hence demand for cryogenic equipment from Asia Pacific is expected to grow at a CAGR of 7.9% between CY2022 and CY2027.

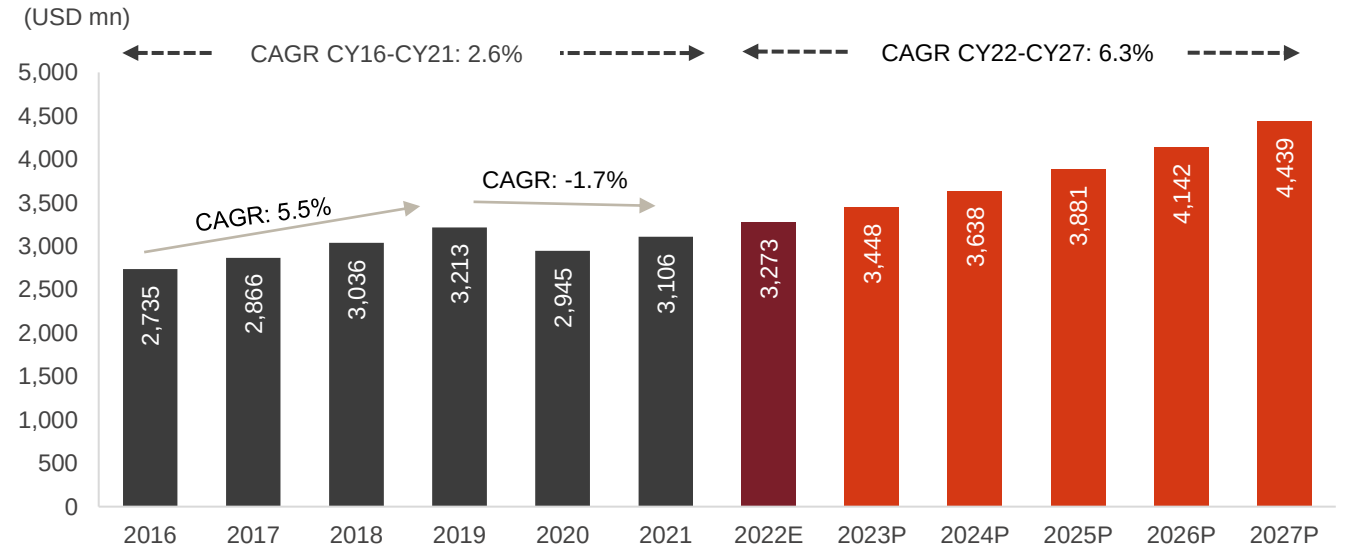
**Demand for cryogenic equipment in Asia-Pacific**




*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

Europe is the second largest region for cryogenic equipment. Growth in the region between CY2022 and CY2027 is expected to be strong at 6.3% CAGR, though slightly lower than Asia-Pacific and North America. Developments in LNG gas infrastructure in Europe, modernisation of Germany's healthcare industry, and European nations' efforts to achieve net zero emission will drive demand for LNG and Hydrogen cryogenic equipment. Overall, demand for cryogenic equipment is expected to be driven by the electronics, metallurgy and energy and power segments.

**Demand for cryogenic equipment in Europe**



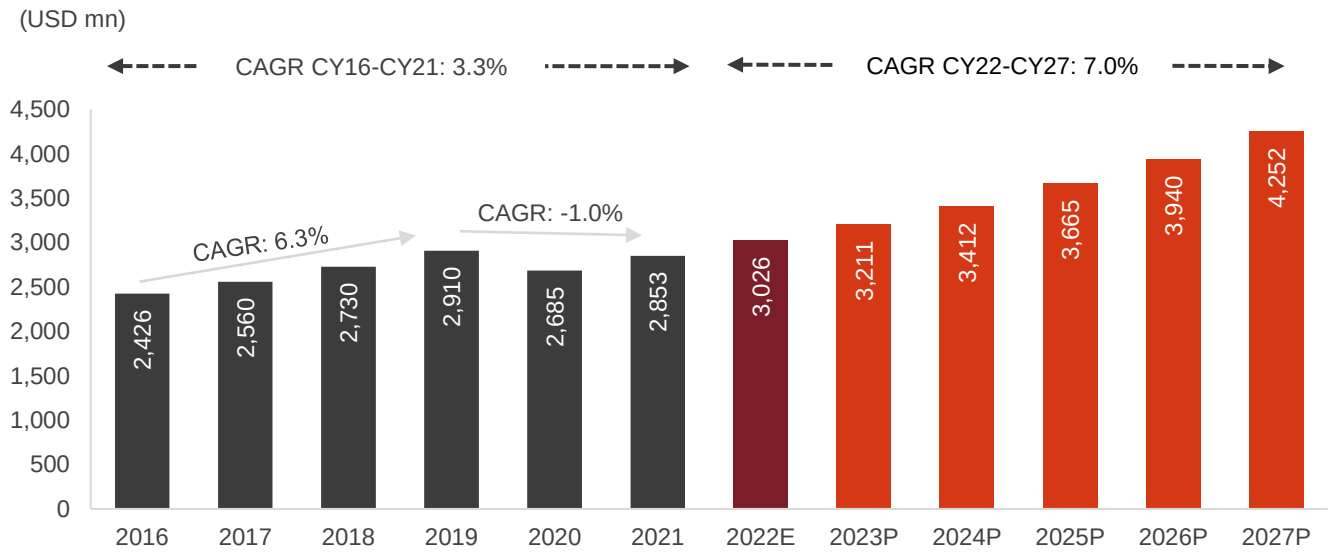

*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

In the case of North America, the cryogenic equipment market is expected to be driven by demand from the electronics, and energy and power sectors. There have been significant investments in the clean energy space in the region, with several start-ups and industrial and energy majors looking to find solutions to the climate change issue. Also, the severe chip shortage owing to the fallout from the pandemic has highlighted the need to be self-

reliant for high-tech industries to maintain technological and economic leadership, with many discussions between political leaders and the electronics industry to bring critical processes such as chip manufacturing to the US.

With rising production of natural gas, the volume of natural gas exports (majorly LNG) has grown significantly as well. Also, the shale boom and reshoring of manufacturing in the US, growing chemicals and plastics sectors in Canada, and demand from onshore and offshore fields in the Gulf of Mexico are expected to propel growth of the cryogenic tanks market in the region.

**Demand for cryogenic equipment in North America**




*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

# 4 Domestic cryogenic equipment industry

## 4.1 Regulations and government policies impacting demand for cryogenic gases

### Regulation driving shift towards cleaner fuels

The Paris Agreement, which has been ratified by India, set an objective of limiting global temperature rise this century to well below $2^0$ Celsius over pre-industrial levels, and to pursue efforts to limit temperature increase further to $1.5^0$ Celsius. To achieve this target would require a significant increase in the share of zero or low emission vehicles.

This target, combined with growing environmental and sustainability awareness among the population, is expected to transform the global auto industry from internal combustion engines to green mobility, such as hybrid vehicles, electric vehicles, fuel cell vehicles, and alternative-fuel vehicles.

Regulations on fossil fuel can have two types of impact:

- Direct impact: where the regulations mandate use of cleaner fuels such as ban on diesel commercial vehicles in Delhi that cause an abrupt shift to alternate fuels
- Indirect impact: where the regulations on emission control or monitoring such as fuel efficiency and Bharat Stage (BS) emission norms which increases cost of ownership of such devices / vehicles reducing their economic competitiveness via-a-vis other fuel options which cause a gradual shift towards alternatives.

While the natural gas demand for smaller vehicles such as cars, UVs, 3W, small commercial vehicles and intermediate commercial vehicles is mostly in compressed natural gas (CNG) form the demand for natural gas is likely to increase and any shortfall is likely to be met with LNG imports driving demand for cryogenic equipment for LNG transport and handling.

#### 4.1.1. CAFE norms for passenger vehicles to increase fuel efficiency

While Bharat Stage (BS) norms target pollutant emissions such as hydrocarbons, nitrous oxide, particulate matter etc, fuel efficiency norms target carbon emission by limiting the $CO_2$ emissions from vehicles. In India, fuel standards for vehicles came into force in April 2017 for petrol, diesel, liquefied petroleum gas and CNG PVs. These standards are based on the corporate average fuel efficiency (CAFÉ) system rather than specific vehicle level emission limits, and targets to improve the fuel consumption of PVs by 2022 gradually over a period of time.

The first phase of the regulation was implemented on April 1, 2017 with the introduction of BS-IV emission norms. It was decided that the highest permissible carbon footprint would be 130 gm per km till March 2022. In the second phase, starting April 2022, it would be reduced to 113 gm per km. The investment required to make the vehicles more fuel efficient will add to the cost of vehicles to the end users eventually. This is expected to incentivise the shift towards greener technologies such as natural gas and electric vehicles as OEMs will find it increasingly difficult to meet the norms with petrol and diesel vehicles alone, which in turn, will increase demand for natural gas.

### 4.1.2. Transition from BS-IV to BS-VI

BS emission standards are issued by the government to regulate the output of air pollutants from motor vehicles. In January 2016, the government decided to skip BS-V and transition directly to BS-VI norms. It fixed the deadline of April 1, 2020 for manufacturers to commence vehicle production compliant with the BS-VI emission norms.

**BS-VI regulations demand major reduction in PM and NOx levels for passenger vehicles**

| Type of Vehicle | Unit | BS IV | BS VI | Change |
|---|---|---|---|---|
| **Diesel** | | | | |
| HC | gm/km | 0.3 | 0.17 | **-43%** |
| NOx | gm/km | 0.25 | 0.08 | **-68%** |
| PM | gm/km | 0.025 | 0.0045 | **-82%** |
| **Petrol** | | | | |
| NOx | gm/km | 0.08 | 0.06 | **-25%** |
| PM | gm/km | - | 0.0045 | **Newly added** |

*HC: Hydrocarbon, NOx: Nitrogen oxides, PM: Particulate matter*
*Note: HC, NOx, and PM refer to pollutants from the vehicle exhaust*
*Source: ARAI*

**Addition of devices and subsystems in a BS-VI compliant vehicle**

| Pollutant | Devices / Subsystems to be included to reduce the Pollutants |
|---|---|
| NOX- Nitrous oxide | ▪Exhaust Gas Recirculation<br>▪Selective Catalytic Reduction<br>▪3 way catalyst<br>▪Lean NOx Trap |
| HC- Hydrocarbons | ▪Secondary Air Injection<br>▪3 way catalyst<br>▪Diesel Oxidation Catalyst<br>▪Purge Control Valve<br>▪Canister |
| PM- Particulate matter | ▪Diesel Particulate Filter<br>▪Gasoline Particulate Filter |

*Source: CRISIL Research*

BS-VI compliant PV prices increased 2-4%, with the cost of diesel variants rising more than other fuel variants. Adding of devices and systems to reduce emission levels adversely affected prices of such vehicles driving a shift towards natural gas vehicles increasing natural gas demand.

### 4.1.3. CV Emission norms

In February 2016, the government decided to skip the BS-V emission standards and move directly to BS-VI norms by April 2020. The stringent BS-VI norms incorporate substantial tightening of nitrogen oxides (NOx) and particulate matter (PM). These emission standards pushed vehicle prices higher — diesel trucks and buses segment witnessed a higher rise in costs due to the significant upgradation of engines and exhaust systems.

According to our estimates, implementation of the BS-VI norms will result in a 12-15% hike in the cost of diesel trucks. Percentage increase in vehicle price for BS-VI models over BS-IV was more pronounced in LCV trucks and buses and relatively lower for tractor trailers and MAVs. As the BS-VI norms were implemented in April 2020, the increase in vehicle prices and subdued finance availability resulted in a sudden increase, both in the initial cost of acquisition and total cost of ownership of vehicles running on diesel. This has been driving a shift towards more economical natural gas vehicles, increasing the demand for natural gas.

### 4.1.4. Fuel efficiency norms of heavy commercial vehicles likely to be enforced in fiscal 2023

To make heavy-duty trucks and buses more fuel efficient, the Ministry of Petroleum and Natural Gas and the Ministry of Heavy Industries are in talks to notify fuel efficiency norms. We expect the norm to be enforced in fiscal 2023. Based on talks with stakeholders, BS-IV-compliant diesel vehicles of categories M3 and N3, with GVW of 12T and above, will have to comply with these norms. Unlike the CAFÉ system for passenger vehicles, commercial vehicles are required to meet the 'target diesel fuel consumption' value for a specific set of speeds, which is dependent on the vehicle’s GVW, axle configuration, and category. While the implementation system is different the increasing pressure to reduce carbon emissions by increasing fuel efficiency is likely to increase the cost of such vehicles reducing their competitiveness vis-à-vis natural gas and electric vehicles.

### 4.1.5. Types of gas pricing in India

Natural gas pricing in India has undergone a sea change from being fixed by the government in the early 1970s to greater market determination (based on formulas linked to international prices) of prices. There are broadly two pricing regimes for gas in the country - domestically produced gas and imported LNG.

### 4.1.6. Domestic gas pricing mechanism

Administered Pricing Mechanism (APM) gas is produced from gas fields awarded by the Government to entities on nomination basis prior to the Production Sharing Contract (PSC) regime. The prices of gas produced from these fields were administered by the Government. Landfall price of APM gas was fixed at $1.79 per mmbtu (on Net Calorific Value (NCV) basis) till May 2010, post which it was increased by the government to $4.2 per mmbtu (on NCV basis).

On October 18, 2014, the Cabinet Committee on Economic Affairs (CCEA) approved a new mechanism for determining the price for domestic natural gas where, the domestic price of natural gas is the volume weighted average of gas prices at Henry Hub, Alberta Gas Reference Point, NBP and Russia. Prices at the three trading hubs/Russian domestic price will be deducted by $0.5 per mmbtu to account for transportation and treatment charges.

Gas prices are determined on a half-yearly (April and October) basis and based on trailing four quarter prices at these hubs, with a one quarter lag. For instance, prices for April to September will be based on the average prices over January to December in the previous year.

Based on the new pricing mechanism, domestic gas prices were revised downward for the October 2015-March 2016 period, to $3.82 per mmbtu (on Gross Calorific Value (GCV) basis) from $4.66 per mmbtu (on GCV basis) earlier. Post that, prices were further downward revised to $3.06 per mmbtu (on GCV basis) for the April 2016-September 2016 period, reflecting weakness in global gas prices. The prices for the period, April-September 2017 had been fixed at $ 2.48 per mmbtu. The prices were further revised to $ 3.36/mmBtu from October 2018 - March 2019, compared with $3.06 from April 2018 - September 2018, reflecting a recovery in global market. Currently, domestic gas prices are at $2.39 per mmbtu, revised for the period April-September 2020.

Also, new discoveries (made post October 2014) in deep and ultra-deep-water areas and areas with high temperature-high pressure would be allowed a premium over this base price. Gas produced from such fields would be allowed marketing and pricing freedom, however its price will be capped based on the price of substitute fuels such as fuel oil, imported coal, naphtha and imported liquefied natural gas (LNG). For the period April 2020-September 2020, the price ceiling for gas produced from these fields is fixed at $5.61 per mmbtu (on GCV basis). Price ceiling on gas price prevents price shocks to gas customers who will find it beneficial to use gas during energy price volatility.

### 4.1.7. R-LNG pricing

In India, at present, Petronet LNG is the only player in the regasified liquefied natural gas field with long-term contract, for sourcing 8.5 mtpa LNG from Rasgas Qatar. Until December 2009, the FOB price of LNG from RasGas was capped at $2.53 per mmbtu after which, the price has been linked to the price of Japanese Crude Cocktail (JCC) and was to be determined as per an agreed formula. As a result, FOB prices of long-term LNG increased gradually to $13.7 per mmbtu in 2014-15.

However, on December 31, 2015, Petronet LNG (PLL) renegotiated the terms of its long-term LNG supply contract with Rasgas, Qatar. Rasgas agreed to modify the formula for calculating the LNG price, which led to the reduction of the LNG price by half; it also waived off the penalty for low volume offtake in 2015. On the other hand, Petronet LNG committed to increase the volume of LNG to be purchased from Rasgas.

As per the renegotiated contract, the basis for calculating the LNG price has been modified to make it more responsive to recent crude oil price (Dated Brent) movements. Under the earlier contract, the cap and floor price for crude oil was set based on the average price for the preceding 60 months. While this mechanism limited volatility in the contracted LNG price, it also prevented a sharp correction in the contracted LNG price in 2015, despite crude oil price declining by almost half.

From January 2016 onwards, the average crude oil price of only the previous three months is considered to calculate LNG price. While this has made LNG price much more volatile compared to the earlier formula, it has also led to almost a 50% decline in LNG price.

Domestic gas prices averaged at $2.1 per mmBtu (metric million British thermal unit) in fiscal 2021 compared to $2.5 per mmBtu in fiscal 2020. The decline in prices was due to subdued gas prices at different international gas hubs. For the first half of fiscal 2022 i.e. from April-September 2021, domestic natural gas price was at $1.8/ mmBtu, due to lower prices at international gas hubs as a result of supply glut. Considering the sustained over-supply, lower prices and lower demand due to Covid-19 restrictions, prices in second half (October 2021-March 2022) settled at $2.9/ mmbtu mark. In fiscal 2022, spot LNG prices have averaged at $16.8/ mmbtu, (although prices have increased between December and February due to high heating demand with onset of winter). Spot

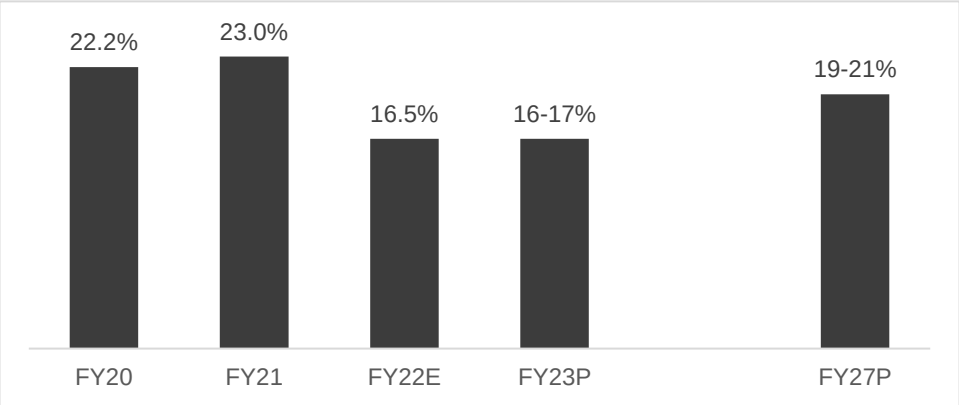
LNG price touched to all-time high of US$38/mmbtu in August due to significant increase in demand from Northern Asia along with logistics constraints. Though, spot LNG price corrected from those levels in a month but higher LNG price in recent months took a toll. Global LNG storage level depleted sharply over the last 6 months. European LNG storage declined to 29.8% (332TWh) in Apr'21 compared to 92% in Nov'20 (1,033TWh). Similarly, the case with others as well where non-EU storage also declined to 35% level from 75% in Nov'21.

**Impact on R-LNG pricing on demand for power from natural gas**

With declining domestic gas production and power not being a priority sector any more for domestic gas, the generation from gas plants has become costlier owing to high prices of re-gasified liquid natural gas (RLNG). The variable cost of generation from RLNG would be more than Rs 10 per kWh as against Rs 2-3 per kWh for coal-based plants. Even after the government's initiative to support RLNG-based power generation until March 2017, the average plant load factor (PLF) for gas-based plants remained low at 22.5% over the past three years, with the private sector plants operating at even lower PLF of 15.4% in fiscal 2021. However, PLF for gas-based plants improved to ~22.97% in fiscal 2021, on account of improvement in gas supply and cheaper gas prices.

However, in fiscal 2022, gas consumption from the power sector declined, as PLF declined to 16.5% owing to higher LNG prices. Due to continued higher gas prices in fiscal 2023, gas-based power plant's PLF is expected to remain low at 16-17%. Therefore, gas consumption from this sector is expected to remain subdued.

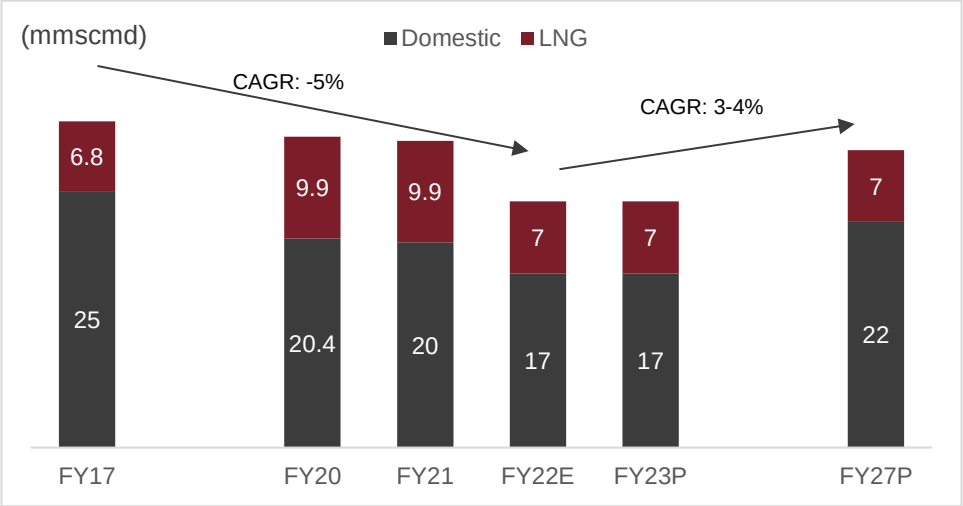
**Plant load factor for gas-based power plants**




*Note: E: Estimated; P: Projected*
*Source: CRISIL Research*

Our long-term forecast: We expect gas demand to decline at 3-4% CAGR between fiscals 2022 and 2027, to 29-30 MMSCMD, owing to a low base of fiscal 2022, when consumption dropped because of higher LNG prices. In the long run, gas-based power plants' PLF is expected to increase marginally from low levels of fiscal 2022. Therefore, demand is expected to increase, but average PLF of gas-based plants is expected to remain low at 19-21%. Lower PLF, given the lower competitiveness of gas against its alternates, will lead to muted demand from the power segment.

**Plant load factor for gas-based power plants**




*Note: E: Estimated; P: Projected*
*Source: CRISIL Research*

### 4.1.8. LNG as an auto fuel and fuelling infrastructure key to LNG adoption for auto sector

In 2017, the government notified the use of LNG as an auto fuel by amending the Central Motor Vehicle Rules (CMVR), which paved the way for manufacturers to develop vehicles using LNG. Further in 2018, the Gas Cylinder Rules were amended to include Auto LNG (LNG meant for automotive fuel) under its regulatory framework. Trials for the first LNG bus was held in November 2016 to test the feasibility of LNG powered vehicles. However, there has not been any siginificant market development on this till now either on the auto-LNG dispensing station or on LNG vehicle availablility side. This is a chicken and egg story as LNG vehicles can't operate without auto-LNG dispensing stations hence LNG vehicles are unlikely to be launched commercially. While auto-LNG dispensing station setup without vehicles to supply to will be a loss-making affair.

This deadlock was broken in November 2020 with the Government of India kicking off construction of 50 LNG fuel stations along the golden quadrilateral connecting the four corners of the country. In phase-I, 50 LNG stations have been awarded of which, Indian Oil will set up 20 LNG Stations, while Bharat Petroleum and Hindustan Petroleum will set up 11 LNG stations each while the rest are being set up by Gujarat Gas and JV of GAIL with OMC's. These are mostly expected to be setup on the western side of the golden quadrilateral on the Delhi-Mumbai, Mumbai-Bangalore, Bangalore-Kochi and Chennai-Kolkata route. This will serve as an important first step to developing an LNG ecosystem for automobiles.

In phase-II, 50 more stations are expected to be awarded which are expected to be along the Delhi-Kolkata and Mumbai-Indore route. Further, 900 more stations connecting the major highways are expected to be awarded to ensure that the major freight carrying routes along the length and breadth of the country will be covered over the next three years. A total of 1,000 stations are planned with a total expenditure of Rs.100 bn to setup with LNG stations along the national highway network, industrial corridors, and mining areas of the country.

Auto-LNG dispensing station are being setup in phases along the golden quadrilateral as these stations will require LNG to be supplied though LNG tanker trucks which will carry LNG from large LNG terminals located along India's coastline which are supplied with LNG from LNG bulk tanker ships. Unlike CNG stations which can operated with piped natural gas, LNG stations will not be able to do so as cost of liquefying piped natural gas will add to cost

significantly. One major benefit of setting up LNG fuel stations along the goldern quadrelateral especially along the coastline is that the closer they are to the LNG terminals lower will be the cost of transporting fuel to these stations.

**Exising LNG Terminals**

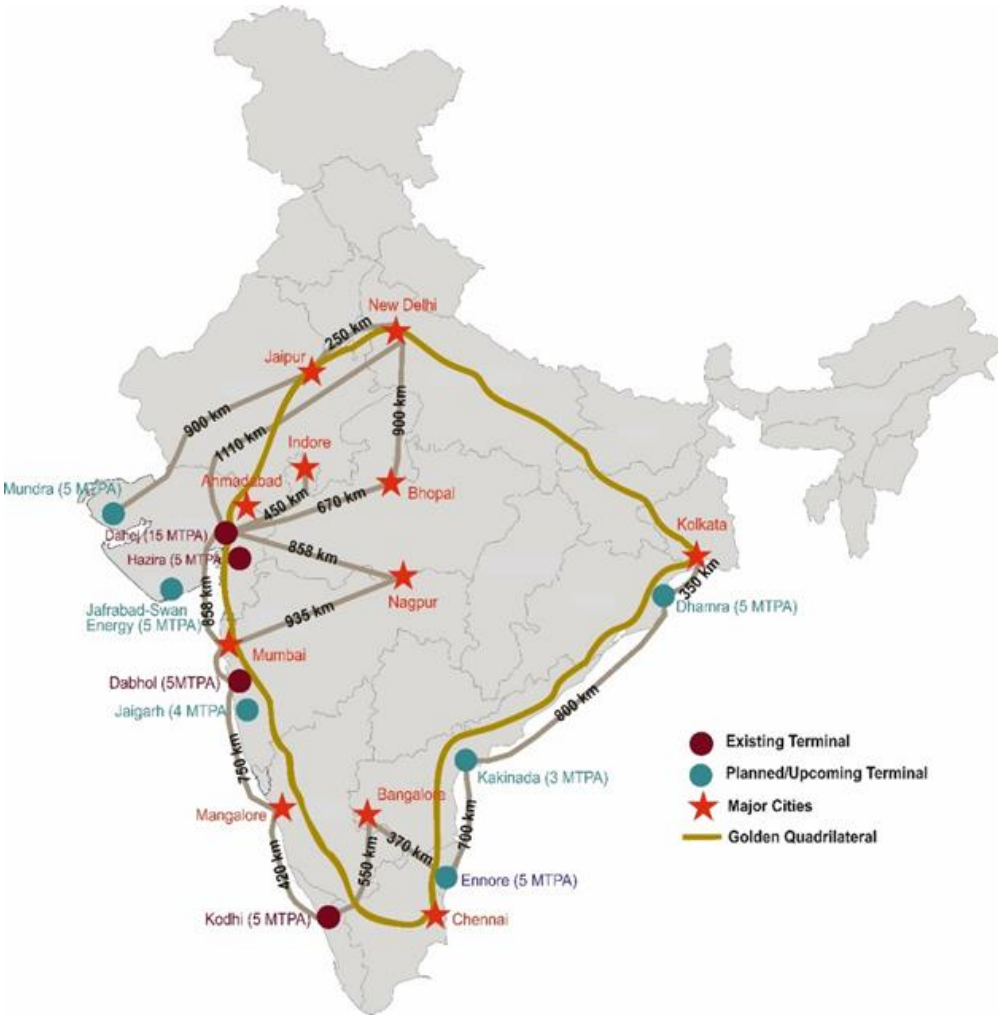
| LNG terminal | Entity/ promoters | Capacity | Year of commissioning |
|---|---|---|---|
| Dahej | Petronet LNG | 17.5 | 2004 |
| Hazira | Shell Energy | 5 | 2005 |
| Dabhol Ratnagiri | Konkan LNG | 5 | 2012 |
| Kochi | Petronet LNG | 5 | 2013 |
| Ennore | IOC | 5 | 2019 |
| Mundra | GSPC LNG | 5 | 2020 |

*Source: CRISIL Research*

**Upcoming LNG Terminals**

| LNG terminal | Entity/ promoters | Capacity | Expected commissioning |
|---|---|---|---|
| Dhamra | Adani Total Group | 5 | FY23 |
| Jaigarh | H-Energy | 5 | FY24 |
| Chhara | HPCL and Shapoorji Energy | 10 | FY24 |
| Jafrabad | Swan Energy | 5 | FY24 |
| Dahej | Petronet LNG | 5 | FY25 |
| East coast | Petronet LNG | 4 | FY27 |

**Existing and planned/upcoming LNG terminal locations**




*Source: CRISIL Research*

While OEMs are yet to launch LNG commercial LNG vehicles the infrastructure being put in place will give confidence to the other stakeholders in the industry such as transporters and financers to transition to LNG.

LNG auto fuelling stations can be of two types, LNG stations and LCNG stations. The main difference being that while LNG stations only dispense LNG, LCNG stations can also provide fuel for LNG as well as CNG vehicles using equipment to convert LNG to CNG. This is an important distinction as in the current scenario, there are no LNG vehicles on road in India. Hence, till LNG vehicle population builds up LCNG stations can cater to CNG vehicles such as passenger vehicles, three wheelers and light and intermediate commercial vehicles where a rapid shift from diesel to CNG is seen with rise in diesel prices.

With the government is pushing the use of LNG as fuel for long-haul transportation, along with PSU oil and gas majors such as IOCL, HPCL, BPCL etc private companies such as Shell and H-Energy are also looking to setup LNG stations to cater to LNG demand from long distance heavy commercial vehicle traffic.

### 4.1.9. Share of natural gas vehicles likely to increase going forward

Maruti Suzuki already offers CNG models in Alto, Swift and Ertiga. Other OEMs have started offering CNG option at least in entry level cars as well. Recently, Hyundai introduced CNG options for its i10, Santro and Aura models. Tata Motors also has CNG variants for Tiago, with Tigor and Altroz expected to also come with factory fitted CNG kits.

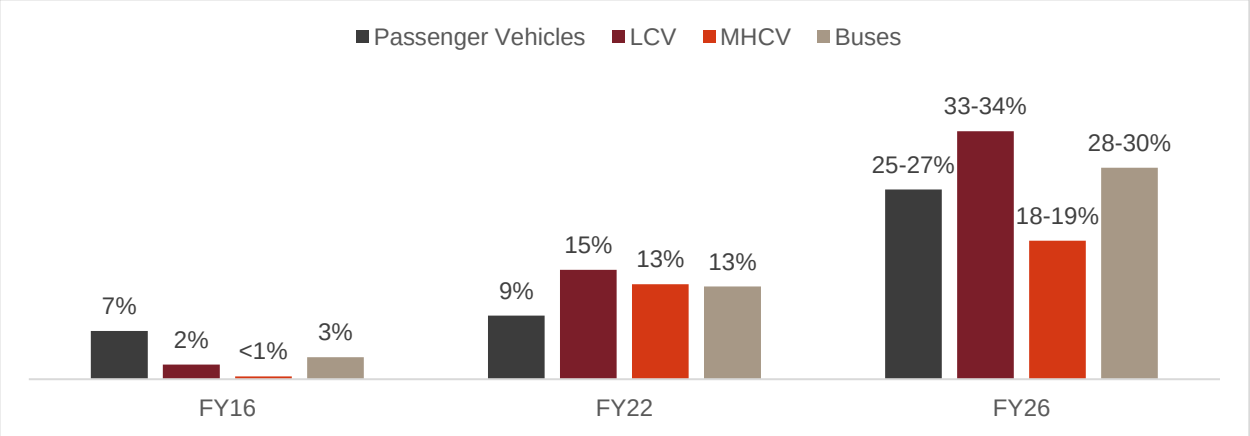
That said, currently, CNG is primarily available in major metros and tier-I cities. Long waiting time to refill CNG vehicles has led to low buyer preference for CNG variants. However, the CNG network is expanding rapidly. The government's focus for a gas-based economy has targeted 10,000 CNG stations by 2030. The industry is also exploring measure to boost the CNG ecosystem with mobile refilling CNG facilities, wherein CNG refilling is set up in shopping malls, offices, etc.

Diesel variants posted the sharpest decline owing to most manufacturers phasing out diesel variants in passenger vehicles on account of increase in the cost of the vehicle due to BS-VI, making the powertrains unviable. Traction in CNG variants was seen because of better cost economics as compared with other fuel types.

Share of CNG has seen a sharp increase in LCV and passenger vehicle segment in the last five years. The major shift has been post BS-VI norms implementation. Share of natural gas vehicles is expected to continue to increase due to favourable cost economics due to lower gas prices compared to diesel and expansion in city gas distribution (CGD) network across the country.

In MHCV segment, diesel still accounted for 87% share in FY2022 while CNG saw a rapid increase to about 13% from less than 1% in FY2016. However, for large power requirements, such as for heavy loads and long-distance transport, the size/number of CNG tanks required increase significantly. This affects the cost competitiveness of vehicles as it results in lower payloads and limited running distances. Time taken to fuel CNG vehicles is another deterrent as many CNG stations are more catered towards smaller vehicles which use smaller nozzles for filling CNG as the amount of CNG required for smaller vehicles such as cars and smaller commercial vehicles is much lower than required for trucks. For longer distance transport LNG is expected to gain favour as large amount of gas can be stored in liquefied form which is ideal for heavy duty trucks on long trips. Currently all natural gas vehicles are CNG variants however with the government notifying LNG as an auto fuel and plans underway to setup a national LNG dispensation grid the share of LNG vehicles is also likely to increase especially in the medium to heavy commercial vehicle (MHCV) segment.

**Historical share of natural gas (CNG/LNG) vehicles across segments**




*Source: CRISIL Research*

**Emission norms of other segments**

Emission norms for tractors and construction equipment have been renamed to agricultural tractor and other equipment (TREM) norms and construction equipment vehicles (CEV) norms by the government in a notification dated 5th Oct 2020.

Tractors with over 50 horsepower (hp) will be required to comply with the new TREM IV emission norms once they come into effect, to reduce the emission of pollutants. While the share of > 50 hp tractors is limited at about 10% of the sales, the emission regulations are on a tightening trend not just for on-road vehicles but all other vehicles such as tractors and construction vehicles.

TREM-V and CEV-V are notified to be applicable from FY2025 which will further increase the stringency in emissions. The broader goal is to reduce emission of pollutants and greenhouses gas and this will keep manufacturers looking for alternatives to reduce emissions.

Similar norms are also applicable for emissions from gensets used for power generation. In 2002, the standards were developed for diesel engines over 800kW and were phased in between 2003 and 2005. Emission limits for <800kw gensets were introduced in 2005 and further strengthened in 2013. In 2016 emission standards for smaller <19kw spark ignition engines using petrol/natural gas were introduced. These regulations targeting lower emissions from emissions from will increase costs of genset operating on diesel and petrol. Gas based genset are seeing demand especially in areas where air quality is poor. For e.g., the Delhi government had banned the use of diesel gensets when AQI index hit ‘very poor’ in the city. This has potential to incrase demand for natural gas-based equipment increasing demand for natural gas.

**Indian Space Policy and Defense Acquisition Procedure to support domestic manufacturing of rocket and missiles**

The governments’ thrust in developing the space sector can be seen with the activity in the sector such as, Department of Space after allowing the private companies to enter the Indian space sector in June 2020, had also proposing a policy to enable the private Indian companies to develop new systems as well as sell services to foreign companies, allowing FDI and supporting domestic companies in the space sector with access to ISRO facilities and expertise. Around 75 start-ups have registered under space technology category in the Startup India portal since the time private participation was allowed and allowing of FDI in the sector can further boost the investment and development of the sector. The development of cryogenic space engines by startups will increase demand for liquid oxygen at it one of the key ingredients along with either liquid hydrogen or LNG.

**Hydrogen policy introduction by central and state governments**

In the budget speech 2021-22, the Finance Minister of India proposed to launch National Hydrogen Mission to support hydrogen production from green power sources. The stated aims for the National Hydrogen Mission are to lay down the vision, intent and direction for harnessing hydrogen energy. It aims to develop India as a global hub for manufacturing hydrogen and fuel cell technology across the value chain. A specific strategy for the short tem (4 years) and long-term principle (> 10 year period) to be put forward which can facilitate demand creation in segments such as fertilizer, steel, petrochemical etc while being flexible to capture benefits from advances taking place in hydrogen technology. The mission also aims to aid the government in meeting tis climate targets and making India a green hydrogen hub.

Along the lines of the Nation Hydrogen mission, the central government has introduced the Green Hydrogen and Green Ammonia Policy in Feb 2022. The policy aims at boosting the domestic production of green hydrogen to 5

MTPA by 2030. It has provided open access, grid finance and charted out a favourable regulatory environment to provide fast approvals for green hydrogen and green ammonia projects. Due to high cost of production of green hydrogen currently, it has provided free inter-state transmission system for 25 years for capacity install by June 2025 which will lower the cost of green hydrogen. It has also authorized 30-day renewable energy banking at limited charges set by state commissions. State governments too are looking to draft state level hydrogen policies to support the hydrogen sector within the state. Gujarat and Tamil Nadu governments have already announced that they are working on coming out with a hydrogen policy.

As per a study by Rocky Mountain Institute (RMI), the prices of green hydrogen to halve from the current $1.7-$2.4/kg in 2030 to $0.6-$1.2/kg by 2050. The current cost of green hydrogen is estimated to be between $4.1-7/kg. The significant reduction in prices is expected to drive demand for green hydrogen.

RMI estimates, from the basis of price parity alone, the share of green hydrogen in overall hydrogen demand can increase from 16% in in 2030 to 94% in 2050 while currently the share of green hydrogen is estimated to be miniscule. This implies a cumulative electrolyser capacity of 20GW in 2030 and 226GW by 2050 which is an 11x increase in 20 years translating to about 13% CAGR of green hydrogen production capacity over the period. The report estimates a cumulative value of the green hydrogen market in India of $8 billion by 2030 and $340 billion by 2050. The key industries driving the demand for hydrogen would be refining, ammonia and methanol in the near term while steel production and heavy duty trucking are expected to drive demand toward the latter end of the period accounting for over 50% of the demand for green hydrogen. The forecast of demand for green hydrogen is done without assuming any policy intervention. Hence, support from central and state governments call further accelerate the trend.

RMI estimates the rise in demand for green hydrogen to benefit the environment by an estimated 3.6 giga tonnes of cumulative CO2 emission between 2020 and 2050 while the financial saving accounting from reduced energy import costs are estimated to be to the tune of $246 billion to $358 billion in the same period while providing other benefits such as energy security and lesser impact of energy prices on India’s foreign exchange situation.

**Regulations for cryogenic equipment in India**

In India, Petroleum & Explosives Safety Organization (PESO) is the nodal agency covering cryogenic equipment manufacturing and operations such as tanks for cryogenic gases. Cryogenic equipment rules are governed by the Static & Mobile Pressure Vessel (Unfired) Rules, 2016. The licenses required to design, manufacture, repair such equipment are provided by PESO for a period of 3 years and are renewed if all requirements are met. These licenses cannot be transferred from one person/company to another person/company. Equipment manufactured will required testing every year for safety relief values, two years for pressure vessels containing toxic and corrosive gases and every five years for other vessels. Getting PESO approvals can be difficult due to the nature of products governed by PESO. The process can be very stringent and large number of documents / information may be required based on type of approval required. Since cryogenic systems have stringent certification requirements and engage the products in rigorous testing and quality checks and hence customer stickiness can be high.

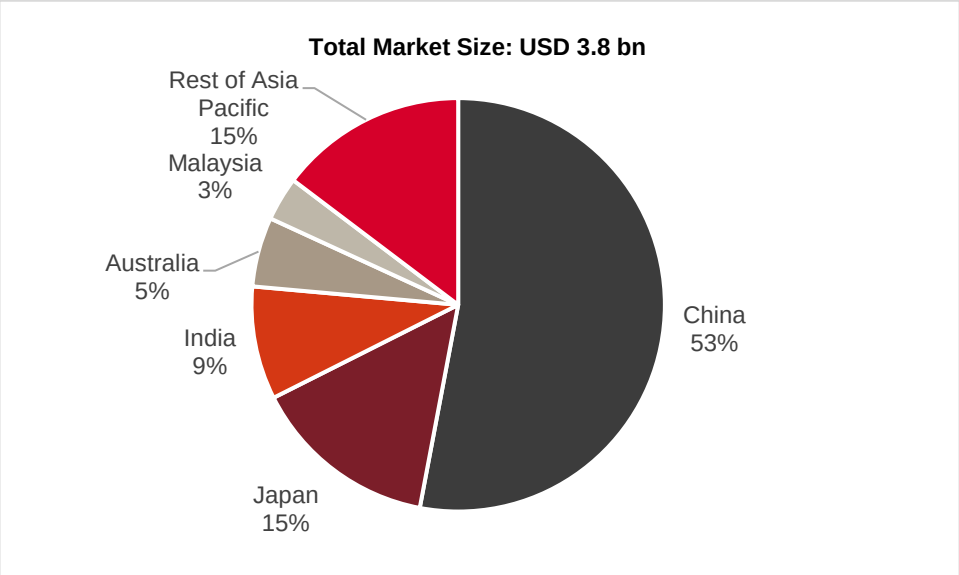
As per the Legal Metrology Act, 2009 weighing and measuring instruments have to be approved as specified in The Legal Metrology (Approval of Models) Rules, 2011 to ensure the security and accuracy of the weighments and measurements. These regulations are applicable for fuel dispensing equipment such as petrol, diesel, LNG dispensers etc. As of November 2022, only two LNG dispenser manufacturers have received the certificate of approval under the rules. One is Cetil Dispensing Technology which is based in Madrid, Spain and Inox India based in Vadodara, India which is the first Indian manufacturer of LNG dispensers to get the approval.

## 4.2 Market Size of domestic cryogenic equipment industry

Asia Pacific is the largest share of cryogenic equipment demand by region due to large share of production in sectors such as metallurgy, chemicals and electronics. It accounts for 34% of the global cryogenic equipment demand. The Asia-Pacific region is not only the largest market for cryogenic equipment, but also projected to be the fastest growing between CY2022 and CY2027

The largest market in the Asia Pacific region is China which has a large manufacturing industry and has become one of the key suppliers of a variety of products to the world. The market in China is primarily propelled by development of LNG infrastructure projects. Japan is also having many high-tech industries such as electronics and heavy engineering but is also one of the largest LNG importers in the world which drives demand for cryogenic equipment. India is the third largest market for cryogenic equipment in the Asia Pacific regions account for 8-10% of the demand for cryogenic equipment.

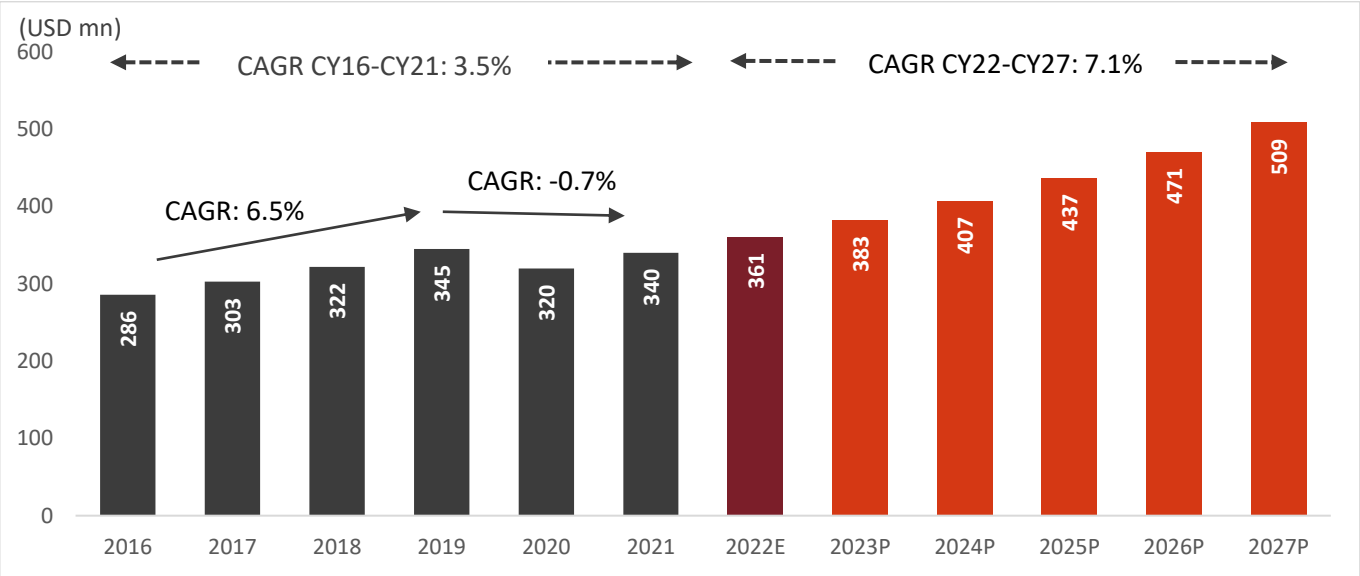
**Share of demand for cryogenic equipment in Asia Pacific by country in CY2021**




*Source: Markets and Markets, CRISIL Research*

The domestic cryogenic equipment market size was estimated to be USD 340 bn in CY2021. The demand for cryogenic equipment was steadily growing at a rate of 6.5% CAGR between CY2016 and CY2019 before being impacted by the COVID-19 pandemic. The ensuing lockdown and travel restrictions saw the demand growth for cryogenic equipment stall for two years between CY2019 and CY2021. Going forward demand for cryogenic equipment is expected to grow at a CAGR of 7.1% between CY2022 and CY2027. Driven by increase in industrial output, investments in electronics and space sectors and shift towards cleaner fuel sources such as LNG and hydrogen in the industrial and transport sector.

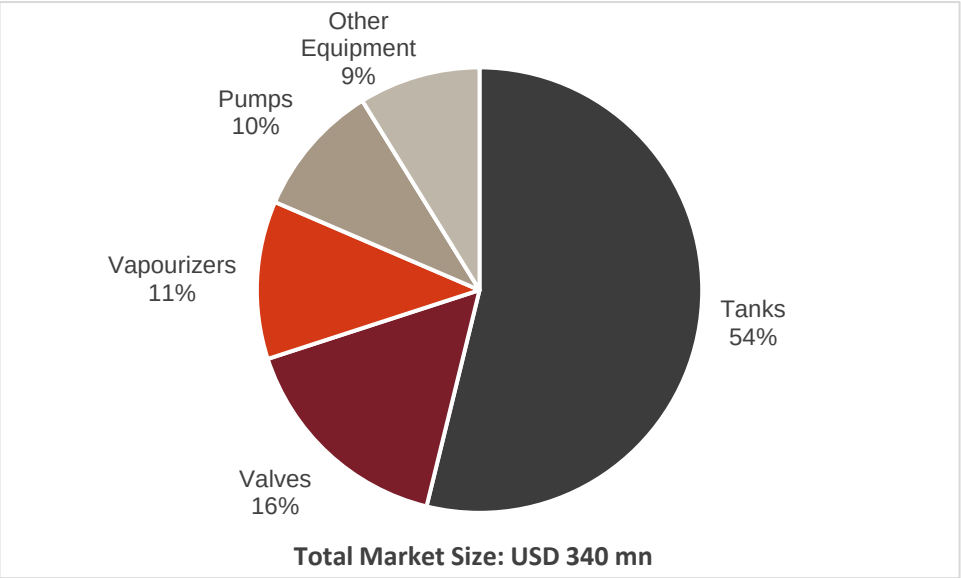
**Domestic cryogenic equipment demand**




*E: Estimated; P: Projected*

*Source: Markets and Markets, CRISIL Research*

**Share of types of cryogenic equipment in domestic market in CY2021**




*E: Estimated; P: Projected*

*Source: Markets and Markets, CRISIL Research*

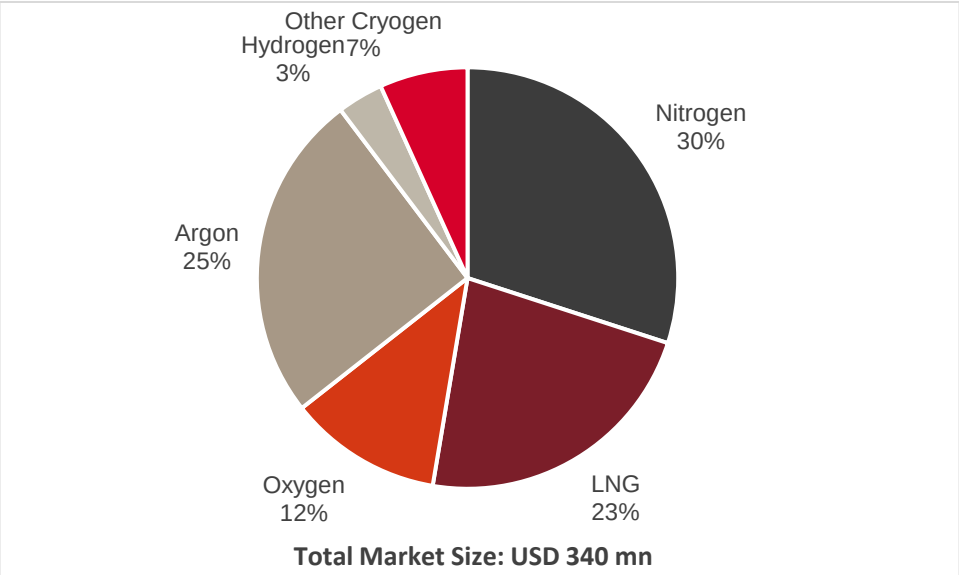
Of the types of equipment used, tanks used for storage and transportation form a major share with over half of the total cryogenic equipment demand. The other major types of equipment are valves which are used to control flow and for safety at 16%, vapourisers which convert cryogenic liquids to gaseous form at 11% and pumps at 10%. The other equipment accounting for 9% includes pipes, regulators, freezers, dewars, strainers, samplers, heat exchangers, leak detection equipment, dispensers, and manifolds, fittings, vacuum jacketed / insulated piping, hoses, connections etc

## 4.3 Market size of domestic cryogenic equipment by cryogen

The major sources of cryogenic gases are atmospheric air, which is separated into its constituents by air separation units, and energy gases, such as LNG and hydrogen. While LNG, a fossil fuel, is extracted from drilling, hydrogen can be produced from renewable and non-renewable sources. While most of the hydrogen produced currently is from fossil fuels, in the long-term hydrogen produced from renewable sources i.e., “green hydrogen” is expected to increase as cost for producing green hydrogen declines. This is expected to drive demand for hydrogen as a source of clean fuel as it would be produced from fully renewable sources and also emits no pollutants during use.

That said, nitrogen has wide application across industries. However, LNG, which is used as a fuel source, is seeing rising adoption as a cleaner fuel source and is expected to see the fastest growth across cryogens. Other gases that form 7% of the total demand for cryogenic equipment are helium, nitrous oxide, ethylene, and carbon dioxide.

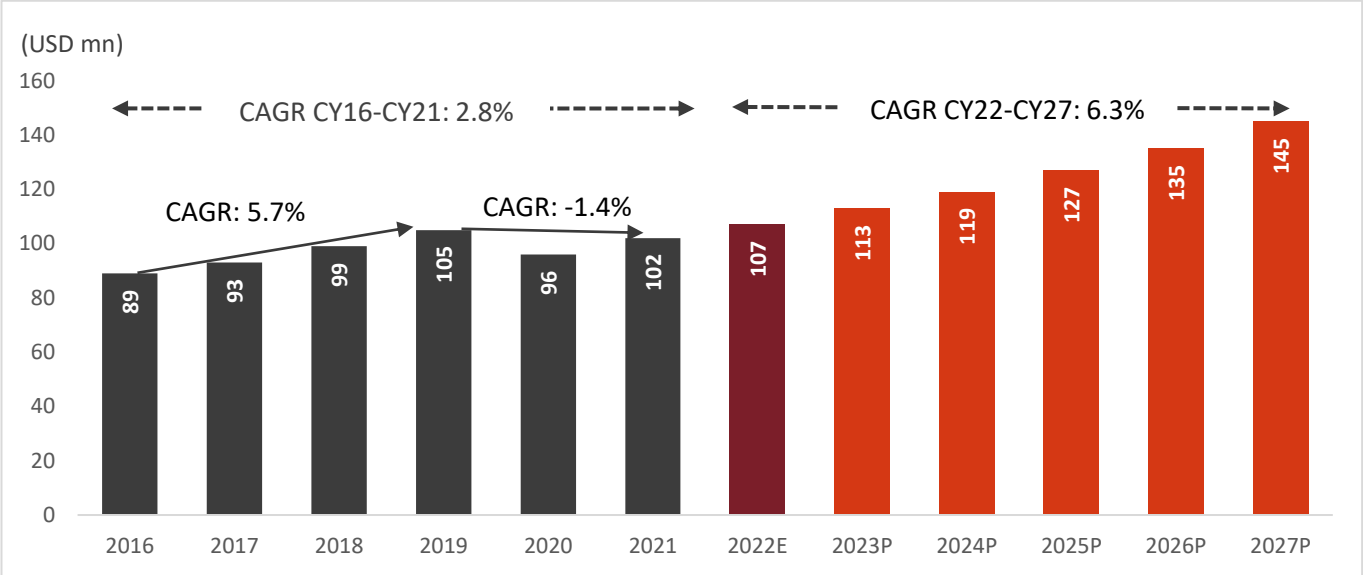
**Share of cryogenic equipment demand by cryogen in CY2021**




*Source: Markets and Markets, CRISIL Research*

Nitrogen is the most abundantly available gas in the atmosphere. Demand for cryogenic equipment from nitrogen is estimated to account for 30% of the total cryogenic equipment demand in India. It has wide application in industries such as fertilizer and chemical industries and for medical use owing to its high availability in the atmosphere and its inert nature. Going forward demand for cryogenic equipment from liquid nitrogen is expected to grow at a CAGR of 6.3% between CY2022 and CY2027

**Domestic demand for cryogenic equipment from nitrogen segment**

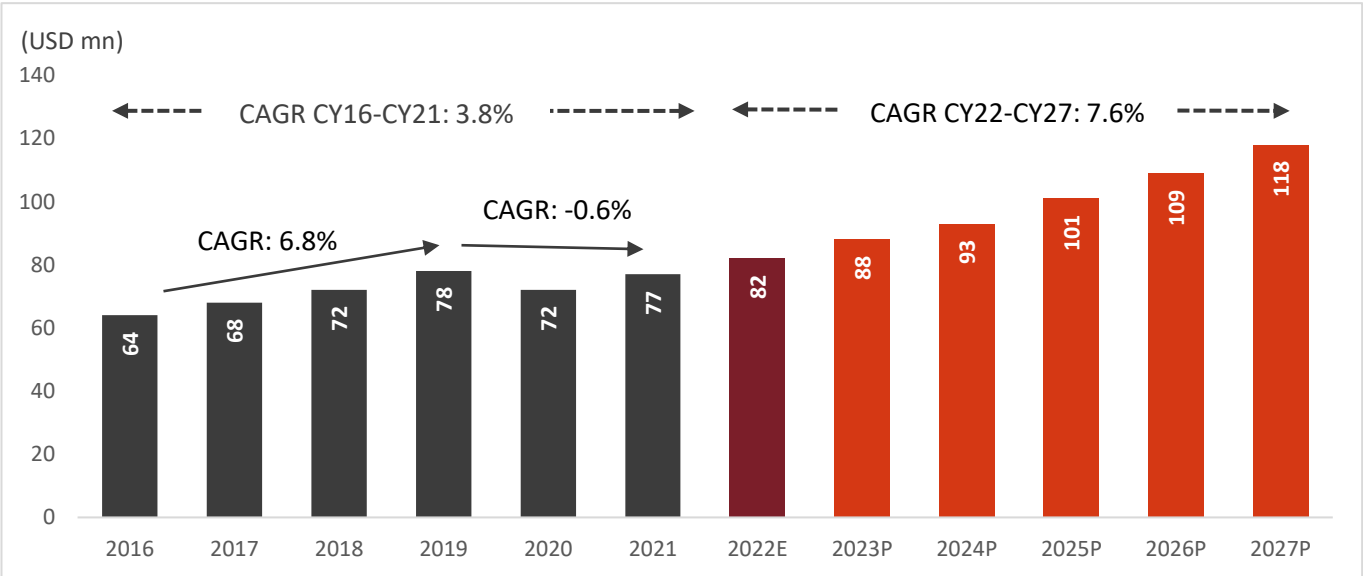



*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

Demand for cryogenic equipment from oxygen is estimated to account for 12% of the total cryogenic equipment demand in India. Oxygen is also abundantly available in the atmosphere and has a key role in combustion and the oxidation processes in industries such as metallurgy for production of steel and metal fabrication. It also finds use in petrochemical, medical and aerospace applications.

Between CY2022 and CY2027, demand for cryogenic equipment of liquid oxygen is expected to grow the second-fastest, at 7.6% CAGR. Electronics and metallurgy industries are projected to be the key demand drivers for oxygen-related equipment.

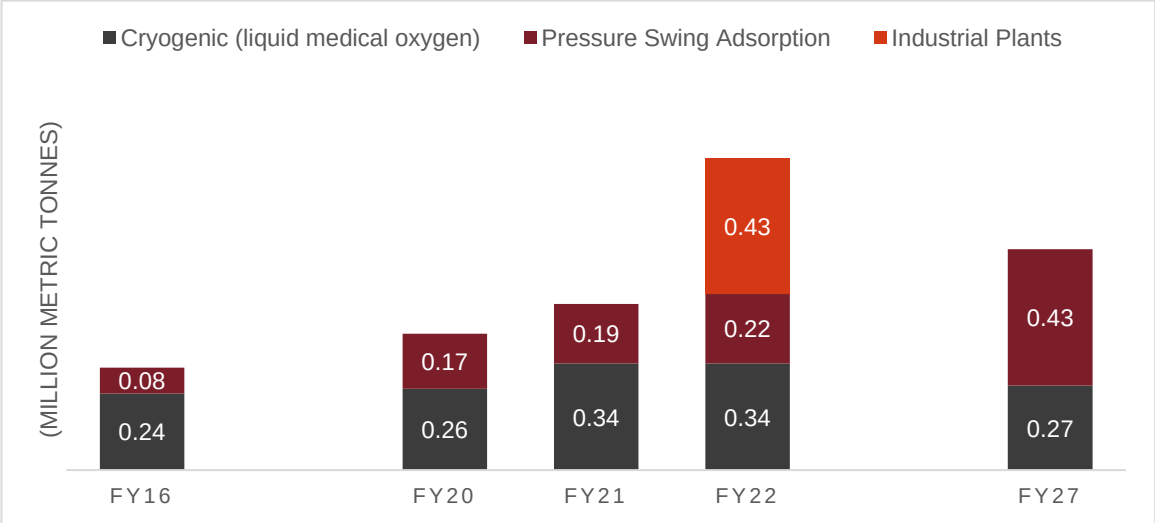
**Domestic demand for cryogenic equipment from oxygen segment**




*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

Out of the total demand for liquid oxygen, about 20% of the liquid oxygen demand is for medical applications. The oxygen supplied to the medical segment called liquid medical oxygen (LMO) has additional standards to adhere to over and above what is required for industrial applications which is monitored by Central Drugs Standard Control Organisation (CDSCO).

**Domestic medical oxygen demand from cryogenic vs non-cryogenic sources**




*Source: CRISIL Research*

The demand for medical saw a surge in CY2020 and CY2021 due to the COVID-19 pandemic and the need for concentrated oxygen for some patients suffering from extreme symptoms of COVID-19 with breathing issues. Due to the lockdown across the world there were many supply issues in meeting the demand for cryogenic equipment for LMO. The huge surge in cases in a short period necessitated the diversion of industrial equipment to meet the medical segment during the waves of infection with as each new variant emerged. However, the highest demand was seen during the second wave (Delta variant) which spread fast and caused a much higher peak case load in a short span of time.

The demand for cryogenic equipment saw a surge from the medical segment during CY2020 and more so in CY2021 however, due to shortage of cryogenic equipment availability and difficulty in quickly transporting liquid oxygen from the air separation unit plant to hospitals in remote locations many pressure swing adsorption (PSA) plants were setup to meet the additional demand which do not require cryogenic equipment as the oxygen is produced in gaseous form.

Pressure swing adsorption (PSA) is a type of technique to separate gases by using an adsorbent material such as zeolite which is used as a trapping material for gases under high pressure and later when the process swings to low pressure the trapped gas is released and captured.

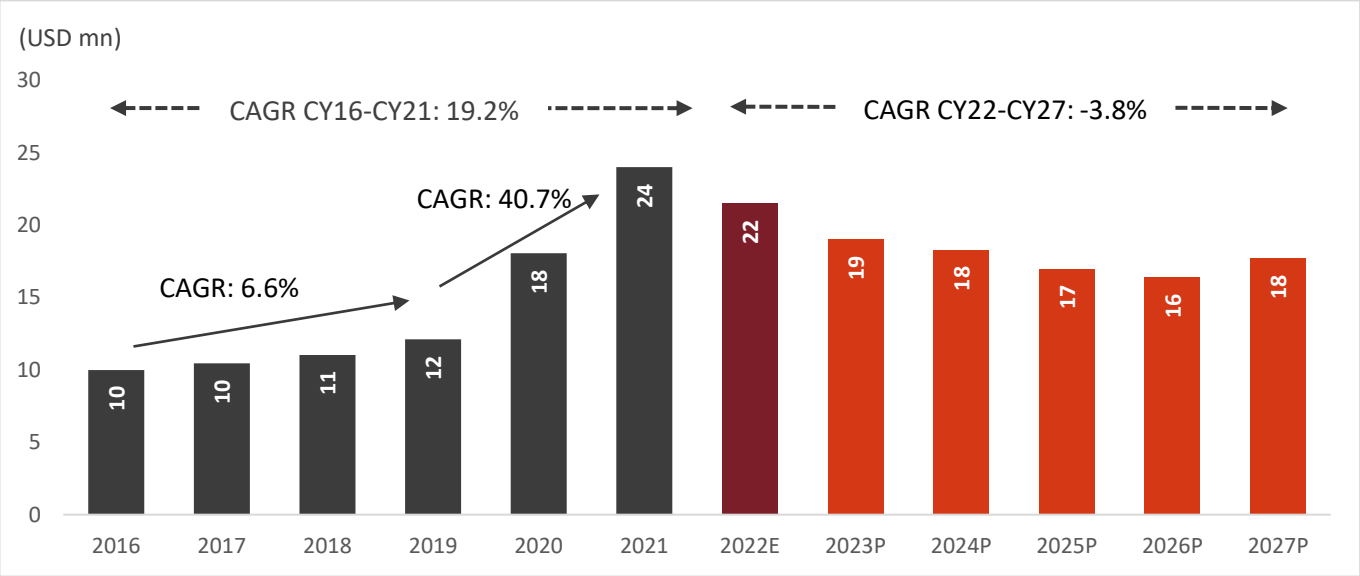
PSA plants are cheaper to operate and also produce a continuous steam of oxygen from the atmosphere as long as there is a continuous source of power. This is ideal in cases where the requirement is far away from an air separation unit (ASU). It also produces oxygen directly in gaseous form and no vaporizers are required.

The downside of PSA plants is that the purity of oxygen produced is lower than that of ASU's, about 93% vs >99.5% from ASU's. However, for respiration purposes highly concentrated oxygen cannot be used. High purity oxygen of greater than 99% needs to be diluted before supplying it to the patient's lungs. This drawback is not an issue for PSA plants for medical applications however, for industrial used highly pure oxygen may be required

based on application which can only be produced from ASU. Secondly, PSA plant will continuously produce oxygen as long as power supply is available and disruption in power supply will impact oxygen production.

In the wake of the COVID crisis, there has been an effort to increase the readiness to meet oxygen demand. The number of PSA plants are likely to increase and cater to most of the incremental oxygen demand and demand for LMO transported to hospitals is likely to remain stagnant over the next five years as oxygen produced by PSA plants are in gaseous form. Hence, the demand for cryogenic equipment from medical applications is expected to see a marginal decline in the post-COVID scenario as most of the cryogenic equipment demand going forward from the medical segment is likely to be from replacement demand rather than new capacity additions.

**Domestic demand for cryogenic equipment from liquid medical oxygen (LMO) segment**

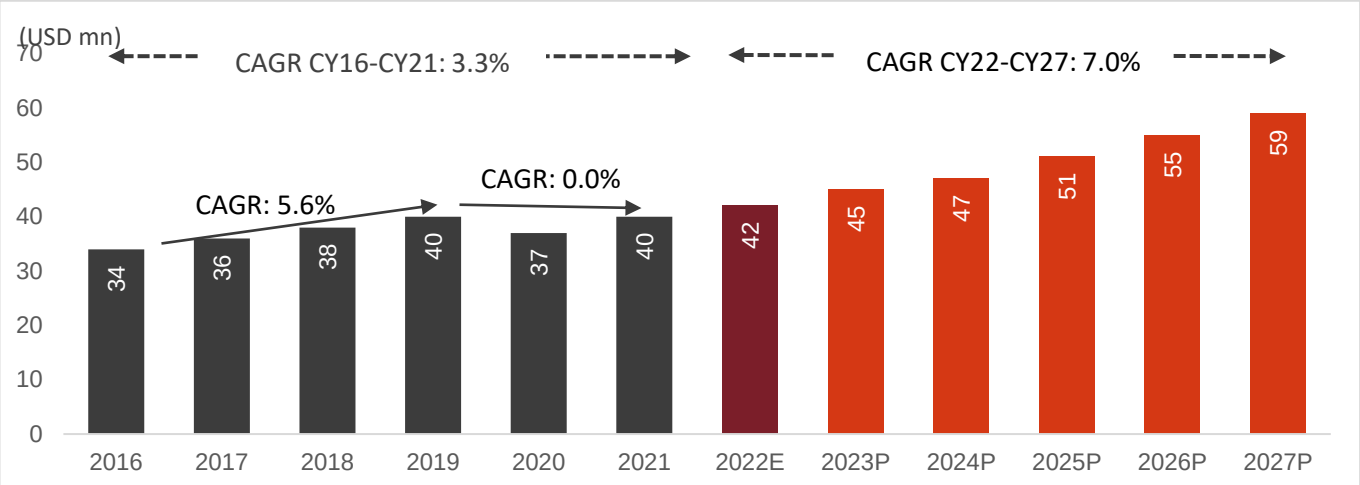



*E: Estimated; P: Projected*
*Source: CRISIL Research*

Argon is an inert gas and is rarely found in the atmosphere, thus making it expensive to produce. Argon is used in critical industrial processes, such as manufacturing of high-quality stainless steel and production of impurity-free silicon crystals for manufacturing electronics. In fact, liquid argon is extensively used in the semiconductors industry. Other applications of liquid argon include fabrication of specialty alloys, lasers, and metals. It has medical applications as well, specifically in cryosurgery and situations that require an inert environment.

From CY2022 to CY2027, demand for cryogenic equipment from the liquid argon segment is expected to grow at 7% CAGR. Increasing investments in the semiconductor and electronics space and support from policies such as India Semiconductor Mission, demand for argon and, hence, demand for cryogenic equipment from the segment is likely to increase.

**Domestic demand for cryogenic equipment from argon segment**

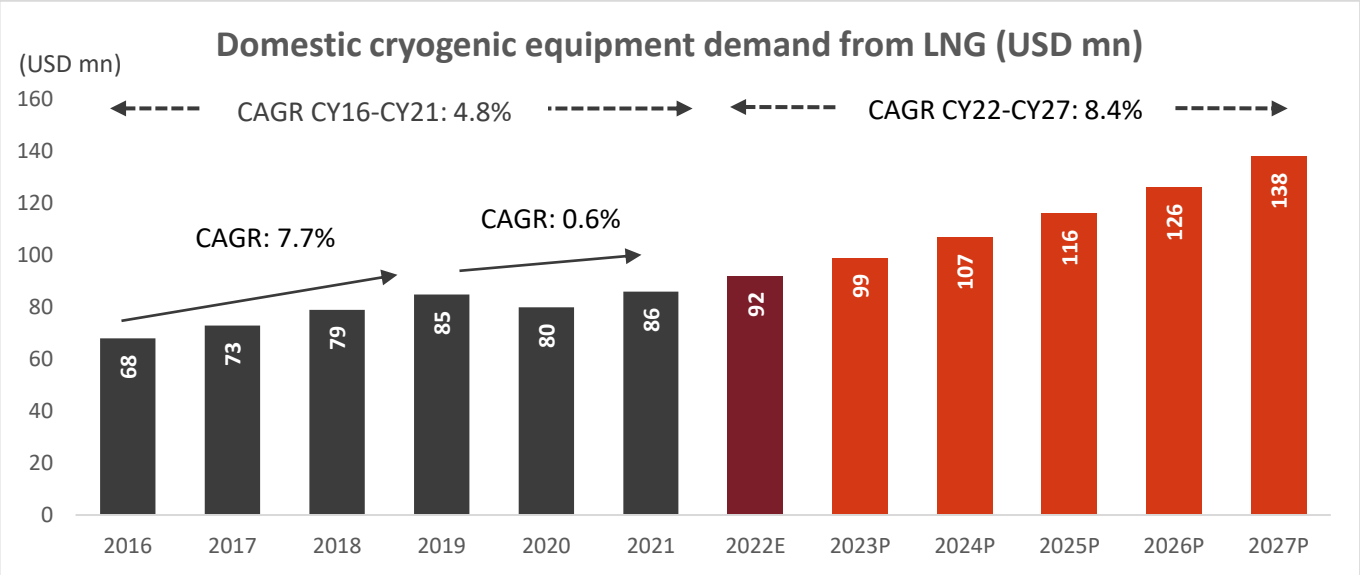



*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

Domestic gas demand increased ~6% in fiscal 2022. The growth was driven by higher offtake from end-use industries as economic activity picked up pace. In fiscal 2022, industrial activity and personal mobility gained traction, leading to healthy growth in segments such as CGD. Demand from refineries also rose, with improved demand from petroleum products. However, demand from power segment declined as higher LNG prices affected gas-based power plant's PLF. Gas demand from fertilisers segment was also grew marginally owing to weak demand for fertilisers due to uneven rainfall.

The growth trajectory of gas consumption went off-track in fiscal 2021 due to Covid-19-related challenges owing to constrained transportation and industrial activities. Subsequently, overall demand of gas was stable. In fiscal 2023, demand from natural gas is expected to grow at healthy pace of 10-12%, driven by healthy demand from fertilisers (16-17% on-year) and city gas distribution (CGD) (18-20% on-year) segments. Domestic natural gas production is expected to increase over the next 4-5 years; however, reliance on LNG would continue because of continued demand-supply mismatch i.e., as gas demand increases, the shortfall will be required to be met through LNG imports. CRISIL Research expects LNG demand to clock 11-13% CAGR between fiscals 2022 and 2027. However, because installed regasification capacity is forecast to almost double to 73.0-78.0 mtpa in fiscal 2027 from 42.5 mtpa in fiscal 2022, average utilisation of LNG terminals is set to range between 58-60% in fiscal 2027, lower than ~64% in fiscal 2021. While demand for cryogenic equipment for LNG storage, distribution and handling is expected to increase at a rate of 8.4% CAGR between CY2022 and CY2027.

**Domestic demand for cryogenic equipment from LNG segment**

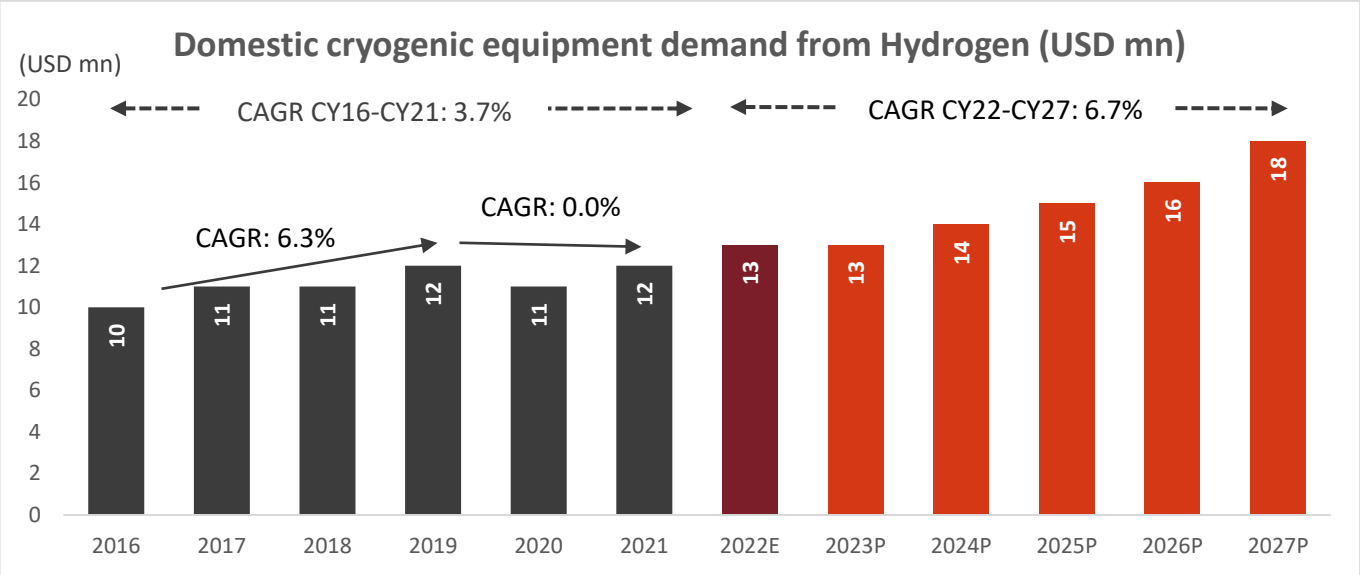



*E: Estimated; P: Projected*
*Source: Markets and Markets, CRISIL Research*

The hydrogen segment in India is expected to see a strong growth with government's emphasis on developing a hydrogen economy in the country. The major issue with hydrogen is the volatile nature of the gas which is easily combustible and also more complicated to transport and handle. The infrastructure to handle the gas is being rapidly developed and on the other side the cost of producing hydrogen is also being worked on to make it more competitive against other fuel types given its potential to be a completely green fuel produced from renewable sources alone. However, due to applications such as fuel cells are still in their nascent stages widespread use of hydrogen is expected to be at least a decade away. The current demand for hydrogen is likely to be from industries such as steel and fertilizers which may shift to hydrogen in a bid to reduce their carbon footprint.

Reliance Industries Ltd has announced its plans to become a net zero carbon firm by 2035. RIL has plans to invest in INR 600 billion to build a 5000-acre green energy complex in Jamnagar, Gujarat. The complex will house an electrolyser plant to produce green hydrogen. Vedanta's Sesa Goa Iron Ore Business is seeking a tie-up with IIT Bombay to develop processes for manufacturing green steel. In April 2022, Indian Oil Corporation, Larsen & Toubro along with ReNew Power annouced a joint venture to develop the hydrogen sector in India. Refining, steel and fertilizer sectors will be the focus of the JVs' initial efforts as these are expected to account for a major share of the hydrogen demand currently. Going forward demand for cryogenic equipment from liquid hydrogen is expected to grow at a CAGR of 6.7% between CY2022 and CY2027.

**Domestic demand for cryogenic equipment from hydrogen segment**




*E: Estimated; P: Projected*

*Source: Markets and Markets, CRISIL Research*

# 5 Domestic Industries driving demand for cryogenic gases

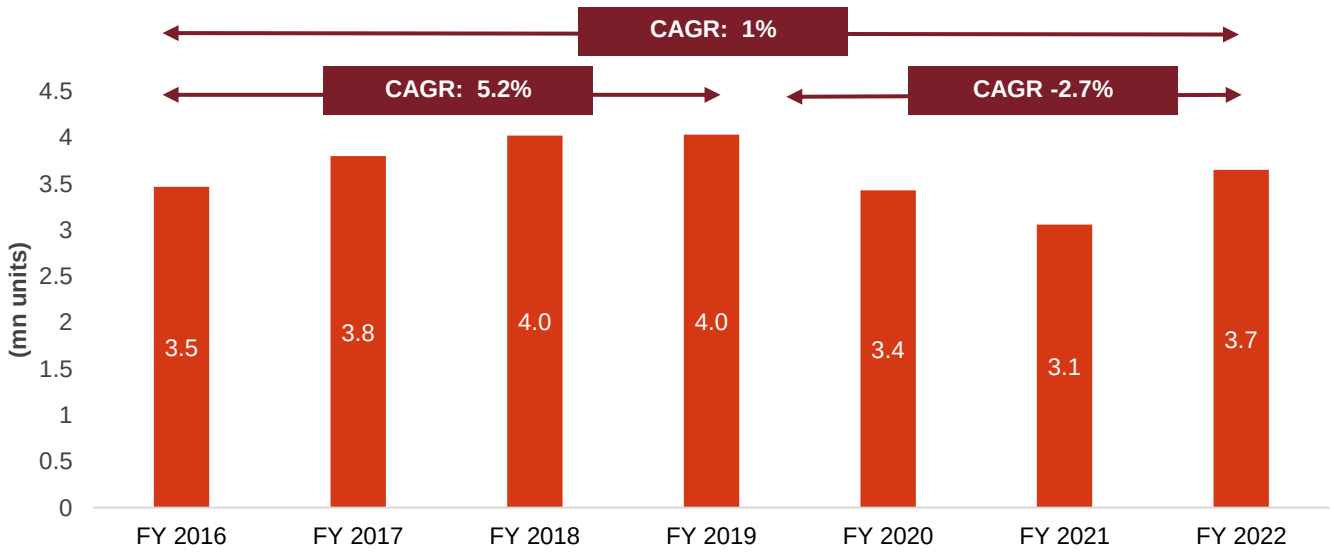
## 5.1 Review and outlook of the Indian automobile industry

Demand for automobiles drives demand for cryogenic gases as metals such as steel and aluminium are key inputs for manufacture of automobiles and also fabrication of metal parts will require gases such as oxygen for cutting and welding. Besides inputs, there has been a surge in demand for CNG vehicles post implementation of BS-VI norms as there has been a sharp increase in vehicle prices for emission control equipment which are required to be installed in automobiles in order to meet the stringent emission norms under BS-VI standards in both passenger and commercial vehicles. Another factor supporting sales of CNG vehicles is the increase in crude prices which has made the prices of petrol and diesel rise to record highs increasing the cost of owning such vehicles. As of April 2022, petrol prices of Rs.105/ltr are 48% higher than CNG at Rs.71/kg. As of October 2022, petrol prices are Rs.106.29/ltr, a 19% higher than CNG at Rs. 89.5/kg. CNG being a cleaner fuel and also lower in cost has benefited which many OEM's also launching CNG variants of their vehicles. While in the passenger vehicles CNG variants were offered on some vehicles directly from factory the trend has seen an increase post BS-VI implementation. Even on the commercial vehicle side there have been many CNG variant launches. Although CNG vehicles do not require cryogenic equipment, the rising demand for CNG will support demand for LNG as shortfall will be met with increase in LNG import driving demand for cryogenic equipment for LNG transport, storage and handling.

### Review of Indian passenger vehicle industry (FY2016 to FY2022)

Production of passenger vehicles (PVs) in India rose at a healthy 5.2% CAGR between fiscals 2016 and 2019, with domestic demand as well as exports providing support. Domestic demand was driven by expansion of the addressable market, development of road infrastructure, and stable cost of vehicle ownership as crude oil prices remained low, except for a few months when global output declined because of US sanctions on Iran.

**PV production**




*Source: Society of Indian Automobile Manufacturers (SIAM), CRISIL Research*

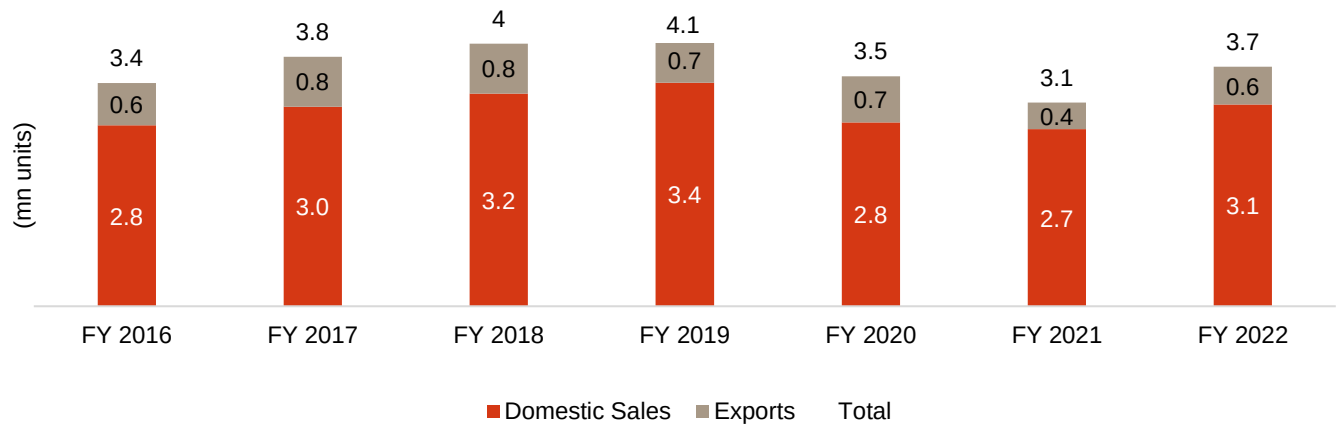
In fiscal 2019, 4 million PVs were manufactured, of which 3.4 million were sold in the domestic market and 0.7 million were exported. But in fiscal 2020, low private consumption owing to slowdown in economic growth and inventory adjustment because of change in emission norms from Bharat Stage (BS)-IV to BS-VI and outbreak of Covid-19 resulted in a 15% on-year decline in production. During the year, domestic sales fell 18% on-year whereas exports remained flat. Further, a second wave of COVID-19 infections also affected PV production at the beginning of fiscal 2022, with a semiconductor shortage further buffeting the industry. Passenger vehicles witnessed several headwinds in the form of multiple waves of COVID-19 as well as semi-conductor shortages which limited overall growth to 13% in fiscal 2022. However, with recovery in economy backed by strong orderbook as a result of pent-up demand, improving supply chain and new model launches to increase overall growth by 27-29% in fiscal 2023.

### Domestic PV sales vs exports

The Indian PV market is domestic-focused, comprising over 85% of sales in fiscal 2021. In fact, the share of exports vis-à-vis overall sales contracted from 18% in fiscal 2016 to 19% in 2022. This could be attributed to slowdown in the global automobile industry as well as major OEMs focusing on catering to the fast-growing domestic market.

In fiscal 2020, though, the export share had risen to ~20% as OEMs refocused on export markets. Stagnating domestic sales over the past three years resulted in foreign automobile manufacturers such as Ford, General Motors, and Volkswagen increasing their focus on exports, thereby improving utilisation by using spare capacity and boosting revenue. These players are developing India as an export hub, as evidenced by the consistent increase in the proportion of exports to their total production share. However, with the exit of GM and Ford, and impact of COVID-19 and major OEMs prioritising fast-growing domestic markets over foreign markets, the export volumes declined through fiscal 2021. Following a ~39% on-year drop in fiscal 2021, exports improved drastically by ~43% in fiscal 2022. Exports are projected to grow in fiscals 2023 and 2024 at an estimated rate of 11-13% and 6-10% on-year, respectively as semi-conductor supplies improve allowing OEMs to boost production and explore export markets for sales which are generally higher yielding than domestic markets.

**PV industry by domestic sales and exports**



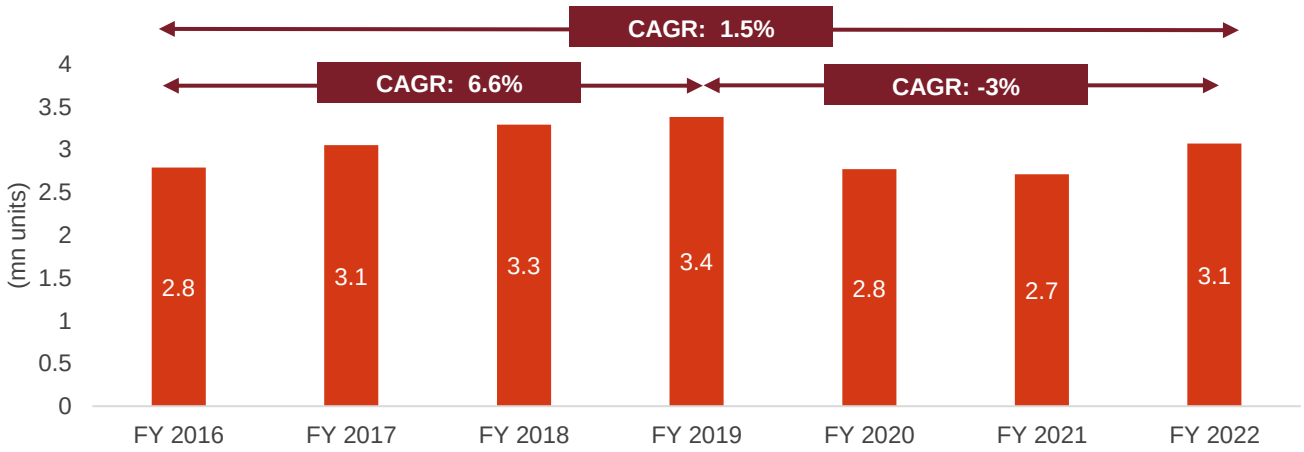

*Source: SIAM, CRISIL Research*

On the domestic front, the PV industry grew 6.6% CAGR between fiscals 2016 and 2019, led by strong growth in utility vehicles (UVs), which rose 14.9% CAGR vs cars, which grew 3.1% CAGR. Improving economic scenario,

higher affordability, and new model launches drove demand during the period. The semi-conductor shortage dented passenger-vehicle production in the first three quarters of fiscal 2022. However, due to the improvement in supply of chips and agile production strategies adopted by OEMs, the fourth quarter of fiscal 2022 saw an improvement in volume. Accordingly, fiscal 2022 saw a growth of ~13% in wholesale volume. In fiscal 2023, we expect volume growth to be 27-29%, due to continued improvement of the semiconductor shortage and support from pent-up demand. We expect volumes growth of 9-11% in fiscal 2024 due to recovery in demand in small car segment as income sentiment improve along with continued traction in UV segment.

In fiscal 2020, though, domestic demand fell 18% on-year because of weak consumer sentiment owing to a slowing economy and inventory correction because of the change in emission norms. Moreover, acquisition costs increased on account of implementation of safety norms, such as mandatory anti-lock braking system, airbags, etc. In fiscal 2021, domestic sales are estimated declined a further 2% on-year as the pandemic and subsequent lockdowns impacted supply chains. The shift towards personal mobility to maintain social distancing, though, arrested a sharper fall in PV sales. Lifting of lockdown measures and improving economic activity in fiscal 2022 resurrected the demand. As a result, the overall growth was restricted to 13% in fiscal 2022.

**PV domestic sales**



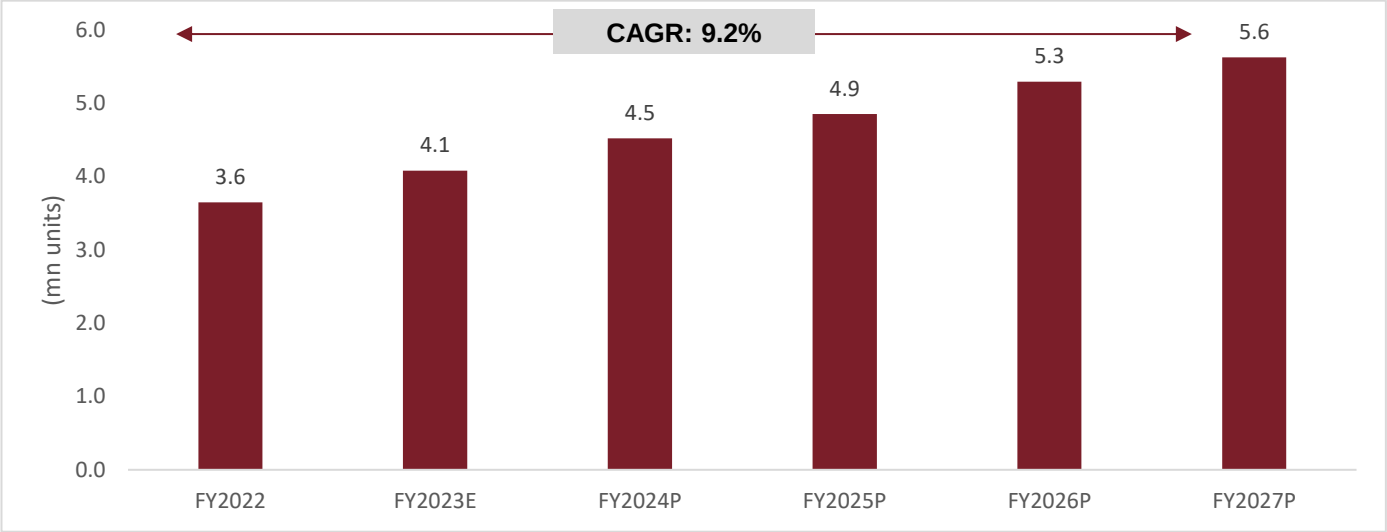

*Source: SIAM, CRISIL Research*

## Outlook of Indian PV industry (FY2022 to FY2027)

### 5.1.1. Production outlook

CRISIL Research projects PV production to grow at 9.2% CAGR between fiscals 2022 and 2027 to 5.1 million units. Post a drop in production in fiscals 2020 and 2021, PV production is expected to increase sharply over the next five fiscals, with domestic sales as well as exports driving growth. Rising domestic demand will be on the back of continued expansion of the addressable market, fast-paced infrastructure development, and relatively stable cost of vehicle ownership as crude oil prices are expected to stabilise at lower levels.

**PV production**




*P: Projected*
*Source: SIAM, CRISIL Research*

However, in fiscal 2022, because of the semiconductor shortage, CRISIL Research expected PV production to be impacted. The semi-conductor shortage dented passenger-vehicle production in the first three quarters of fiscal 2022. However, due to the improvement in supply of chips and agile production strategies adopted by OEMs, the fourth quarter of fiscal 2022 saw an improvement in volume. Thereafter, exports could drive industry growth on efforts by manufacturers to penetrate newer geographies and the Production Linked Investment (PLI) scheme, which incentivises them to export. CRISIL forecasts exports to clock 7.9% CAGR between fiscals 2022 and 2027.

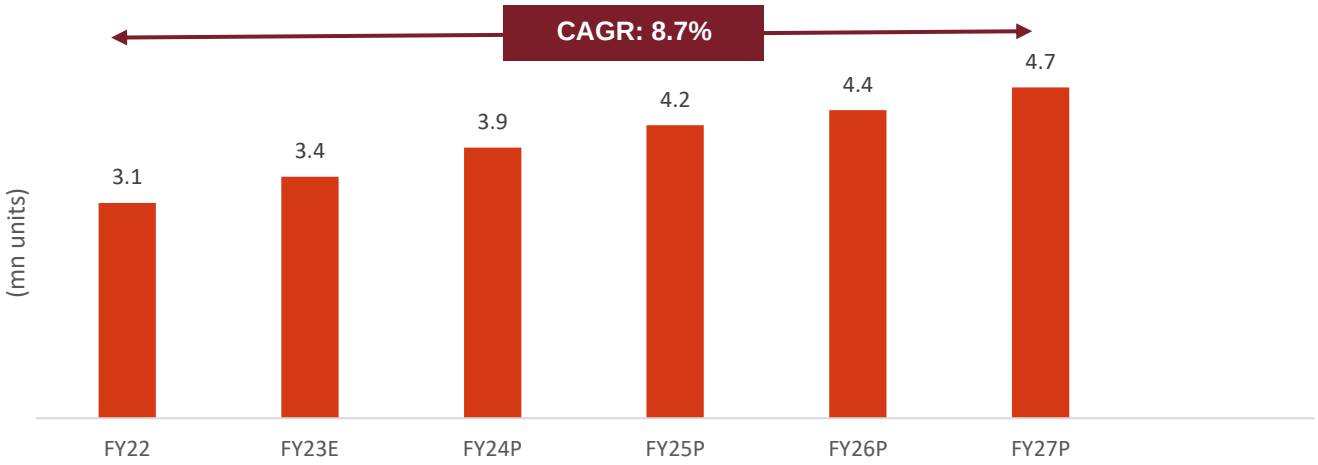
Unlike most developed economies and some developing countries, India's car market is highly underpenetrated. As of fiscal 2020, India had ~24 PVs per 1,000 people. This is significantly lower than developed countries and even other nations in the BRIC block (Brazil, Russia, and China), based on per capita gross domestic product (GDP) – Brazil, Russia, and China had 173, 307 and 99 PVs per 1,000 people, respectively, in 2015. Thus, the country holds tremendous potential for automobile manufacturers. Also, in penetration of cars and UVs vis-à-vis per capita GDP across countries, India is still behind most countries.

Total Cost of Acquisition (TCA) is calculated considering down payment, registration and upfront insurance costs for a buyer. We see that the cost of acquisition increased by 24% between fiscal 2018 and 2021 on account of price hikes by OEMs, safety norms, an increase in registration costs as well as an increase in upfront insurance costs and the early launch of BSVI models. ~5% price hike taken by OEM in fiscal 2022 has led to increase in Total Cost of Ownership (TCO) by 3-5%. Due to a further expected price hike of 2-4% and increase in third party insurance premium is expected to increase TCO by further 3-5%. Going ahead we expect TCO to grow modestly by 1-3% in fiscal 2024 amid stable registration and insurance and softening commodity costs.

Domestic PV sales are expected to increase 10.3% CAGR over the period on a sharply low base of fiscal 2021; the higher growth will be on the back of consecutive years of double-digit declines. In fiscal 2022 as well, sharp rise in

COVID-19 cases during the second wave disrupted the supply chain, thereby elongating the waiting periods of fast-moving models. Over the short-to-medium term, Covid-19-induced demand for personal mobility is likely to support PV sales. And over the medium-to-long term, moderate macroeconomic growth, rising disposable income, relatively stable cost of vehicle ownership, and lower fuel prices are likely to drive PV demand. Other factors that would support demand are rising urbanisation, government support to farm incomes, and improved availability of financing. However, increasing congestion in metro cities and rising popularity of shared mobility services are likely to restrict higher car sales over the long term.

**PV domestic sales**



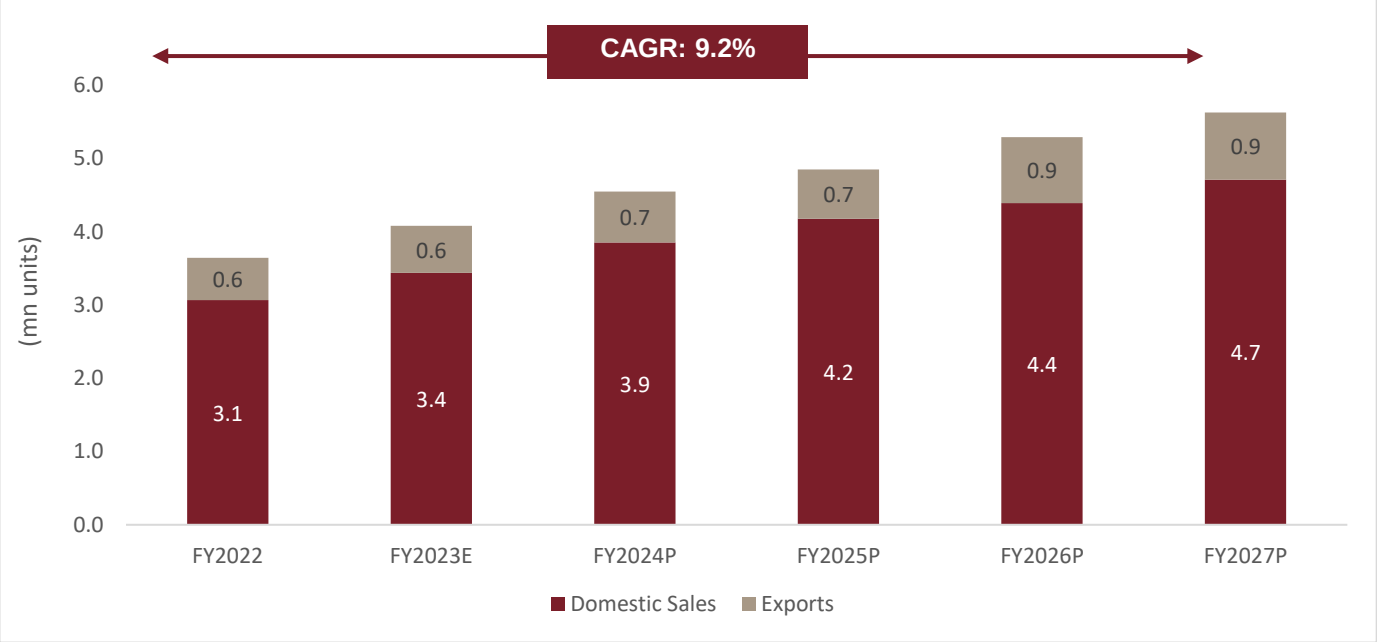

*P: Projected. E: Estimate*
*Source: SIAM, CRISIL Research*

The previous five years, that is fiscals 2017 and 2022, witnessed a flat growth of less than 1% CAGR. We expect sales to log in 8.7% CAGR during fiscals 2022-2027P, anticipating continuous improvement of economic activities, increasing average income and affordability of vehicles. Growth is expected to be better after fiscal 2022, because of healthy macroeconomic growth; increasing disposable income, a modest increase in the cost of vehicle acquisition, rising penetration per 1,000 people, as well as a deeper reach in the rural markets, tier-III and tier-IV cities. Other factors that would aid demand are increasing urbanisation, government support to farm income, and increasing access to vehicle loans. However, increasing congestion in cities and rising popularity of shared mobility services are likely to restrict car sales in the long term.

### Domestic PV sales vs exports

Domestic sales, which formed 84.2% of overall production in fiscal 2022, are expected to grow at 8.7% CAGR between fiscals 2022 and 2027P. Over the period, exports are forecast to grow at 8.4% CAGR on a low base of fiscal 2022.

**PV industry by domestic sales and exports**

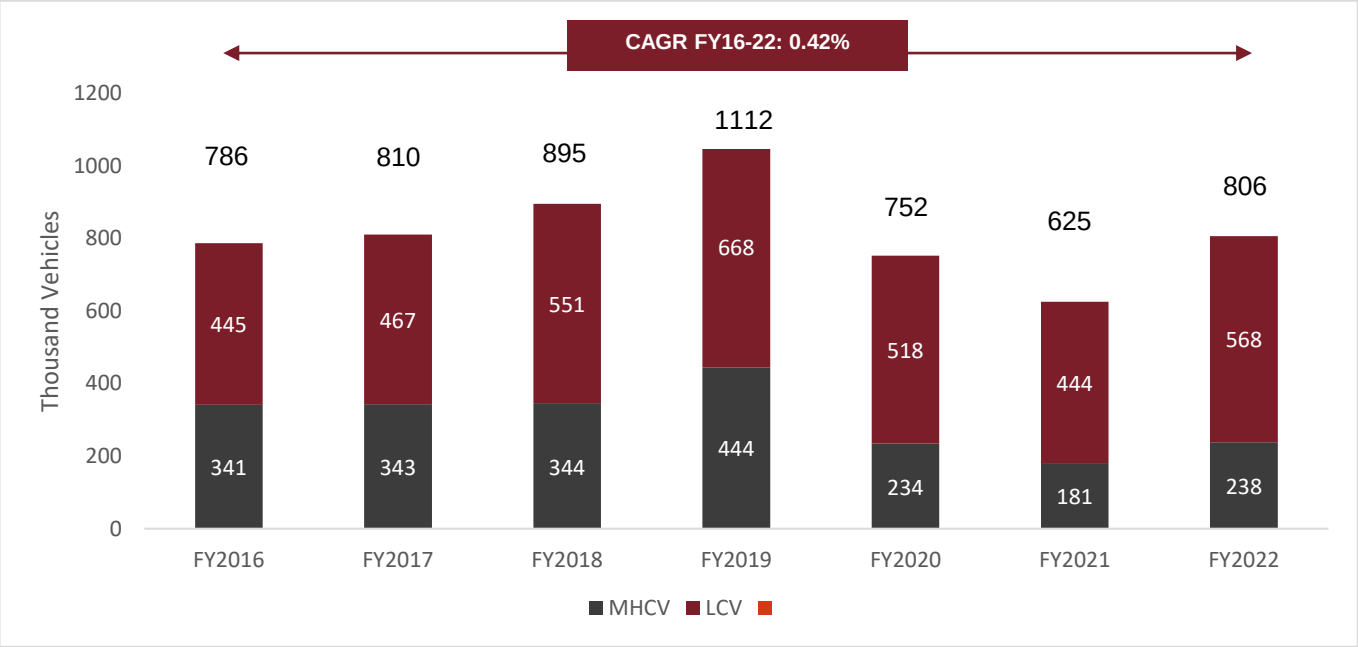



*P: Projected E: Estimate*

*Source: SIAM, CRISIL Research*

## Review of Indian commercial vehicle industry (FY2016 to FY2022)

**CV production by vehicle segments**




*Note: LCV includes vehicles with gross vehicle weight (GVW) less than or equal to 7.5 tonne; MHCV includes vehicles with GVW greater than 7.5 tonne*

*Source: SIAM and CRISIL Research*

Over fiscals 2016 to 2019, production grew at 12.3% CAGR, driven by pick-up in rural and industrial activity, and the government's focus on infrastructure investment. A large portion of the production increase was on robust demand for goods carriers, which clocked 14.1% CAGR. Passenger carrier production, though, declined 1.7% CAGR.

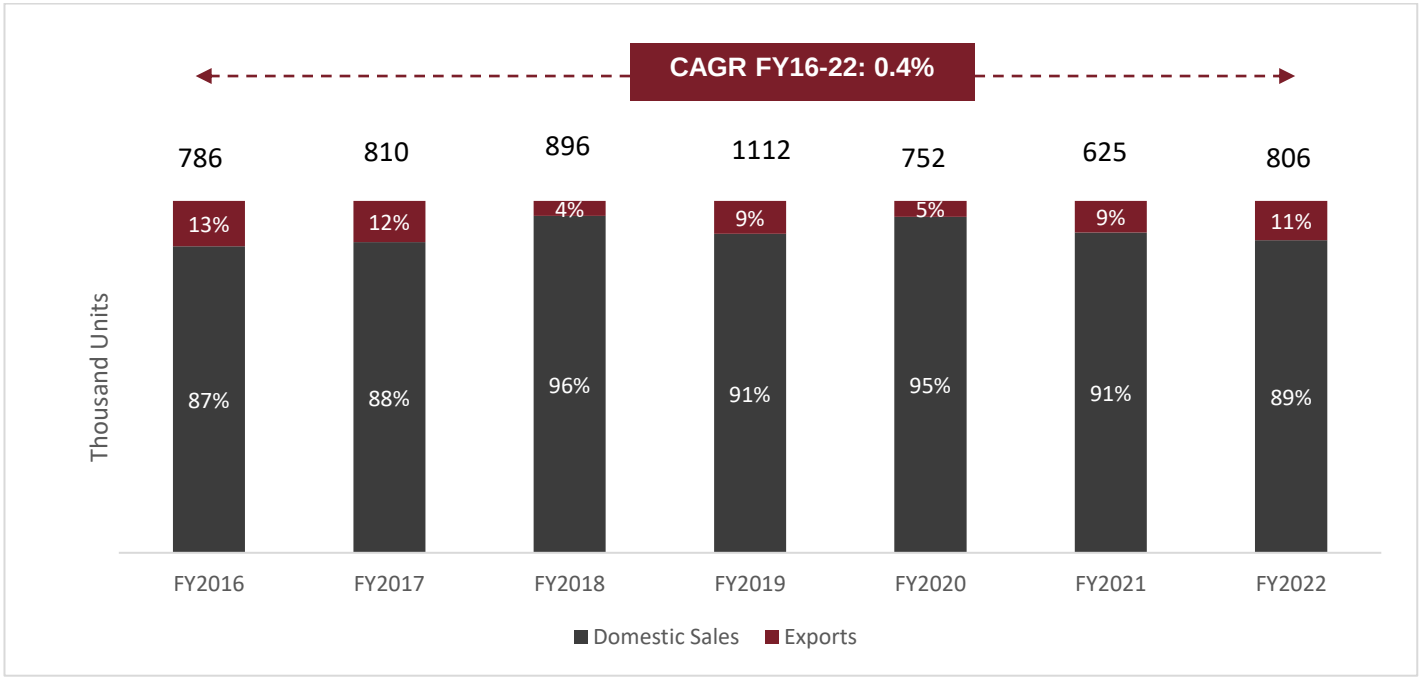
In fiscal 2020, production fell on account of inventory correction as the industry transitioned from BS-IV to BS-VI and a tepid demand for CVs owing to slowdown of the economy and lower government infrastructure spending post the general election. In addition, policy changes in Sri Lanka, one of the major industry export markets, considerably affected exports.

Overall, CV production have shown a marginal growth of 0.4% CAGR over fiscals 2016 to 2022. Within the space, medium and heavy commercial vehicle (MHCV) production declined 5.8% CAGR whereas light commercial vehicle (LCV) improved by 4.2%. However, over fiscals 2016 to 2019, industry production in fact grew at 12.3% CAGR because of a sharp 15% CAGR in LCVs and 9% CAGR in MHCV.

Faster growth in LCV production was on account of strong domestic demand, supported by high replacement demand over fiscals 2018 to 2020, improved rural sentiment, and growing e-commerce penetration. Even during the pandemic, improved rural sentiment and less impact of the pandemic in rural areas resulted in LCVs outperforming MHCVs.

### Split by domestic sales and exports

**CV sales – domestic and exports**




*Source: SIAM, CRISIL Research*

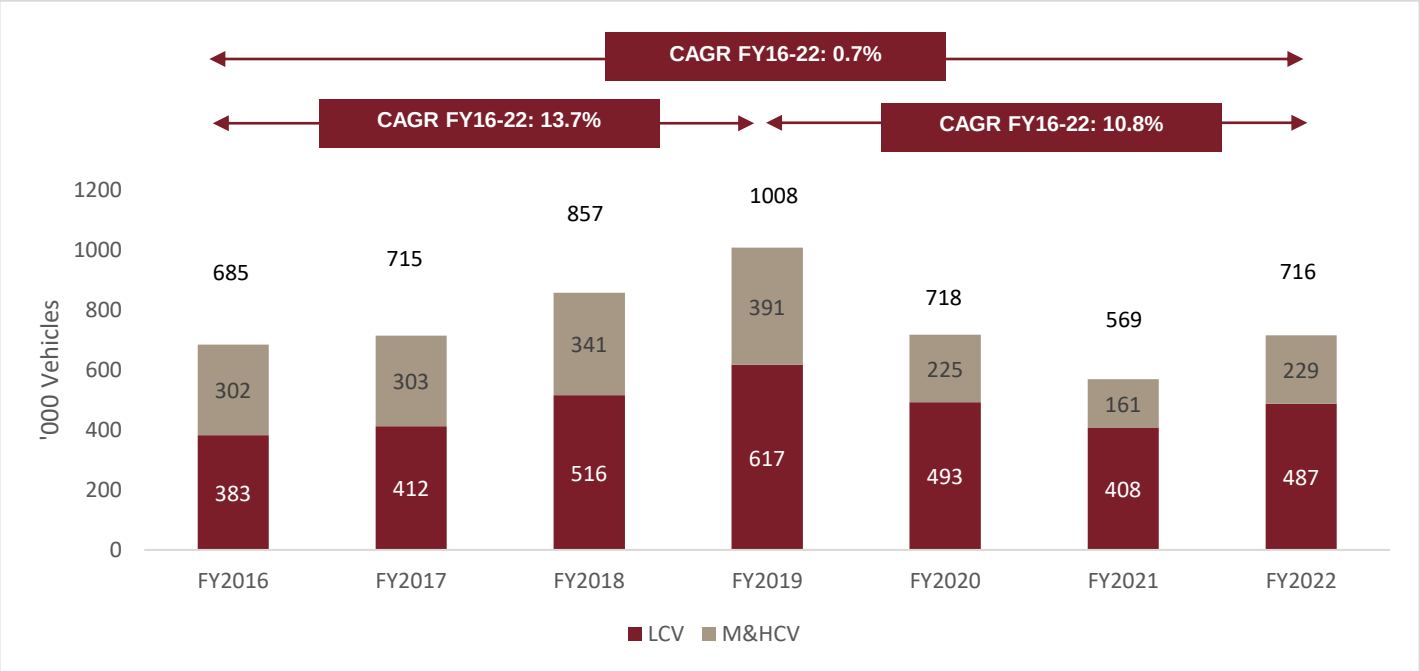
CRISIL Research expects overall CV domestic sales volume to grow by ~22-24% in fiscal 2023 in line with economic recovery across segments, improving transporter profitability and materialisation of deferred replacement demand. Also, with the implementation of BS-VI phase 2 vehicles expected from April 2023, we expect pre-buying to take place in Q4 fiscal 2023 in anticipation of price hikes owing to BS-VI phase 2 implementation resulting in an

estimated ~22-24% y-o-y increase in volume and in alternate scenario where pre-buying expectations won't materialise in Q4 fiscal 2023 culminating in a lower 16-18% increase in volumes.

### Split by CV categories

CRISIL Research expects LCV sales in fiscal 2023 to grow by ~18-20% over a base of ~15% in fiscal 2022 but volumes still to remain below pre-pandemic levels (fiscal 2019). Similarly, MHCV volumes to register ~21-23% increase over a base of ~49% in fiscal 2022 but to remain below pre-pandemic levels. As per our analysis we expect that pre-buying (shift in sales from fiscal 2024) happening in Q4 fiscal 2023 is likely to dent sales in fiscal 2024, leading to a moderation in volume growth of ~9-11% in the coming fiscal.

**Review of CV segment-wise domestic sales**




*Note: LCV includes vehicles with gross vehicle weight (GVW) of less than or equal to 7.5 tonne; M&HCV includes vehicles with GVW > 7.5 tonne*

*Source: SIAM, CRISIL Research*

Over the past five years, the industry weathered major challenges on account of events such as demonetisation, the NBFC crisis, implementation of axle load norms, changes to insurance norms and the transition to BS-VI. A culmination of these factors, particularly post second half of fiscal 2019, resulted in a dampening of demand for CVs. Between fiscals 2016 and 2020, MHCV goods vehicles sales saw a negative CAGR of 8% in the MHCV segment.

Demand for buses in fiscal 2020 was impacted by safety regulations (emergency exit doors, fire detection and suppression, escape hatches and emergency lighting) that led to an increase in cost of ownership of ~Rs 50,000. This was after a price hike of ~Rs 15,000 due to mandatory installation of vehicle tracking system and panic buttons in January 2019.

After the price rise, demand for buses in fiscal 2020 was also hit by weakening private consumption, hampering demand from tourist bus and inter-city travel operators. Weak corporate hiring and production cuts in manufacturing also impacted demand for corporate staff buses. However, schools and route permit buses have shown some

resilience in fiscal 2020. Demand from state transport undertakings (STU) ramped up in the second half of the fiscal, as STUs looked to replace much of their older fleet before the BS-VI price rise.

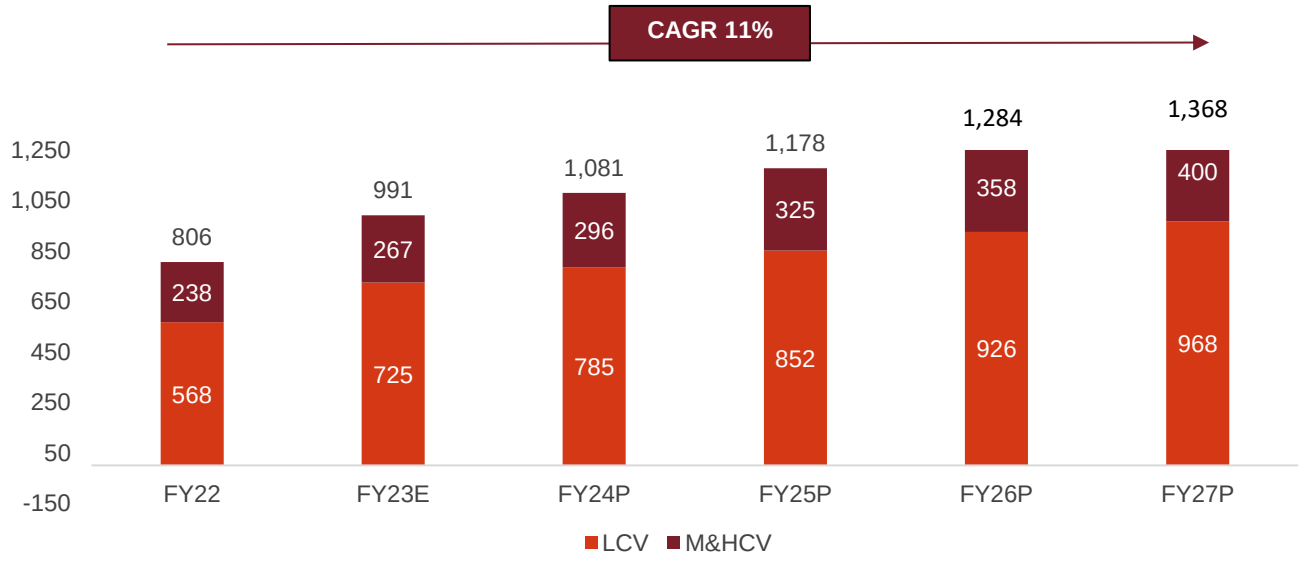
Recently, the pandemic brought the entire economy to a grinding halt, affecting profitability and sustainability of transporters due to lack of availability of freight demand. The industry is, however, now witnessing a gradual pick-up in quarterly sales as consumption demand and industry activity have started gaining pace.

## Outlook on Indian CV industry for next five years

### 5.1.2. Production outlook

Production of CVs in India is expected to increase at 11% CAGR between fiscals 2022 and 2027. MHCV production is expected to grow 10.9% as sales are expected to improve on the back of improving industrial activity, steady agricultural output, and the government's increasing focus on infrastructure. LCV production is expected to grow at a 11.3% CAGR over the same period to cater to demand driven by higher private consumption, lower penetration, greater availability of redistribution freight and improved finance.

**CV production outlook**




*Note: LCV includes vehicles with GVW of less than or equal to 7.5 tonne; MHCV includes vehicles with GVW > 7.5 tonne; P – Projected*

*Source: SIAM, CRISIL Research*

## Projected split by domestic sales and exports

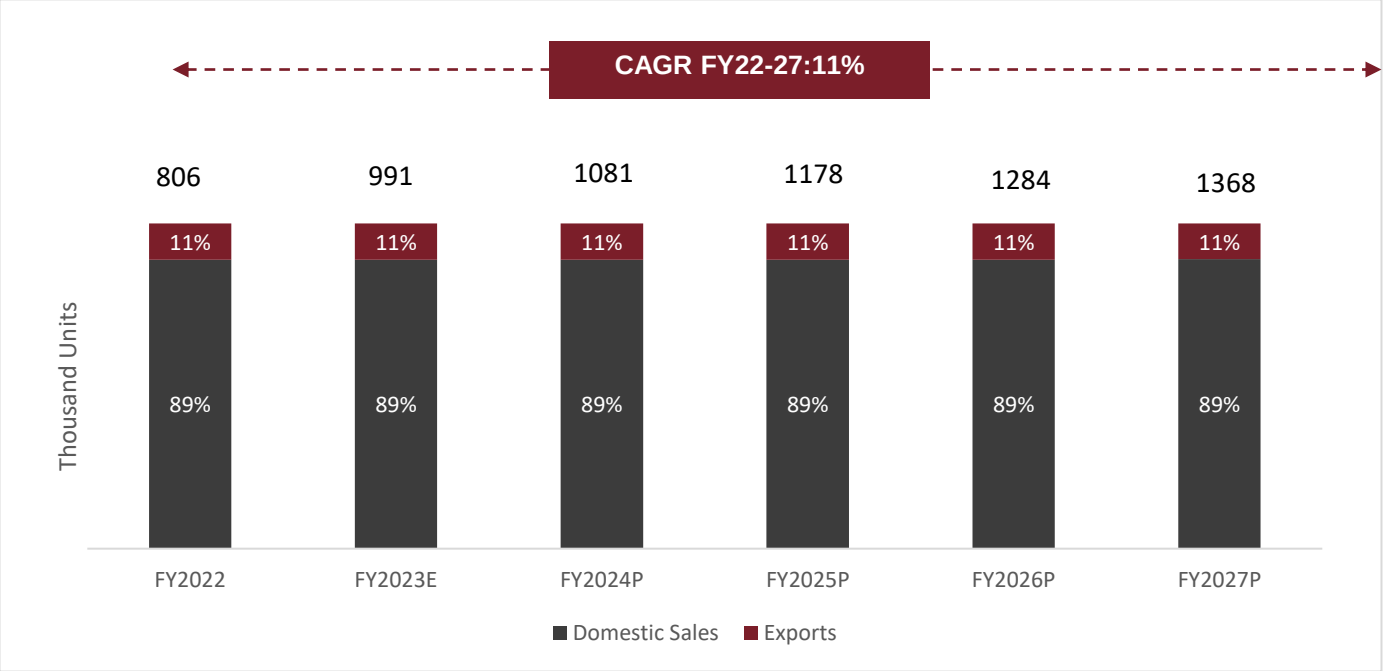
The Indian CV industry is expected to remain domestic-focused, with domestic sales comprising ~93% share of production even in fiscal 2026. However, with exports projected to grow at 9-11% CAGR between fiscals 2021 to 2026, its contribution in overall production is likely to marginally rise over fiscal 2021 levels.

The second Covid-19 wave resulting in lockdowns in key affected areas in the first quarter of fiscal 2022 impacted domestic sales across segments, post a healthy fourth quarter in fiscal 2021. Consequently, LCV and MHCV volumes declined ~42% and ~63% sequentially (on-quarter) and overall CV volumes by ~50%. Also, with a significant share of loans under moratorium amid low fleet utilisation and freight rates, risk-averse financiers limited wholesale offtake. In FY22 LCV and MHCV sales improved by ~15% and ~49% and on-year respectively over a

low base of FY21. As mobility restrictions were relaxed and economic activities started picking up after the second wave abated in Q1 FY22, CV sales have picked up.

On the exports front, manufacturers are directing their investments into expanding presence to other Asian countries from neighbouring countries such as Bangladesh, Nepal, and Sri Lanka to Africa and the Middle East. Domestic players are also considering setting up of assembly operations across multiple markets. Also, going forward, new product line-ups and technology upgradation will allow domestic players to enter relatively advanced markets of south-east Asia. Consultations with the Sri Lankan government is likely to open the market again gradually for Indian exports in the near future.

**CV industry split by domestic sales and exports (projected)**




*Note: P – Projected E: Estimate*
*Source: SIAM, CRISIL Research*

CRISIL Research expects sales of commercial vehicles to grow at a CAGR of 11% between fiscals 2022 and 2027 aided by healthy industrial growth, focus on infrastructure and higher mining production. CV sales has plummeted ~29% in fiscal 2020 and further by ~21% in fiscal 2021. The fall in sales had created a low base over which volumes have witnessed growth of ~26% in fiscal 2022. The past five year CAGR of domestic CV sales, despite a low base, the five-year CAGR between fiscal 2022 and 2027 will be similar to previous peaks. Tonnage growth to be marginally higher compared to volume growth as preference for higher tonnage vehicles in increasing among transporters.

## Key trends and developments affecting commercial vehicle demand

### 5.1.3. Fillip in industrial output

The overall Indian industry's gross value add (GVA) had been growing tepidly, averaging 5% between fiscals 2015 and 2020. After a weak fiscal 2021 due to the pandemic, CRISIL Research expects industrial GVA to bounce back rapidly in fiscal 2022 and stabilise at ~6.3% CAGR (fiscals 2022 to 2026), driven by the government's focus on

'Make in India' and growth of consumption, particularly led by growth in rural incomes. Moreover, improvement in infrastructure and higher expected corporate expenditure is likely to revitalise the capex cycle, going forward.

CRISIL Research also expects coal production to expand at ~6% CAGR between fiscals 2019 and 2024, driven by rising demand for electricity and the onset of commercial mining, while iron ore mining will also likely grow at a healthy pace during this period, aiding tipper demand.

#### 5.1.4. Government's focus on infrastructure

The National Infrastructure Pipeline (NIP) proposes to spend Rs 111 trillion of capital expenditure in infrastructure sectors in India over fiscals 2020 to 2025.

Infrastructure investment from fiscal 2013 to 2019 was Rs 57 trillion. Power, roads and bridges, urban, digital infrastructure and railways together constituted over 85% of the total infrastructure investment. The centre and states were the major funding sources for sectors such as power and roads and bridges, with moderate participation from the private sector. Digital sector investments were largely driven by the private sector, while investments in the irrigation sector were predominantly made by the state governments.

The NIP thus aims to double infrastructure investment annually from the current average of Rs 10 trillion per year to Rs 22 trillion. Of the total NIP investments of Rs 111 trillion, 40% worth of projects are under implementation, 30% at the conceptualisation stage, and 20% under development. Almost 83% of project allocation indirectly benefits the commercial vehicle sector in India, and this push for infrastructure is a major driver of growth.

#### 5.1.5. Scrappage policy

The MoRTH, in August 2018, considered incentivising the scrapping of vehicles sold before April 2005 (15 years old). After deliberations on the modalities on implementation of the norm, the government currently aims to promote vehicle scrapping by exempting registration charges for truck purchases made after scrapping older trucks. To scrappage of older vehicles, the government has increased the registration charges for older vehicles and increased stringency of fitness tests. These will entail higher costs for owners of older vehicles. Hence, by disincentivising the ownership of older vehicles, the government expects the scrappage of older vehicles to increase. We believe the impact of the norms to be limited on additional scrappage (apart from vehicles scrapped in the normal course of business). If, through higher incentives from the government and OEMs, transporters are able to be incentivised to scrap vehicles older than 15 years, we expect 6,00,000- 6,50,000 MHCVs to be available for scrapping.

#### 5.1.6. Commissioning of dedicated freight corridors to affect road freight and CV sales

The dedicated freight corridor (DFC) is intended to help the Indian Railways regain lost freight share by cutting turnaround times between importing and consuming destinations, compelling several industries to realign their logistics strategies. The DFC and associated logistics parks can significantly reduce plant-level inventory, enabling huge savings in working capital. Not only will the DFC bring about faster freight movement, but it will also aid the economy by decongesting major highways due to the increased shifting of freight to rail. It will also allow for faster evacuation of cargo from ports, improving efficiency. Thus, roads, which have outperformed rail over the past decade, will lose some share to rail once the DFC is commissioned.

### Demand for goods carrying medium & heavy commercial vehicle to lead in the next five years

MHCV sales are likely to rise by ~9-11% compound annual growth rate (CAGR), over a low base, from fiscal 2022 to 2027 (five-year CAGR), as compared to the previous five-year (FY17-22) fall in CAGR of ~2%. Moreover, tonnage addition is expected to improve in-line due to a better product mix (higher growth in MAV and T-Trailer demand despite a shift to lower tonnage vehicles due to axle norm). Factors driving long-term MHCV sales will be the improving industrial activity in the country, steady agricultural output, and the government's focus on infrastructure. However, volume growth will be limited due to efficiencies achieved from the goods and services tax (GST), better road infrastructure along with the commissioning of the dedicated freight corridor (DFC).

Factors driving long-term MHCV sales will be industrial growth aided by 'Make in India' initiatives, focus on infrastructure and higher mining production. However, factors such as the Commissioning of DFC would restrict road freight growth and enhanced operations due to better road infrastructure would lower truck demand

**LCV sales to grow at a modest pace in the long run**

Light commercial vehicle (LCV) demand is expected to expand at ~8-10% CAGR from fiscal 2022 to 2027, due to higher private consumption, lower penetration, greater availability of redistribution freight and improved finance. Upper-end light commercial vehicles (ULCVs) offer the transporter lower returns, as compared with ICVs, and are most suited for captive use. Entry restriction on ICV trucks and higher tonnage MHCVs is expected to keep demand from this segment buoyant. However, higher toll on ULCV trucks vs. pickups will limit growth in the segment. Replacement demand is expected to be positive in fiscal 2023 as some replacement sales that was expected in FY20 and FY21 would have got deferred to subsequent years. Improving volumes up for replacement in the terminal years would aid demand growth.

## 5.2 Review and outlook of the Indian cement industry

Cement production is an energy intensive process with a lot of energy required for crushing, grinding and heating raw materials. Cement plants use coal, pet coke or diesel in the manufacturing process creating a lot of emissions of greenhouses gases and other pollutants. With rising focus on environmental damage such as global warming and sea level rise, harmful effect of pollution on humans as well as wildlife, there is an increasing pressure on companies to shift to greener processes. Use of natural gas can significantly reduce the pollution caused from cement manufacturing process.

### Review of the Indian cement industry (FY2016 - FY2022)

Cement is a high-volume and low-value commodity. Transporting cement beyond a distance, therefore, makes it unviable for end-users. Cement consumption varies region-wise because the demand-supply balance, per capita incomes and levels of industrial development differ in each state, and consequently, in each region. Hence, supply and capacity utilisation in the cement industry is influenced by demand growth and level of consolidation in the region. In fiscal 2022, cement demand grew 8% (by volume) on a low to medium base in fiscal 2021. The second wave of Covid-19 hit the economic growth in the first half of fiscal 2022. However, demand for cement remained stable in the second quarter despite monsoon due to pent-up demand from the first quarter. The demand took an unexpected hit in the third quarter when unseasonal rains, labour unavailability due to wedding season, sand mining ban in some states, and festivities led to a sharp slowdown in demand momentum, leading to on-year demand de-growth of ~4%. In the fourth quarter, the demand growth was flat on-year because of high cost of building materials.

In 2021-22, the eastern region accounted for the largest share of demand (~24%), followed by south (~23%), north and west (~19% each) and central (~18%).

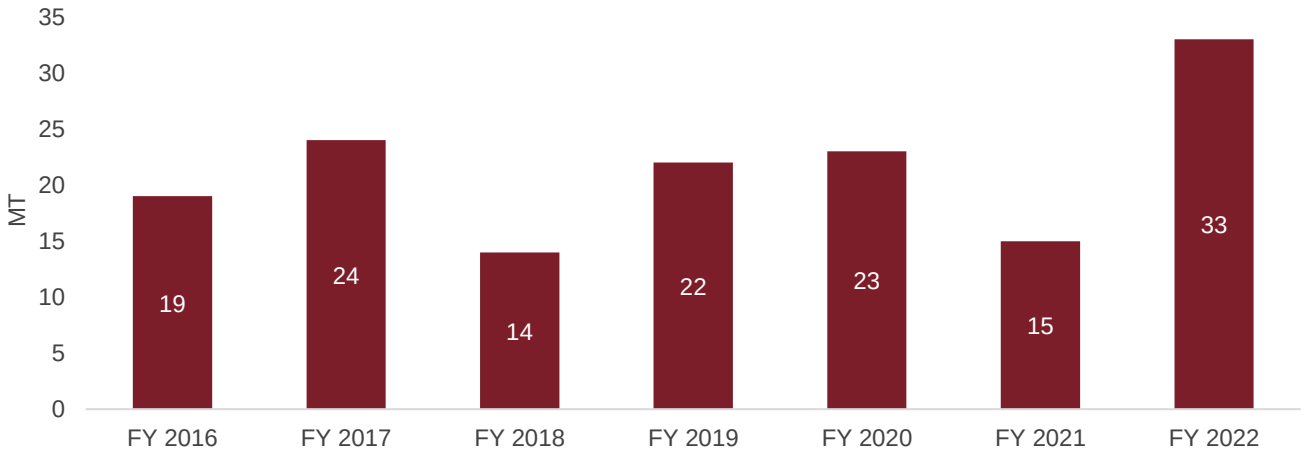
CRISIL Research estimates overall installed capacity of cement at 565 million tonne per annum (MTPA) as of fiscal 2022. Improving demand expectation, tight market situation in select regions and increasing utilisation had triggered a wave of new capacity announcements, especially by large players, in 2021.

However, due to adverse macroeconomic conditions and significant impact of first and second waves of the Covid-19 pandemic on the underlying business, players had delayed or cancelled their ongoing/upcoming/new expansion projects in first half of fiscals 2021 and 2022. Further, extended local lockdowns and manpower unavailability impacted the construction activities in the ongoing expansion projects, leading to delay in capacity additions.

These deferred capex plans have flown into the latter half of fiscal 2022 and this fiscal, leading to expectations of higher capacity addition of 27-29 MT in the current financial year. In fiscal 2023, though, the cement industry is projected to add only 27-29 MT (inclusive of grinding and interagted units) vis-a-vis ~33 MT added in fiscal 2022 as higher input costs in the form of elevated power and fuel prices have dented players' profitability, leading to lower cash flows and slowdown in capital expenditure (capex).

The cement industry is estimated to have added 33 million tonne of grinding capacity in fiscal 2022 and over 15 mtpa of capacity commissioned in fiscal 2021. Further, robust capacity addition of over 27-29 MT is expected in fiscal 2023. Capacity addition momentum is expected to continue in fiscal 2023 due to positive demand outlook and players' efforts to maintain market share by capacity in a competitive market which will lead to continued thrust towards capacity expansion especially by large players.

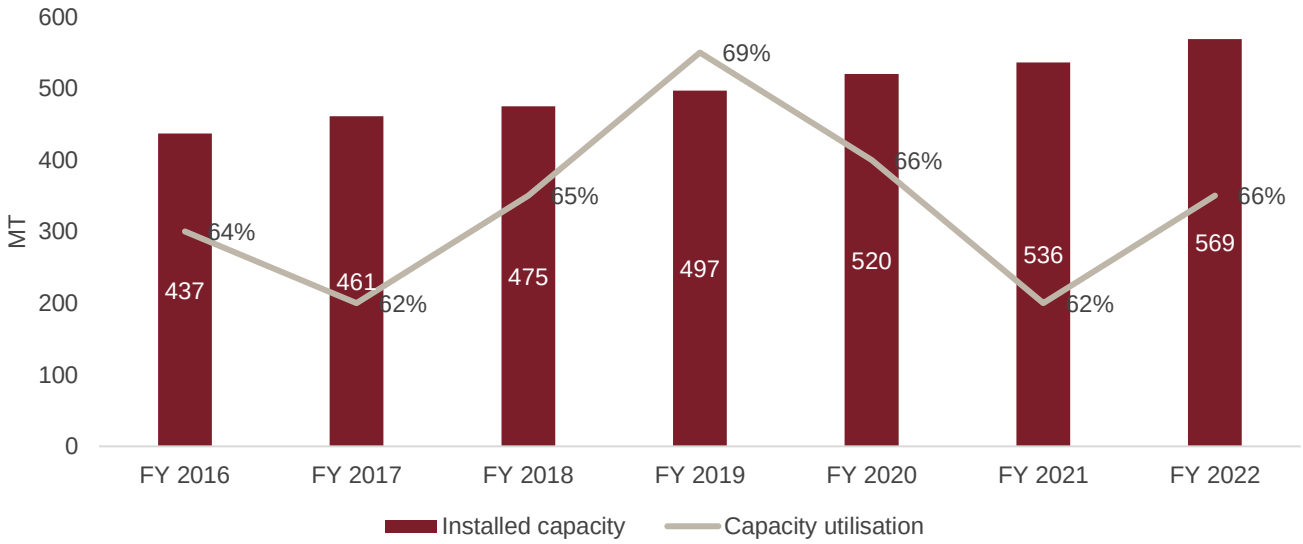
**Review of capacity additions (FY2016 – FY2022)**




*Source: CRISIL Research*

CRISIL Research expects operating rates of cement players to rise to 66-68% on-year this fiscal, after recovering to ~65% in the previous fiscal from the lows of ~62% in fiscal 2021. In fiscal 2022, a second wave of Covid-19 infections in the first quarter, seasonal weakness in the second quarter, and demand slowdown in the third quarter kept utilisation levels low. Operating rates were low also because of high capacity additions of ~33 million tonne (MT).

**Trend in capacity utilisation (FY2016 – FY2022)**



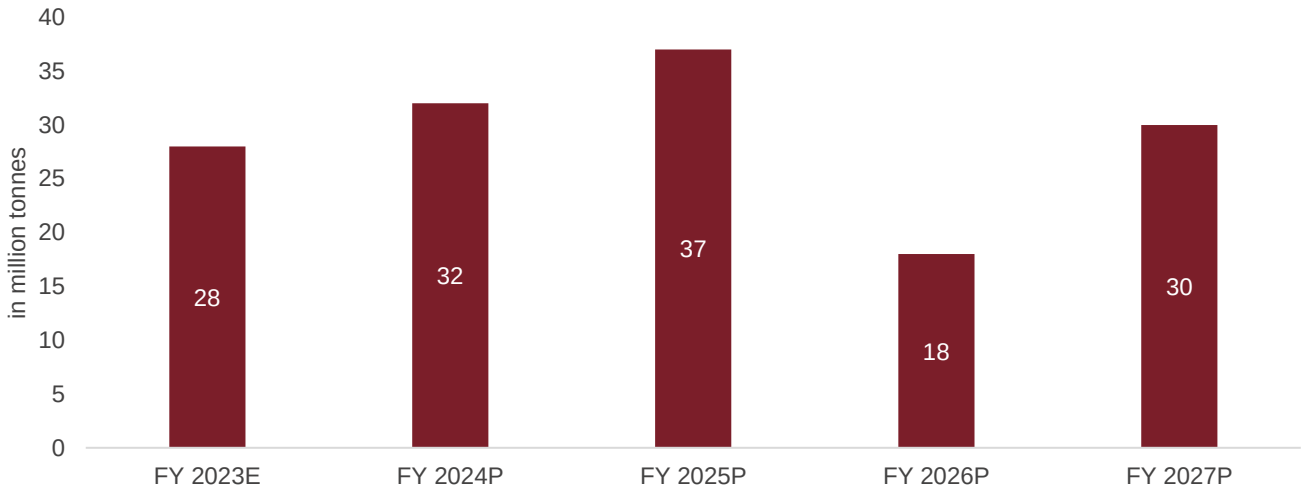

*Source: CRISIL Research*

In fiscal 2022, cement demand grew 8% (by volume) on a low to medium base in fiscal 2021. The second wave of Covid-19 hit the economic growth in the first half of fiscal 2022. However, demand for cement remained stable in the second quarter despite monsoon due to pent-up demand from the first quarter. The demand took an unexpected hit in the third quarter when unseasonal rains, labour unavailability due to wedding season, sand mining ban in some states, and festivities led to a sharp slowdown in demand momentum, leading to on-year demand de-growth of ~4%. In the fourth quarter, the demand growth was flat on-year because of high cost of building materials. Prices of commodities such as steel, aluminium, cement and aggregates rose after the Russia-Ukraine war started, leading to supply constraints and higher prices of crude-oil-derived commodities, which dampened the construction sector. Thus, after growing in double digits in the first half of the year, demand growth was limited to just 8% on an annualised basis in fiscal 2022.

## Indian cement industry outlook (FY 2021 - FY 2027P)

Players resumed capex plans in the latter half of fiscal 2021, which ran well into the next fiscal, leading to 26-27 MT capacity addition in fiscal 2022. Capacity-addition plans are expected to remain strong even in fiscal 2023, with 27-29 MT likely to be added as deferred capex. The second wave of the pandemic in the first quarter of fiscal 2022 induced short-term demand hiccups and a delay in execution. However, this did not materially affect the capex plans. Various players have announced long-term growth plans with healthy capacity addition amid increasing comfort and visibility of positive demand outlook in the long term, despite near-term headwinds due to cost inflation.

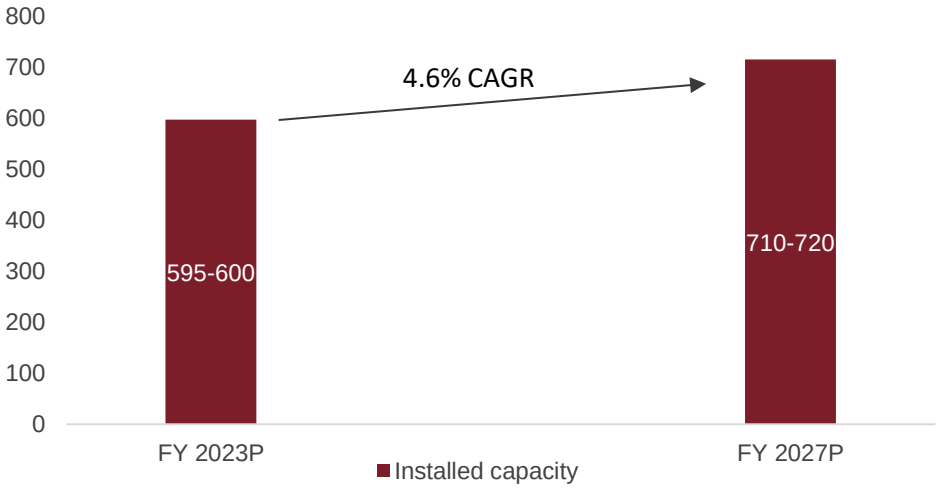
**Outlook on capacity addition (FY 2023E – FY 2027P)**




*E: Estimate P: Projected*
*Source: CRISIL Research*

In fiscal 2023, pan-India utilisation levels are projected to inch up to 66-68%, with rising demand. A further pick-up in utilisation levels will be curtailed because of additional 27-29 MT of capacities coming onstream. Capacity addition momentum is expected to continue in fiscal 2023 due to positive demand outlook and players' efforts to maintain market share by capacity in a competitive market which will lead to continued thrust towards capacity expansion especially by large players. The cement industry is estimated to have added 33 million tonne of grinding capacity in fiscal 2022 and over 15 mtpa of capacity commissioned in fiscal 2021. Over fiscals 2023 to 2027, operating rates are forecast to average 67-69%, marginally higher than the ~65% in the previous five years due to robust capacity additions to the tune of 140-150 MT over the next five years. Healthy demand growth of 5.5-6.5% CAGR over the next five years vis-a-vis 5% CAGR between fiscals 2018 and 2022 will aid utilisation levels, but higher capacity additions will limit further growth in operating rates.

**Outlook on installed capacity levels (FY 2023E – FY 2027P)**




*P: Projected E: Estimate*
*Source: CRISIL Research*

CRISIL Research expects demand to grow at a similar rate of 8-10% in fiscal 2023 after witnessing ~8% growth in fiscal 2022 as low base effect wanes and high construction costs impact demand in early fiscal 2023. However, demand is supported by tailwinds of strong demand from rural housing and infrastructure. CRISIL Research expects cement demand to log a CAGR of 5.5-6.5% over the next five years (FY23-27) against a CAGR of 4.5-5.5% in the past five years (FY18-22), driven by a raft of infrastructure investments and healthy revival in housing demand. Key infrastructure projects in the road, metros and irrigation segments and the government's thrust on capex to bolster other infrastructure will drive cement demand in the near term. Demand witnessed a robust ~18% on-year growth in the first quarter this fiscal on a low base driven by pickup in infrastructure contruction and a strong recovery in individual housing, both rural and urban. However, demand in the secod quarter is expected to have declined because of seasonal weakness as monsoons hamper construction activities across regions.

Over fiscals 2023 to 2027, operating rates are forecast to average 67-69%, marginally higher than the ~65% in the previous five years due to robust capacity additions to the tune of 140-150 MT over the next five years. Healthy demand growth of 5.5-6.5% CAGR over the next five years vis-a-vis 5% CAGR between fiscals 2018 and 2022 will aid utilisation levels, but higher capacity additions will limit further growth in operating rates.

## 5.3 Review and outlook of the Indian fertiliser industry

Natural gas is a key input for the fertiliser industry. It is used as a feedstock for production of ammonia from which most of the fertiliser such as urea is produced. The high amount of hydrogen that can be generated from natural gas is preferred compared to other fossil fuels. Natural gas is also cleaner and reduces the complexity vis-à-vis other fossil fuels. However, going forward there is also a view that ammonia can be produced from greener sources of fuel such as hydrogen which is produced using CCUS (Carbon Capture, Utilisation and Storage) technologies which doesn’t emit carbon into the atmosphere or even from hydrogen produced from renewable sources such as solar and wind which can significantly reduce the carbon footprint of the industry.

### Review of the Indian fertiliser industry (FY 2016 – FY 2022)

Fertilisers are vital for sustaining and increasing food production to meet the increasing food requirement. Fertilisers can broadly be categorised into nitrogenous, phosphatic, potassic, and complex. Application of fertilisers varies from region to region based on nutrient requirements, cost of fertilisers and farmer preferences. In India, nitrogenous fertilisers account for the bulk of consumption followed by phosphatic fertilisers.

The different chemical fertilisers differ from each other based on their nutrient content. For example, urea has 46% nitrogen and no phosphate or potassium, while DAP has 18% nitrogen, 46% phosphate and no potassium). Their application as well differs for different crops.

Different crops require different proportions of N, P and K. For instance, one tonne of paddy absorbs 9.74 kg of nitrogenous nutrient, 3.12 kg of phosphatic nutrient and 3.26 kg of potassic nutrient from the soil, while one tonne of wheat extracts 15.96 kg of nitrogenous nutrient, 1.89 kg of phosphatic nutrient and 3.43 kg of potassic nutrient from the soil.

The quantum of nutrient absorption also varies across different kinds of soil. In India, the ideal NPK usage ratio is supposed to be 4:2:1. In reality, the usage ratios differ from region to region, due to variations in soil types, crops grown and farmer price preferences. This discrepancy in the usage ratio is driven primarily by farmer preferences. For instance, the consumption of nitrogenous fertilisers in India is much higher than that of phosphatic and potassic

fertilisers. This is because the impact of nitrogenous fertiliser consumption is immediately visible and the cheaper availability of urea as compared to the other fertilizers.

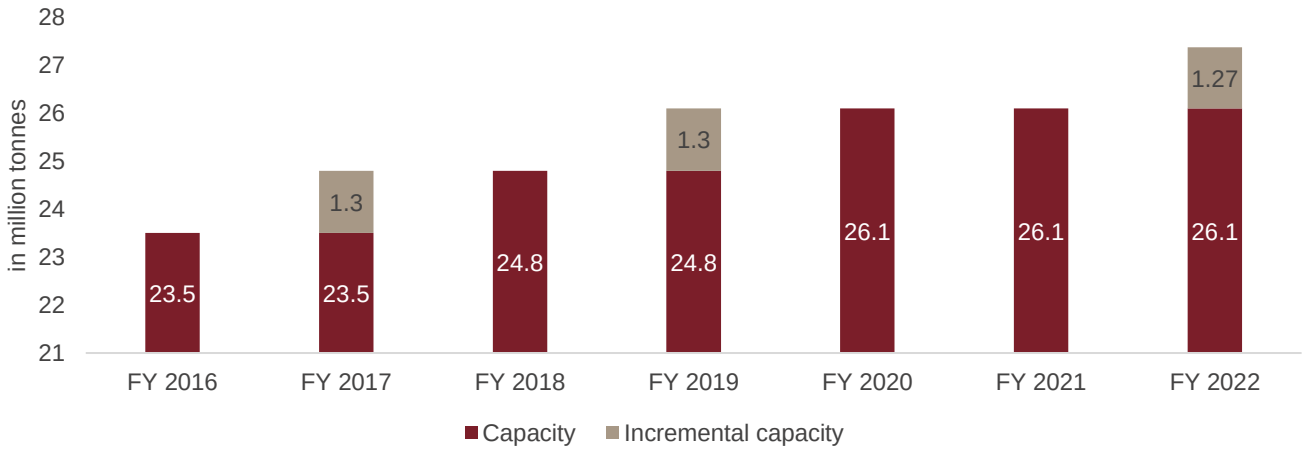
In the past decade, there has not been any significant technological advancement in the basic manufacturing process of fertilisers. The focus has largely been on refining existing processes to reduce power consumption, increase efficiency, develop better autoclave materials to enable production at a higher temperature and pressure, and improve the choice of catalysts.

The manufacture of ammonia and urea (nitrogenous fertilisers) is highly technology intensive as compared with the manufacture of complex fertilisers. The processes and equipment for almost all fertilisers (except for single super phosphate) are procured from overseas technology licensors. The basic process designs in the fertiliser industry are patented and most countries use them under a licensing system.

To reduce dependence on imports and increase domestic urea production to keep pace with demand, the government introduced the Urea Investment Policy, 2014. With the government aiming to revive sick urea plants, major capacities are likely to be commissioned in the next few years.

Urea capacity increased in fiscal 2017 on account of the commissioning of the Raniganj plant by Matix Fertilisers (1.3 MT). The plant, which started operations in October 2017, is not operational due to inadequate supply of feedstock. It is likely to re-commence operations in first quarter of fiscal 2022. Another capacity addition of 1.27 MT happened in fiscal 2019 with the commissioning of Chambal Fertilizers's Gadepan III plant in January 2019. The plant operated at optimal capacity in fiscals 2020 and 2021.

**Review of fertiliser capacity additions (FY2016 - FY2022)**




*Source: CRISIL Research*

To address the players' concerns over setting up new capacities based on relatively higher priced liquefied natural gas (LNG), the government has extended the applicability of its gas-pooling mechanism to new plants from fiscal 2019. Pooling of domestic gas and LNG has made the cost of gas for all urea plants uniform. This has benefitted new plants, which would have otherwise relied on LNG.

At the expected gas cost of $8.5 per metric million British thermal unit, floor and ceiling prices are set at $325 per tonne and $350 per tonne, respectively. Hence, with international urea prices projected to be in the $280-300 range

over the next five years (on account of a fall in capacity utilisation rates), return on net worth could be lower or might be capped at 12% in the initial few years.

Meanwhile, in the absence of the assured offtake clause, if the landed cost of international urea price is below the reimbursed price, the government may import urea to reduce its subsidy burden instead of procuring urea from domestic players. This would compel players to either lower their utilisation rates or sell excess urea in international markets at a discount, which would impact their returns.

The weak financial position of some urea companies and removal of the assured offtake clause are therefore restricting players from setting up new plants.

#### 5.3.1. Review of domestic demand for fertilisers

CRISIL Research expects domestic fertilizer demand to grow by ~3% in fiscal 2023, on a low base. In FY22, fertilizer consumption had declined by ~7% due to erratic monsoon in key months of rabi and kharif. In addition, a supply crunch for key fertilizers was witnessed on the back of elevated international prices, and limited availability of fertilizers in the global market following export curbs from key countries. Although rainfall during the season was 99% of the long period average (LPA), it was unevenly distributed at 110%, 93%, 76% and 135% of the LPA during June, July, August and September, respectively. This affected the sowing of kharif crops. In addition, there was a supply crunch in key fertilisers on the back of elevated international prices and limited availability of fertilisers in the international market following export curbs from key countries.

In fiscal 2023, we expect non-urea fertilizer consumption to grow by ~3%, while urea is also expected to grow by 3% over the last fiscal. Increasing awareness among farmers about the benefits of complex fertilizers will aid faster growth in the non-urea segment.

In fiscal 2021, the domestic demand for fertilisers increased by 7.5% (volume terms). Demand for urea and non-urea grew by 4.4% and 11.2%, respectively. Demand remained buoyant in the first half on account of timely arrival of monsoon, migration of labourers to hometowns, increased kharif acreage, improved reservoir levels, and government norms. In the second half, fertiliser demand growth moderated to 1% on-year over a high base of 10%.

### Indian fertiliser industry outlook (FY2023 – FY2026P)

CRISIL Research expects overall domestic capacity to increase ~1.3 MT by fiscal 2025. It takes between three and three-and-half years for a brownfield plant and four years for a greenfield plant to be commissioned from the date of commencement of construction.

The deadline to commission the Ramagundam revival plant was initially planned for December 2019; however, the project was delayed further to March 2020. The plant, which is expected to add 1.3 MT of urea capacity, was ready for commissioning activities as of April 2020. However, unavailability of contract labour due to Ramagundam being a Covid-19 hotspot area delayed the plant commissioning. The plant finally came on stream in August 2021.

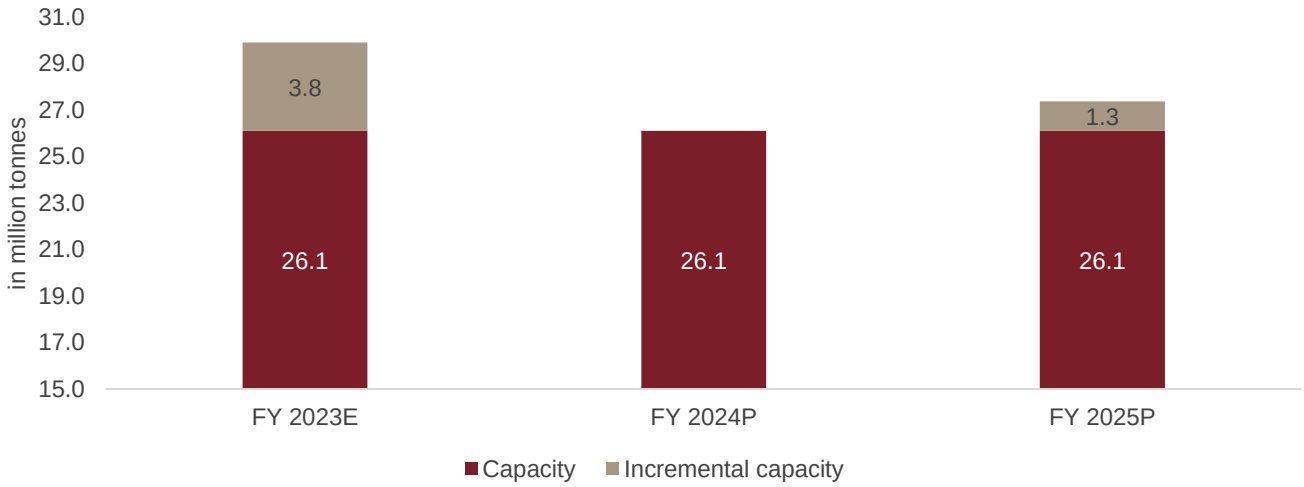
Further, the government has been trying to revive sick urea units in Sindri, Gorakhpur, Talcher, and Barauni in addition to the Ramagundam plant. The schedule for the Gorakhpur unit of Hindustan Fertilizers and Chemicals Limited has been completed. Until November 2021, Sindri and Barauni fertiliser plants achieved 92.8% and 92.5% of progress, respectively. National Fertilizers Ltd (NFL) and Rashtriya Chemicals and Fertilizers Ltd (RCF) have acquired 11% stake each in FCIL's Sindri unit.

In complex fertilisers, with existing plants already operating below ~75% capacity utilisation, CRISIL Research expects only one greenfield project in the next five years (by Krishak Bharati Cooperative Ltd with a capacity of ~1 MT).

In the case of phosphatic fertilizers, Paradeep Phosphates Ltd is in the process of enhancing production capacity of its non-urea fertilisers, including DAP (di-ammonium phosphate) and NPK (nitrogen-phosphorus-potassium) by nearly 50% to 1.8 MT from the present 1.2 MT.

In fiscal 2021 and 2022, urea imports have been almost the same in volume terms. However, rising international prices of urea and increasing natural gas prices are now big concerns in front of the Government as well as manufacturers. Soaring prices of coal in China, the main feedstock for ammonia production, forced fertilizer factories to cut production, which led to a supply crunch eventually contributing to the increased urea prices. The Russia-Ukraine crisis has worsened the situation. Amid this global issue, domestic production of urea is set to increase by 2.54 million tons with the planned commissioning of Sindri and Barauni plants of Hindustan Urvarak & Rasayan Ltd. Overall urea capacity in India is projected to increase by ~6.35 million tons by fiscal 2025. With increasing domestic production and global turmoil situation, import is expected to decline by ~20% in FY 23.

**Outlook on fertiliser capacity additions (FY 2023P – FY2025P)**




*E: Estimate P: Projected*
*Source: CRISIL Research*

### 5.3.2. Outlook on demand (FY2022 – FY2026P)

From fiscals 2023 to 2027, demand for overall fertilizers is expected to witness a compound annual growth rate (CAGR) of 2.5-3.1% to ~70 million tons. Urea is expected to grow at a 1.8-2 % CAGR to reach 36 -37 million tons by end of FY 27. Urea will continue to have a dominant share in fertilizers owing to a higher preference among marginalized farmers (constituting ~45% based on holding size) and middle-income farmers. However, growth is expected to be slower than the fifteen-year (till FY 22) CAGR of ~2.5% due to increasing awareness among farmers regarding soil fertility.

On the other hand, non-urea fertilizers are expected to register ~3.5–3.7% CAGR to reach ~35 million tons by 2027. Initiatives taken by the government (soil health card scheme) towards increasing awareness among farmers and training programs conducted by fertilizer companies will be the key growth drivers. As part of the scheme, a total of 107 million and 115 million soil health cards were distributed in the first (2015-17) and second cycle (2017-

19) of the scheme, respectively. The adoption of non-urea fertilizers is projected to increase in the long term driven by such awareness programs.

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## 5.4 Review and outlook of the Indian oilfield equipment and services industry

In oil & gas refining and other downstream processes, industrial gases such as nitrogen, hydrogen, oxygen, and CO2 are consumed for chemical synthesis. In addition, nitrogen and CO2 have been effectively used as injection fluids for enhanced oil recovery (EOR) and widely used in oil field processes for gas cycling, reservoir pressure maintenance, and gas lift. Demand for oilfield equipment and services is likely to also increase demand for cryogenic gases as higher production of crude oil will increase the demand for cryogenic gases from the downstream petrochemical industry where a variety of chemicals and other intermediates are manufactured which require industrial gases.

### Review of the Indian oilfield equipment and services industry (FY2016 – FY2022)

#### Domestic exploration & production spending to increase in 2021 as demand improves

The exploration and production (E&P) industry is dependent on the energy security requirements of countries. Any fluctuation in demand for crude oil can impact the industry. Over the years, growth in crude oil demand and the subsequent increase in oil prices provided momentum to drilling operations. However, a sharp decline in crude prices in the past years and budget cuts by oil and gas exploration companies have impacted drilling adversely, affecting oilfield services companies. With crude oil prices falling to $30 per barrel levels in the first half of 2020 due to travel restrictions from Covid-19 after recovering in 2018 and 2019, drilling operations were severely impacted in the year.

However, with the opening up of the economy the demand for crude has surged as travel after easing of restrictions has seen a strong recovery from pent-up demand. Demand for crude oil has caused prices to surge and while the recent geo-political issues surrounding Ukraine have pushed past the $100 per barrel. This has resulted in improvement in utilisation of rigs.

Oilfield equipment and services form the core of the drilling industry and investments in this form the largest capital expenditure by E&P players. With upstream players trying to curtail their operating costs by optimising usage of oilfield services and re-negotiating contract prices, oilfield equipment providers will see an erosion in their profitability.

#### E&P capital expenditure recovered in 2021, investments to increase further in 2022 and 2023

Crude oil prices declined in 2020, as the pandemic directly impacted oil demand from the road transportation and airlines industries due to the lockdown-forced restricted movement. Demand from industries also dropped as manufacturing came to a standstill. However, production cuts announced by OPEC provided some support to oil prices in the second half of 2020.

Subsequently, investments in the E&P sector took a big hit as the multi-year low oil prices rendered many projects and players, especially those operating in tough terrain, economically unviable. In fact, majors such as Shell, Total,

British Petroleum and Chevron cut their capex 15-20% for 2020. Evidently, the number of rigs in operation globally also declined.

The situation improved slightly in 2021, with recovery in demand and economic activities. However, players remained cautious about their capex and postponed significant and long-term investment until demand was visible., CRISIL Research expects global E&P spending to increase 15-20% on-year to $400-450 billion in 2022 amid increasing oil prices coupled with gradual recovery in demand leading to heightened drilling activities.

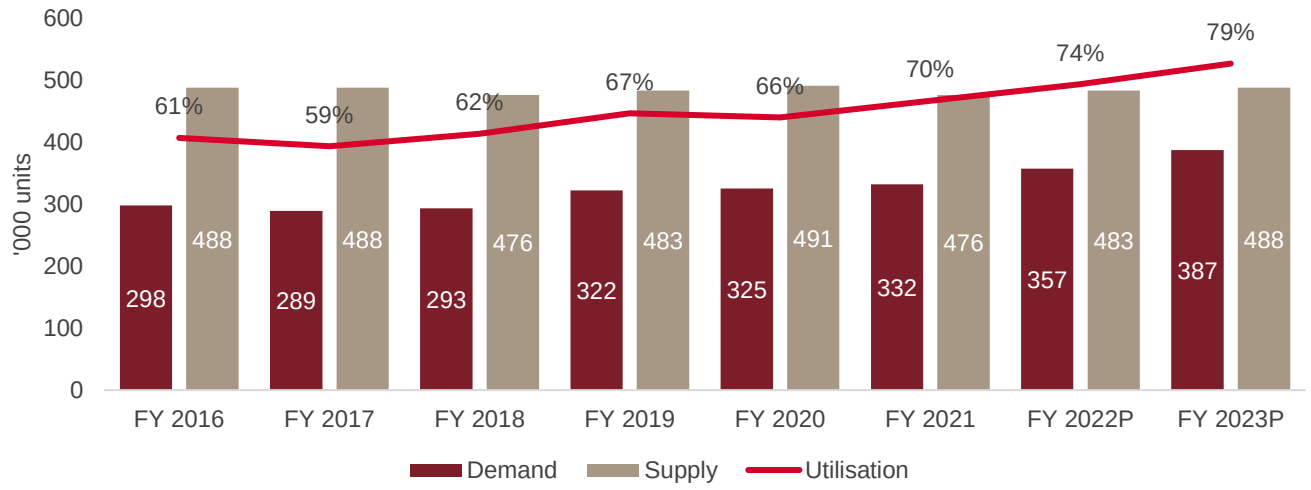
We estimate capex of domestic E&P players to have increased 12-15% on-year in fiscal 2022. Upstream investments are estimated to have increased to Rs 450-470 billion from an estimated investment of Rs ~405 billion in fiscal 2021. Only projects that are in the advanced stage of commissioning or are viable at low crude oil prices will get funds. Others will either be postponed or shelved until the prices recover.

Aggregate revenue of the domestic oilfield equipment and services industry declined ~6% on-year in fiscal 2022. Under the current market circumstances, with major E&P players announcing a significant increase in their spending budget, we expect more opportunities for these players in terms of new rig contracts. However, they may face difficulties in bagging new contracts, particularly because of their worsening financial condition, aging fleet and fierce competition from domestic and international rivals

### Leading charter rates to remain high in 2021

Leading charter rates for jack-up rigs, semi-subs and drill ships have increased in 2021, due to higher retirement of rigs. Considering the sharper decline in upstream investments and lower rig demand, retirement of older rigs and postponement of new deliveries was seen in 2020. Even in 2021, retirements were higher vis-a-vis deliveries. In 2022, we do expect elevated prices to support demand and retirement of older units to keep charter rates high. Furthermore, E&P players tried to charter advanced jack-up rigs, such as premium jack-up and harsh weather rigs, in offshore oil fields instead of semi-submersible and drill ship, wherever possible. This supported charter rates of jack-up rigs.

**Demand, supply and utilisation rates for jack-up rigs (FY2016 – FY2023)**

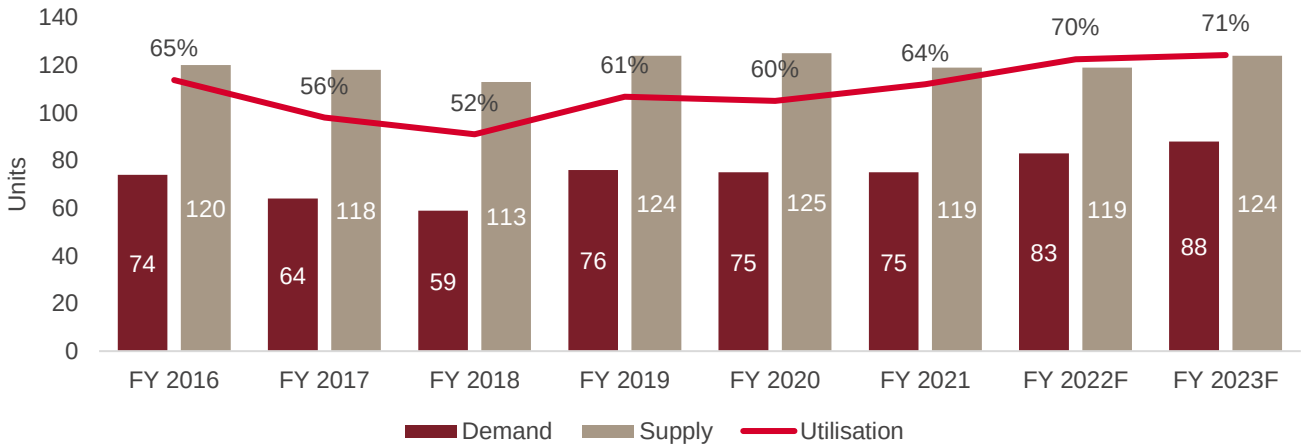



*Source: Industry, CRISIL Research*

The jack-up rigs market has improved in 2021 as E&P activities increased. However, more than one-third of current jack-up supply is 35 years of age or older, leading to high retirements in 2020 as well as 2021, with Valaris and

Borr Drilling retiring their older fleet. This was not offset by new deliveries, leading to a decline in the total fleet. Subsequently, utilisation rates are estimated to have increased to ~70% amid increase in contracted fleet and decline in total fleet. Leading charter rates of 300+ WD jack-ups are estimated to have continued to rise in 2021, due to increased demand for premium and modern rigs. Similar trend was seen in 2020 as well. The jack-ups market is expected to see an improvement in 2022 as E&P activities see an increase due to soaring crude oil prices. Utilization rates are estimated to increase to ~74% amid increase in immediate requirement to boost crude production.

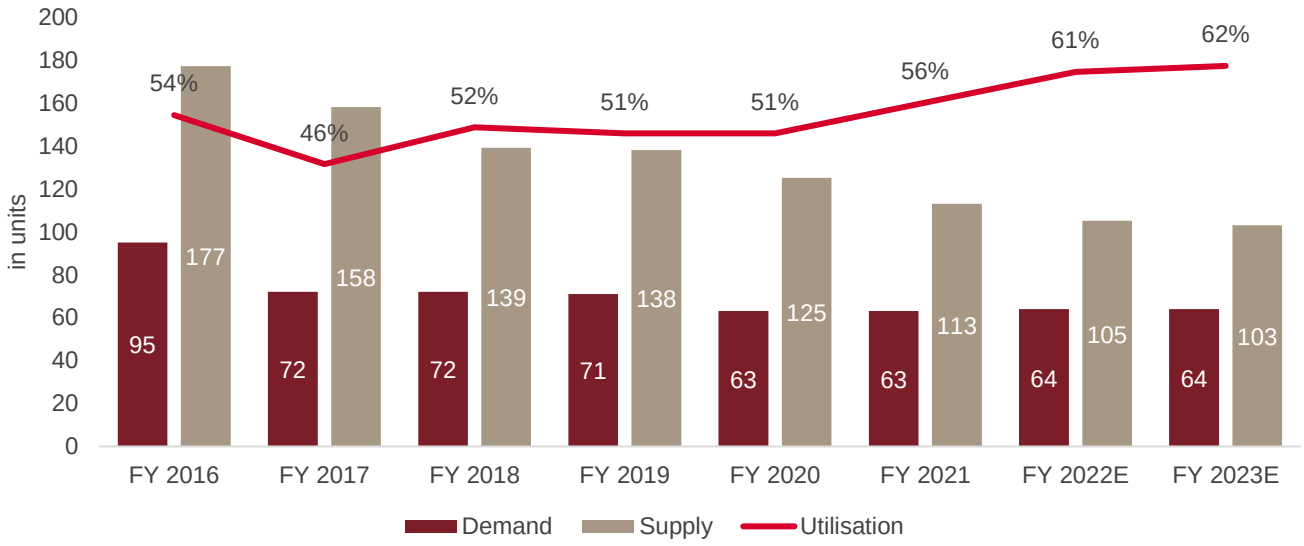
**Demand, supply, and utilisation rates for drill ships (FY2016 – FY2023)**




*Source: ndustry, CRISIL Research*

Despite the pandemic, drillship demand remained stable in 2021, with demand further expected to grow in 2022. However, increased preference for drillships vis-à-vis semi submersibles will support higher growth in the future. Eighteen drillships are under construction, all of which were scheduled to be delivered by the end of 2022. However, some of these delivery dates may be delayed. In the medium term, utilisation rates are expected to range 65-70%.

**Demand, supply, and utilisation rates for semi-submersibles (FY2016 – FY2022)**




*Source: Industry, CRISIL Research*

Demand for semi-subs declined ~11% on-year in 2020, due to reduction in drilling activities as crude oil prices declined amid the pandemic. Given the decline in oil prices in 2020, many players postponed or even shelved their investment plans for deeper and geologically challenging oil wells, as it was economically unviable for them to open, develop and operate such wells and fields at sub-$50 per barrel levels. Demand for semi-submersibles was under pressure in 2021 also and estimated to have declined 2-4% on-year in the year given the competition from drillships. Also, in 2021, six submersible ships were expected to retire against a delivery of two. However, the market is over-supplied, and we could see postponement, leading to an increase in utilisation given the reduction in total fleet. Consequent to retirement of fleets, charter rates are also expected to increase. In 2022, 5 semi-subs are expected to retire against delivery of 2. This would lead to increase in utilization levels given reduction in total fleet.

### Charter rates for offshore support vessels to increase marginally

Demand for offshore support vessels (OSVs) is linked to the demand for rigs and thus in 2022, with pick up in rig demand, demand for OSV is likely to improve. It is estimated to have moderated as more rigs equipped with dynamic positioning systems kept the requirement for AHTS (anchor handling tug supply) lower in 2020 and 2021. However, the retirement of OSVs would decline amid the oil price crisis and it will have an adverse impact on the charter rates. The decline will be restricted due to higher usage of PSVs (platform support vessels) for oil storage as the pandemic-induced lockdown has lowered oil demand, resulting in an over-supply in 2020. In 2021, an estimated marginal uptick in demand for OSVs led to increase in charter rates. Charter rates (term rates) are likely to increase in 2022 due to large number of retirements (nearly 100) and lower additions. However, in 2023, higher crude oil prices are expected to reverse the trend of retirals and thus increase supply marginally, thus leading to a slight reduction in charter rates of OSVs. In 2022 OSV demand is expected to increase ~4% on-year after remaining stable in 2021. In 2023, demand is expected to remain stable on-year.

## 5.5 Review and outlook of the India consumer durables & electronics industries

The COVID-19 pandemic sharply increased the demand for computing and connectivity devices such as laptops and mobile phones as well as home comfort products such as AC’s as people were restricted to their homes during the lockdown period. The ensuing shortage of products using electronic semiconductor devices also known as electronic chips have put the spotlight on the concentration of industry as well as the global supply chain. The shortage in such electronic devices have had an adverse impact not just on computers but also on other industries which are increasingly using newer digital technologies such as IoT, AI/ML, cloud/edge computing to become more efficient and increase productivity.

As major economies are looking to become self-sufficient / reduce their dependence on foreign supplies of essential products the Government of India too has stepped up efforts in this regard. India is already a leader in the software field but is lagging in the hardware side. The Government of India has embarked on a mission to strengthen the domestic electronics industry as well and had introduced many policies to support the sector.

Cryogenic gases cater to an array of applications in the electronics industry, such as fibre optics, flat panel displays, integrated circuit manufacturing, packaging, assembly and testing, LED technologies, photovoltaics, printed circuit board (PCB) assembly and testing, and semiconductors which are sub-components of consumer durables. The increase in electronics devices and appliances demand will drive the demand for cryogenic gases from the sector.

## Review of consumer durables and electronics industry (FY2016 - FY2022)

The domestic consumer durables industry – comprising colour televisions (CTV), refrigerators, washing machines (WM) and room air conditioners (RAC) – is estimated to have grown 12-17% in fiscal 2022 on a low base of fiscal 2021.

Second lockdown (partial/ full), restriction on sale of non-essentials; even through online mode in some states is estimated to have impacted demand during the first quarter of fiscal 2022. Air-conditioner sales witnessed higher impact as it's a peak season for them and around 35-40% of the sales happen during the first quarter. Higher product prices due to rising raw material prices will also impact demand. Demand is expected to improve with the onset of festive season in the second half of fiscal 2022. People's focus on hygiene and higher storage capaciity will push demand for washing machine and refrigerator. The household appliances sector is expected to witness 12-17% growth in fiscal 2022 on a low base of previous fiscal, expected increase in discretionary spend and waning impact of pandemic.

The CTV segment is expected to witness 10-15% growth in fiscal 2022 on account of a low base, preference for larger screen sizes, higher discretionary spending and waning impact of the pandemic. Demand slowdown following Covid-19 impacted television (TV) sales in fiscal 2021. Lockdown during the first quarter impacted sales significantly. However, with education going online, there was increased demand for CTVs to meet the need of online classes for children. Further, with people remaining at home, consumption of OTT content is being preferred on large screen. Also, with films being released on streaming services and fear of visiting multiplexes led to demand for CTVs post lockdown. Festive season fared well for CTVs. Sales improved through the online route with social distancing norms in place because of pandemic and customer's preference of having contactless buying. However, significant decline during the first quarter weighed on overall demand. Thus, sales declined ~17% in fiscal 2021.

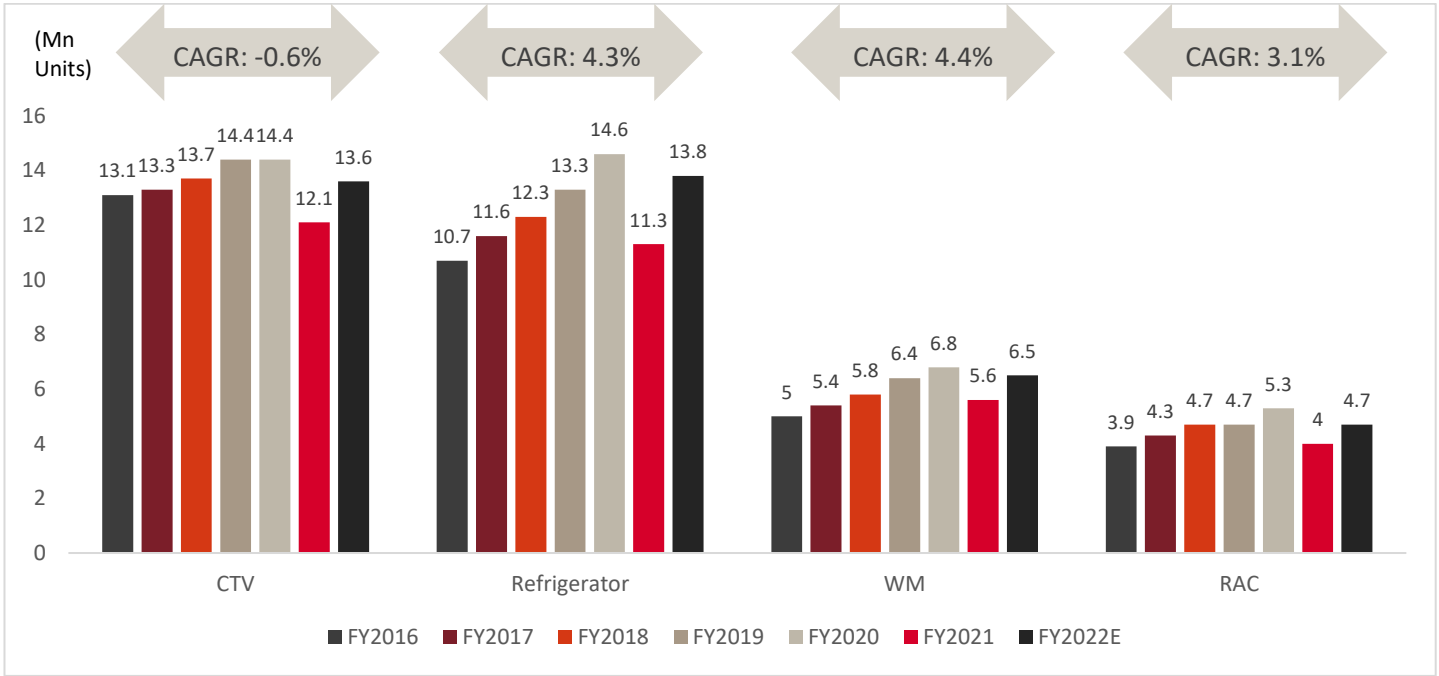
The refrigerator industry reached ~14.6 million units in fiscal 2020 driven by rising household income, growth in the number of nuclear families, and relatively lower penetration (compared with CTVs in the consumer durables industry) drove the demand for refrigerators during this period. In fiscal 2021, refrigerator household penetration is estimated at ~40% in India. While the segment fares relatively better than RACs and washing machines, it still significantly lags the CTV segment. Penetration in the rural market is much lower at ~17%, compared with urban areas, where it was estimated at ~79% in fiscal 2021. Unlike the RAC and washing machine segments, growth in the refrigerator segment is expected to be driven by higher demand from both urban and rural areas. The Washing Machine segment is expected to witness 12-17% growth in fiscal 2022 on account of a low base, people's focus on hygiene and a higher discretionary spending. A low base, higher discretionary spending, no rating revision and waning impact of the pandemic, will help refrigerator demand grow by 11-16% in fiscal 2022. Preference for higher storage capacity will drive demand for refrigerators. Lockdown (partial/ full), restriction on sale of non-essentials; even through online mode in some states is estimated to have impacted demand during the first quarter of fiscal 2022. With first quarter being most productive for AC, demand will take a beating. Demand is expected to improve during the second half of the fiscal with onset of festivals. However, with a low base of previous fiscal, demand is expected to rise by 17-22%.

Demand for semi- and fully automatic machines largely from urban and semi-urban areas. While the former caters to price-sensitive consumers in semi-urban areas, demand for fully automatic (FA) machines comes from the metros and mini metros. Although the FA segment has outpaced the semi-automatic (SA) segment in growth, over the past five years, higher prices and the requirement of continuous running water have curtailed growth of the former in semi-urban areas. Among household appliances, the penetration level of washing machines is low in

India, lagging far behind CTVs and refrigerators. Penetration level in India is estimated at ~19% of total households in fiscal 2021. Urban markets, where washing machines are estimated to have penetrated ~42% of households, account for the bulk of sales. In contrast, rural markets remain significantly under-penetrated, estimated at ~6%, due to lower electrification, consumer perception that washing machines do not clean the collars and cuffs of shirts, and easy availability of manual labour at cheap rates. Lockdown (partial/ full), restriction on sale of non-essentials; even through online mode in some states impacted demand during the first quarter of fiscal 2022. However, with increasing focus on hygiene and people staying at home, washing machine will see increased demand during fiscal 2022. With people looking at products which make their life at home more convenient, higher capacity and fully automatic washing machines are expected to witness higher traction. The segment is expected to witness 12-17% growth in fiscal 2022 on account of a low base, higher discretionary spending and waning impact of the pandemic.

A good summer in fiscal 2018 aided a growth of ~9% in the RACs segment. The Bureau of Energy Efficiency (BEE) revisions led to rise in AC prices in fiscal 2019 and impacted growth. Demand slowdown following Covid-19 impacted AC sales in fiscal 2021. Sales are estimated to have witnessed a decline of around 70% in the first quarter owing to lockdown. First quarter forms around 35-40% of overall sales during the year. Thus, sales decline during the first quarter weighed heavily on the whole fiscal. Sales improved during the second half of the fiscal especially during festivals. Overall, AC demand declined by ~25% in fiscal 2021. Lockdown (partial/ full), restriction on sale of non-essentials; even through online mode in some states impacted demand during the first quarter of fiscal 2022. Demand is expected to improve during the second half of the fiscal with onset of festivals. Players are expected to give various offers such as bundled schemes, extended warranties and various consumer finance offers to drive demand. Multiple finance offers include cashback on credit cards and easy EMI offers. With a low base of previous fiscal, demand is expected to rise by 17-22% in fiscal 2022.

**Review of domestic consumer durable sales trend (FY2016 – FY2022)**




*E: Estimate*

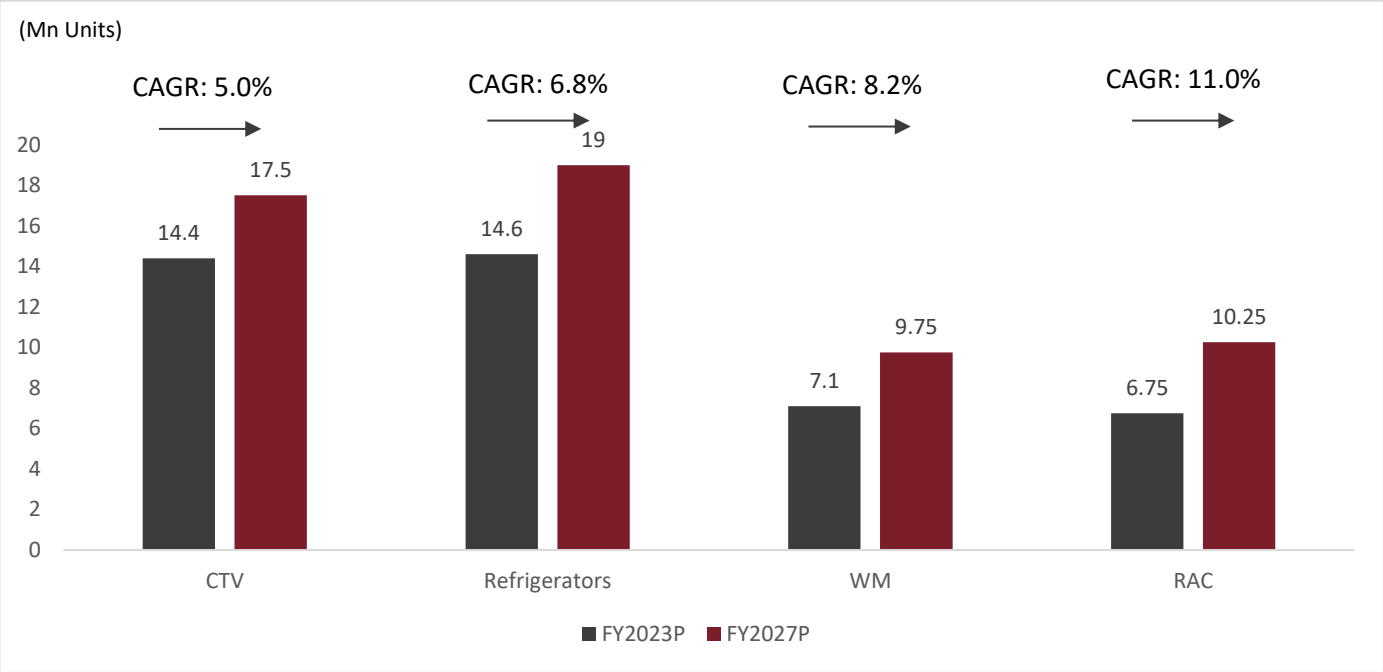
*Source: Industry, CRISIL Research*

## Outlook for consumer durables and electronics industry (FY2023P - FY2026P)

CRISIL Research projects long-term demand for consumer durables and electronics to witness healthy growth on increasing affordability because of stable product prices, easy financing options, increased government spending on rural infrastructure amid higher economic growth, and assuming moderate inflation. Volume growth will be driven by better affordability, shorter replacement cycles, multiple ownership (in the case of CTVs) and current low penetration levels (in the case of other appliances). Between fiscals 2021 and 2026, revenue of the household appliances industry is forecast to grow at 12-14% CAGR. Revenue CAGR over the last 5 year was ~3%, mainly on account of decline in revenues in fiscal 2021.

Although CTVs had the highest penetration among household appliances in fiscal 2021 (57% of total households), rural penetration is still low at ~38%. Rising demand in under-penetrated rural areas and replacement demand, as well as multiple ownership in urban areas could drive long-term growth. The overall TV market is projected to clock 6-7% CAGR in volume terms in long term from fiscal 2021 till fiscal 2026. The CTV market is expected to grow at a CAGR of 5.0% from fiscals 2023 to 2027. In refrigerators, direct-cool and frost-free segments are likely to post CAGR of 8.5-9.5% and 9.5-10.5% respectively in volume terms between fiscals 2021 and 2026. While urban areas will drive demand for frost-free refrigerators, semi-urban and rural areas will mainly lean on direct cool refrigerators, with rural consumers now considering refrigerators as a necessity as well. The refrigerator market is expected to grow at a CAGR of 6.8% from fiscals 2023 to 2027. In washing machines, growth in demand in volume terms for fully automatic (FA) machines could outpace semi-automatic (SA) machines over the next five years. The growth in FA and SA machines is expected to grow at 11-12% CAGR and 8-9% CAGR respectively. While urban areas are likely to drive demand for fully automatic machines, with growing number of working women and rising disposable incomes, price-sensitive consumers in semi-urban areas will drive demand for semi-automatic machines. In fiscal 2021, RAC penetration was only ~16% of total Indian households. Over the next five years from fiscal 2021, the segment is expected to record 13-15% CAGR in volume terms. CRISIL Research expects the washing machine market to grow at a CAGR of 8.2% between 2023 and 2027. The segment will grow riding on low penetration, growing multiple ownership and increased perception among consumers about RACs being a necessity. It is expected to penetrate 22-24% of total Indian households by fiscal 2026. Within the segment, split ACs are likely to log 14-16% CAGR in volume terms over the period fiscal 2021 and fiscal 2026 vis-a-vis 2-3% growth in window AC sales volume. The urban markets are more likely to drive RAC sales, as price-sensitive rural consumers are still reluctant to purchase RACs. The RAC market is estimated to grow at a CAGR of 11.0% from fiscals 2023 to 2027

**Outlook on domestic consumer durable sales trend (FY23P-FY27P)**




*P: Projected*
*Source: Industry, CRISIL Research*

## Key trends and developments in the electronics and consumer durables industry

To enable the growth and development of the industry the government has taken many steps such as launch of the India Semiconductor Mission, Rs. 760 billion budget to support manufacturing, PLI scheme, SemiconIndia conference to encourage interaction amongst stakeholders and catalize the growth of the industry. As per the governments' semiconductor vision document India will consume semiconductors of around USD 70-80 billion to manufacture electronics products worth $300 billion by 2026 with $120 billion of export. The government aims to double India's electronics output by FY2026 from FY2020 levels.

### 5.5.1. India Semiconductor Mission (ISM)

To achieve self-sufficiency in electronics & semiconductors Union Cabinet has approved the Semicon India programme with a total outlay of INR 760 billion for the development of semiconductor and display manufacturing ecosystem in the country. The programme aims to provide financial support to companies investing in semiconductors, display manufacturing and design ecosystem.

India Semiconductor Mission (ISM) has been setup as an independent business division within Digital India Corporation with administrative and financial autonomy to formulate and drive India's long-term strategies for developing semiconductors and display manufacturing facilities and semiconductor design ecosystem. ISM will serve as the nodal agency for implementation of the schemes announced by the government to support the electronics manufacturing ecosystem in India:

- Scheme for setting up of semiconductor fabs in India provides fiscal support to eligible applicants and is aimed at attracting large investments for setting up semiconductor wafer fabrication facilities in the country. Following fiscal support has been approved under the scheme:

- 28nm or Lower - Up to 50% of the Project Cost
- Above 28 nm to 45nm - Up to 40% of the Project Cost
- Above 45 nm to 65nm - Up to 30% of the Project Cost

- Scheme for setting up of Display Fabs in India provides fiscal support to eligible applicants and is aimed at attracting large investments for setting up TFT LCD / AMOLED based display fabrication facilities in the country. The Scheme provides fiscal support of up to 50% of Project Cost subject to a ceiling of INR 120 billion per fab.
- Scheme for setting up of Compound Semiconductors / Silicon Photonics / Sensors Fab and Semiconductor Assembly, Testing, Marking and Packaging (ATMP) / OSAT facilities in India provides a fiscal support of 30% of the Capital Expenditure to the eligible applicants for setting up of Compound Semiconductors / Silicon Photonics (SiPh) / Sensors (including MEMS) Fab and Semiconductor ATMP / OSAT facilities.
- Design Linked Incentive (DLI) Scheme offers financial incentives, design infrastructure support across various stages of development and deployment of semiconductor design for Integrated Circuits (ICs), Chipsets, System on Chips (SoCs), Systems & IP Cores and semiconductor linked design. The scheme provides “Product Design Linked Incentive” of up to 50% of the eligible expenditure subject to a ceiling of ₹150 millon per application and “Deployment Linked Incentive” of 6% to 4% of net sales turnover over 5 years subject to a ceiling of ₹300 million per application.

### 5.5.2. Launch of SemiconIndia

Government has launched the SemiconIndia conference with the aim to make India a global hub for Semiconductor Design, Manufacturing and Technology Development which will help propel the vision of India Semiconductor Mission. The Conference aims to bring together leaders from industry, academia and research institutions to catalize the growth of India’s semiconductor and electronics manufacturing ambitions.

The conference serves as the formal launch pad of India’s semiconductor strategy and policy which envisions making India a global hub for Electronics System Design and Manufacturing. The maiden conference of SemiconInda was held in 2022 from April 29$^{th}$ to May 1$^{st}$.

### 5.5.3. PLI scheme for the white goods industry

- The PLI scheme for white goods (air conditioners and LED lights) has been implemented for fiscals 2022-2029, with a budgetary outlay of Rs 62.4 billion
- The scheme intends to remove sectoral disabilities, create economies of scale, enhance exports, create a robust component ecosystem and employment generation
- The scheme for ACs covers high-value intermediates (copper tubes, aluminium foils, and compressors) and low-value intermediates (PCB assembly for controllers, BLDC motors, service valves and cross flow fans for AC and other components)
- The scheme for LED lights covers core components, such as LED chip packaging, resistors, ICs, fuses, large-scale investments in other components and lighting products such as LED chips/ drivers/ engines, mechanicals, packaging, modules, wire-wound inductors and other components

- The scheme will extend an incentive of 4-6% on incremental sales of goods manufactured in India to manufacturers of ACs and LED lights

#### 5.5.4. PLI scheme for large-scale electronics manufacturing

- The PLI scheme for electronic systems (laptops, mobile phones, tablets, PCs, servers and specified electronic components) has been implemented for fiscals 2021-2025, with a budgetary outlay of Rs 409.5 billion
- The scheme intends to boost domestic manufacturing and attract large investments in the electronics manufacturing industry, including electronic components and semiconductor packaging
- The scheme will extend an incentive of 4-6% on incremental sales of goods manufactured in India to companies engaged in manufacturing of goods covered under target segments.

The government has received proposals from five companies for setting up the electronic chip and display manufacturing plants with an investment of Rs 1.53 trillion under the Semicon India Programme. Vedanta Foxconn JV, IGSS Ventures and ISMC have proposed to set up electronic chip manufacturing plants with USD 13.6 billion investment and Vedanta and Elest have proposed to set up display manufacturing units.

## 5.6 Review and outlook of the consumer foods industry

The consumer foods industry used many cryogenic gases such as liquid nitrogen and carbon dioxide (as dry ice) used as refrigerants, owing to their versatile nature and their wide performance range. These gases are commonly used for the preservation, cooling, and freezing of products in the industry. In addition, these gases are used in the research and laboratory applications of the consumer foods industry.

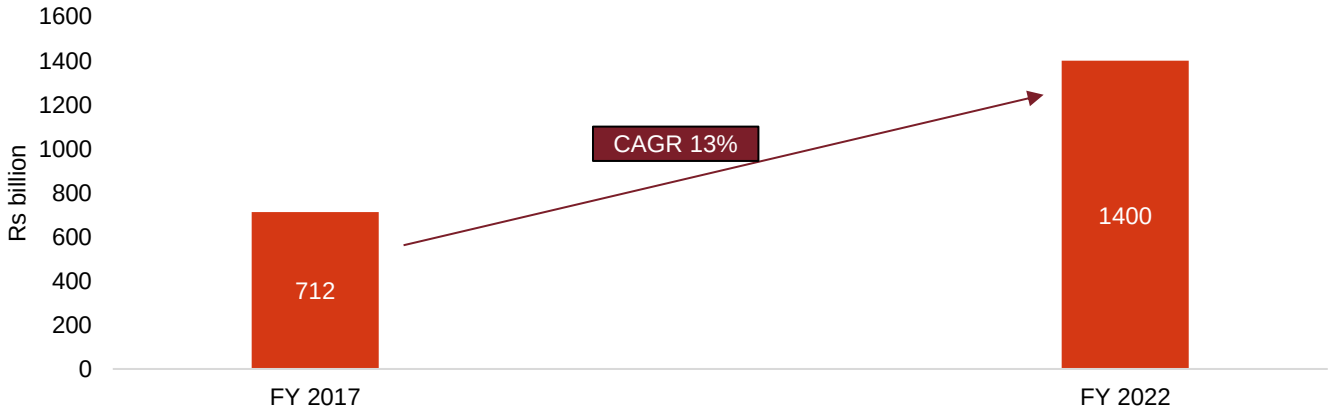
### Review of the consumer foods industry (FY2016 - FY2022)

CRISIL Research estimates the market size of the Indian organized consumer foods industry to be about 1.4 trillion in fiscal 2023. We expect the industry to slightly moderate but continue its growth trajectory in fiscal 2023 and fiscal 2024 led by strong rural demand, favorable population demographics, rising incomes and transition towards premium, healthy and nutritious products. According to CRISIL Research, the domestic consumer foods industry manufactures products through two main routes – contract and standalone. Standalone manufacturing is most preferred for high-value products, as the technology control is retained by the parent company; 55-60% products are manufactured through this route. Contract manufacturing is usually employed by large players, especially in the biscuits and bakery items segment, when a large multinational company wants to expand reach/penetration within a region rapidly and the market volumes are sizeable, while incurring minimal capex.

Organised consumer food industry which grew by 14% between fiscal 2017 and fiscal 2022 is expected to grow by 12-14% in fiscal 2023. The sales growth is expected to marginally improve to 13-15% in fiscal 2024. Rapidly growing modern retail shops (supermarkets and hypermarkets) in urban areas, owing to consumers increasingly preferring to buy 'all under one roof', are expected to drive sales of packaged foods. Online sales are estimated to have risen from 1% share in fiscal 2019 to more than 5% share in fiscal 2022 with more people preferring to order from the convenience of their home. Ease in mobility restrictions, increased social gatherings, recovery in institutional sales and improved activity in key sales points (such as railway stations, bus stations, markets and highways) propelled demand. With rising incomes and rapid urbanisation, consumers appear to prefer premium, nutritious, and healthy foods.

Prices of palm oil, potato and milk which had risen significantly in fiscal 2022 are expected to soften in the current fiscal. However, prices of wheat and maize are expected to remain elevated in the current fiscal amid lower production and declining ending stocks in the country.

**Review of the Indian consumer foods industry (FY2017 – FY2022)**



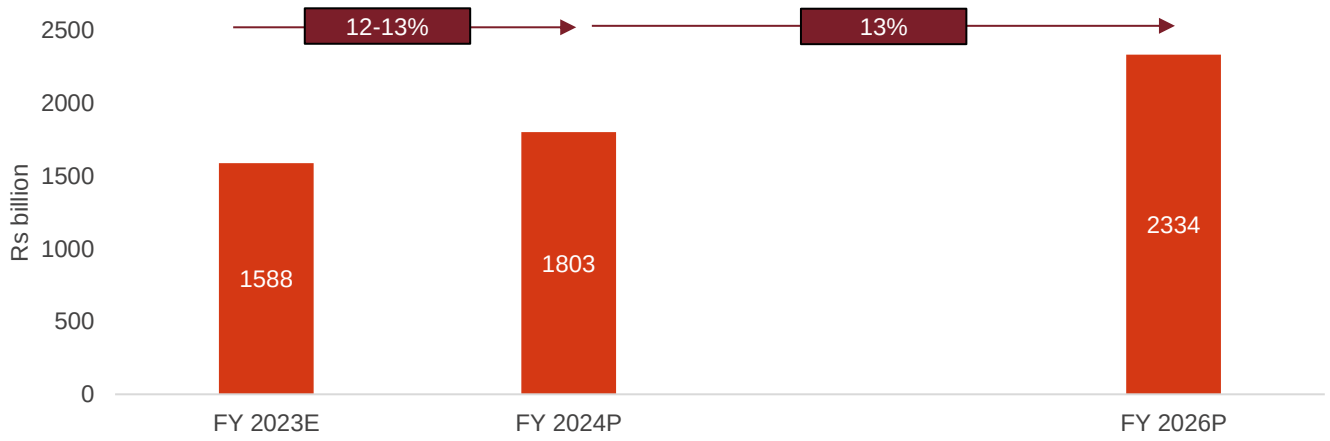

*Source: Industry, CRISIL Research*

## Outlook of the consumer foods industry (FY2023P - FY2026P)

The consumer foods industry is expected to grow 12-13% y-o-y in fiscal 2023 and improve marginally to 12-13% y-o-y in fiscal 2024. Bakery products are expected to register stable growth in the two fiscals, on account of better volume growth in biscuits led by premium and healthy categories after a sales lull in fiscal 2022. With ease in mobility restrictions, the out-of-home consumption of snacks increased, resulting in strong revenue growth in fiscal 2022. Improved penetration of the organised sector amid the pandemic and new bakery products in regional flavours will drive growth of the industry in fiscals 2023 and 2024. Chocolates and confectionery items, being impulse products, witnessed an uptick in fiscal 2022. Reopening of schools, colleges and increased opportunity of celebrations will help the industry surpass the pre-pandemic growth rate in fiscal 2023. Ready to eat/ ready to cook (RTE/RTC) food products are expected to witness strong demand from the B2C channel due to convenience and increase in demand from key sectors such as Horeca (hotels, restaurant, and catering), railways and airlines. The B2B channel will aid RTE/RTC products in fiscals 2023 and 2024.

The biscuit segment's margins are expected to increase slightly in fiscals 2023 and 2024, on account of softening of raw material prices, after contracting 100 bps in fiscal 2022. The bread segment's margin is expected to remain stable in fiscals 2023 and 2024, led by steady demand amid softening of raw material prices. Input prices grew at higher pace than what the industry anticipated, resulting in margin contraction of bread products in fiscal 2022. The chocolate and confectionery segment's margin is expected to expand in fiscal 2023, with cooling down of prices of key raw material. It is expected to remain stable in fiscal 2024. Despite strong rebound in sales of snacks on account of increased out-of-home consumption, margin contracted in fiscal 2022 due to 36% on-year hike in palm oil prices. We expect margin to expand in fiscals 2023 and 2024, as prices of key raw materials, such as palm oil, cools down amid steady demand. The RTE/RTC segment's margin was impacted by higher freight costs as the industry has significant exposure to exports. Revival in global demand, as the pandemic subsides, will keep margins stable.

**Outlook on the Indian consumer foods industry (FY23P-FY24P)**




*Source: Industry, CRISIL Research*

### PLI scheme for food processing

- The scheme was announced on March 31, 2021, with an outlay of Rs 109 billion over fiscals 2022-2027
- It was intended to support Indian brands in the markets abroad and create global food manufacturing champions in India
- The scheme covers RTC/RTE foods, processed fruits and vegetables, marine products and mozzarella cheese
- It targets expansion of food processing capacity by nearly Rs 300 billion and creation of additional direct and indirect employment opportunities for 0.25 million persons by fiscal 2027

## 5.7 Review and outlook of the dairy & milk products industry

Dairy products can quickly deteriorate in quality due to microbial growth and fermentation of products. To prevent this from happening and extend shelf life a variety of gases are used for cooling and packaging of dairy products. Rising dairy intake is likely to increase demand for industrial gases from the dairy industry.

### Review of the dairy & milk products industry (FY2016 - FY2023P)

India is the highest producer and consumer of milk globally and among the fastest growing dairy markets. Domestic milk production has averaged 25-30% share in global milk production since 2015. However, limited quantities of milk left for exports and government regulations, such as regular bans on exports of high-volume products like milk powder and imports limited to premium varieties of butter and cheese, have kept India's share in the milk trade low.

Milk production in India was ~188 million tonne in fiscal 2019 and is estimated to have been 198 million tonne in fiscal 2020. Uttar Pradesh, Rajasthan, Andhra Pradesh, Gujarat, Punjab, Maharashtra, Madhya Pradesh and Tamil Nadu collectively accounted for much of the country's total milk production in fiscal 2020. Uttar Pradesh is the largest milk producer and Punjab has the highest per capita availability.

Domestic milk production logged a CAGR of 6.3% between fiscals 2016 and 2020. However, in fiscal 2021, it fell 3% as Covid-19 affected artificial insemination services in the first quarter. Further, a sharp fall in milk procurement price left limited funds with farmers to invest in their animals. A rise in fodder prices added to the cash crunch, leading to a fall in milk production. In the absence of lockdown restrictions, artificial insemination grew 4% in fiscal

2022, compared with a decline of 2% in fiscal 2021, which will increase milk production this fiscal. Further aided by an expected normal monsoon, milk production is set to grow 6.5-7% this fiscal.

In fiscal 2022, Covid-19 infections in rural regions of the country were more severe, and farmers incurred high medical expenses, which, in turn, hampered their investment in animals. As in fiscal 2021, artificial insemination services saw obstructions again as plants producing liquid nitrogen were directed to produce oxygen. Liquid nitrogen is a key element used in storing animal semen. The short supply of liquid nitrogen is expected to have impacted artificial insemination adversely, slowing down milk production.

This year, demand from the institutional and HORECA (hotel, restaurant and cafe) segments is up because of an increase in social gatherings, outings and travel, and reopening of schools and institutions. Companies that had resorted to selling their products such as ice cream, cheese, SMP and khoa, in smaller packages for retail consumption in fiscals 2021 and 2022 have seen demand rebound for wholesale packs. With changes in eating habits after the lockdown, household consumption of cheese and paneer had increased substantially by about 15%.

The milk segment is expected to grow at 10% this fiscal, similar to the past five-year-CAGR of 9%. The impact of Covid-19 has subsided, industrial demand has returned to pre-pandemic levels and household consumption has been growing steadily. Household consumption will continue growing at a steady pace in fiscal 2024 as well. While household demand for milk increased during the pandemic in fiscal 2021, demand from the hotels, restaurants and catering (HORECA) segment picked up in fiscal 2022. That said, as restaurants and cafes were still not operating at their full capacity, household demand drove the 5% growth in fiscal 2022

### Highly fragmented and unorganised

The organised segment of the domestic dairy sector comprises cooperatives, private companies, and producer companies (companies set up with the help of the National Dairy Development Board), while the unorganised segment comprises local vendors and dairy farmers selling within their area of production.

As of fiscal 2019, unorganised players dominated the Indian dairy industry with ~60% share in the retail market of dairy products. Going forward, the organised segment is expected to grow at a faster pace of 16-18% than the unorganised segment's 12-13%. This is expected boost the share of organised players in the near future. Rising consumerism, growing urbanisation, and preference for branded packaged foods will primarily drive this trend.

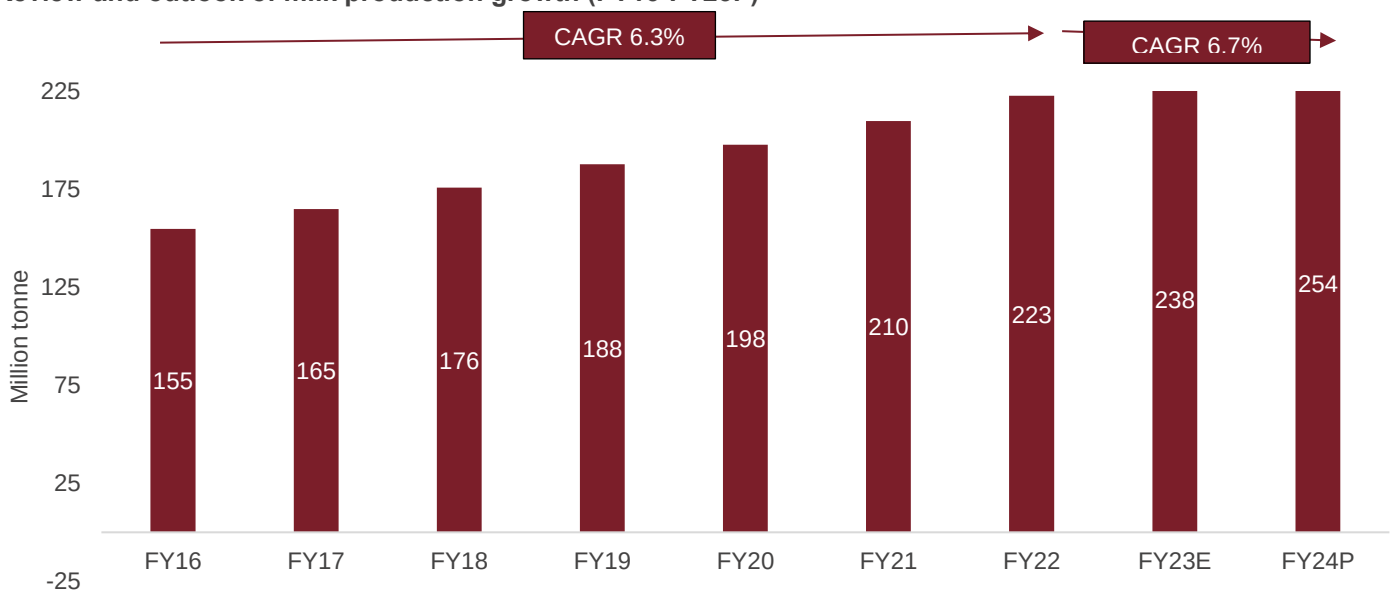
Also, private players are expected to increase their capital investment, which will help them wrest market share from unorganised players. The presence of cooperatives is the highest in Gujarat across the value chain, with the Gujarat Co-operative Milk Marketing Federation (owner of the Amul brand) alone enjoying a whopping market share of 90-95% at the retail level. It procures 85-90% of milk available for marketing in the state.

Co-operatives have upper hand in milk procurement owing to subsidies in a few states. Milk co-operatives in the country have a strong procurement and storage capacity with a wide network of collection and chilling centres at the village level. They also have vehicles that travel door to door across many villages to collect milk. Also, a few state governments such as Karnataka, Telangana, and Haryana offer subsidies of Rs 3-5 per litre to farmers for supplying milk to co-operatives. Hence, they enjoy an upper hand in milk procurement, especially in these states.

On the other hand, private players are investing heavily to strengthen their procurement and distribution network by setting up chilling centres at the village level and building relations with farmers. With the government allocating Rs.

150 billion to incentivise private dairy processing, select states where private players have a strong hold are expected to benefit.

**Review and outlook of milk production growth (FY16-FY23P)**




*Source: NDDB, industry, CRISIL Research*

## 5.8 Review and outlook of the Indian ceramic tiles industry

### Review and outlook of the Indian ceramic tiles industry (FY2016 – FY2024P)

The ceramics industry majorly uses natural gas in the ceramic production process. The ceramic industry is broadly classified under ceramic tiles, glazed vitrified tiles and polished vitrified tiles. Ceramic tiles are used in residential and commercial spaces, primarily for flooring purposes. They are also used for covering walls. The ceramic tiles industry is classified under ceramic and vitrified tiles, and further divided into glazed vitrified and polished vitrified tiles. It is marked by intense competition, due to large presence of the unorganized sector and availability of cheaper Chinese imports.

Ceramic tiles are manufactured by both, large players, and small and medium enterprises, with wide variance in type, size, quality and standard. In terms of production, India ranks third in the world in the ceramic tiles and sanitaryware sector.

Lower-end ceramic tiles face competition from mosaic tiles, whereas the higher-end polished and glazed vitrified tiles face competition from marble flooring.

The Morbi region in western Gujarat is the largest manufacturing hub of ceramic tiles in the country. With over 600 unorganised players along with several joint ventures (JVs) of large players such as Kajaria and H&R Johnson, this region accounts for 80% of India's total ceramic production. This cluster and the adjoining areas are rich in red soil - a basic raw material needed for manufacturing China clay. Other raw materials such as quartz (source of silica) and feldspar are also available, else transported from Rajasthan.

Organised players have outpaced unorganised smaller players over the past few fiscals and hold over 50% market share in value terms since fiscal 2019. Larger players would continue to wrest more market share from smaller

players on the back of higher degree of innovation, wider product range, better distribution network, premiumisation and greater spending on advertisement and marketing initiatives. NGT ban on coal gasifier starting April 2019, along with stricter implementation of E-way bill regulations have helped large players to increase their market share so far.

Liquidity issues due to the NBFC crisis was in the favour of organised players further. As builders faced liquidity issues, receivable days for tile players spiked. Organised players with better liquidity positions were able to operate freely, while SME players were stretched in meeting their working capital needs.

In fiscal 2021, the domestic industry witnessed a 15-20% contraction in volume as well as revenue, while the organised segment largely defended any contraction in volume or value and gained market share. This is also partially attributed to significant rise in exports demand across the globe post imposition of anti-dumping duty on China by the US and China's focus on less carbon footprint from polluting industries such as ceramic tiles, which led to unorganised players focusing only on exports.

Further, continued widening of the dealership network with net dealer addition, as well as rapid penetration into tier 3/4/5 markets and rural markets by organised players left little room for unorganised players in the domestic market.

While the domestic market is estimated to bounce back to its pre-pandemic levels in volume and value terms in fiscal 2022 as well, organised players are further likely to strengthen their position in the domestic market at the cost of the unorganised set, following expansion of distribution network, and better product offerings and brand recall.

Going forward, in fiscals 2023 and 2024, we expect the domestic market to continue to witness rising dominance of organised players as lucrative export opportunities (due to subdued exports from China and tapping into new markets by Indian exporters) in the international markets continue to keep unorganised players engaged in those segments.

**Slew of capacity additions expected by fiscal 2023; key organised players eyeing premium segments, unorganised players to add capacities in wall and floor segments**

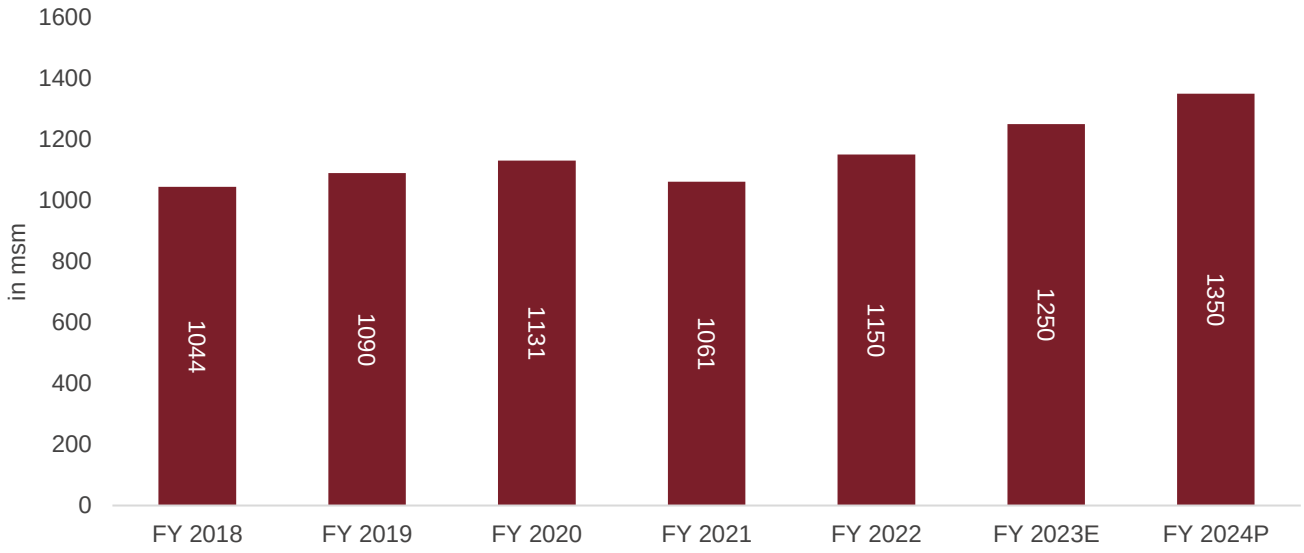
Over the past few years, financials of unorganised players had remained moderate; several players had been under financial stress. This provided large players an opportunity to acquire plants at attractive valuations. The average cost of acquisition is significantly lower at Rs 70-75 million per million square metres (msm), as compared to the cost of setting up a greenfield / brownfield plant. This has led to several joint ventures between large players such as Kajaria, Somany and HR Johnson with small players located in Morbi, Gujarat. The main objective of entering into joint ventures is to add capacity without the gestation period at low cost. It also helps the players expand their footprint. Over a period of time, JVs have become the backbone of capacity expansion, in fact, JVs and contract manufacturing accounted for ~52% of the sales of these players in fiscal 2021 and the first half of fiscal 2022.

In fiscal 2021, large companies such as Kajaria, Somany and Asian Granito announced their capex plans and new capacity augmentation would come into effect in end-fiscal 2022 or early fiscal 2023. Kajaria and Somany are together expected to add up to 24-25 MSM of capacity over the next 2-3 quarters, a combination of both greenfield as well as brownfield expansion. The enhanced capacity additions are set to take place in premium segments such as GVT and PVT.

This capacity expansion and consequent higher sales volumes shall lead to these players further strengthening their hold in the industry. Stronger brand equity, better distribution network, and higher awareness owing to more ad spending are expected to aid major brands in registering robust growth, going forward. Also, organised players mostly cater to the faster-growing segments - vitrified and polished tiles - which will also help them grow faster in value terms and provide increased profitability.

The unorganised segment, on the other hand, had refrained from making any significant capex plans and capacity expansion over the past few fiscals. However, with unprecedented growth in the export markets and favourable near-to-medium term dynamics, the unorganised segment has also announced capacity expansion plans. The segment is likely to add more than 50 new plants with an estimated aggregate capacity of over 125 MSM of ceramic tiles (floor and wall). These plants are likely to be export-oriented plants and are expected to be commissioned by fiscal 2023.

**Trend in ceramic tiles production (FY2018 – FY2024P)**




*E: Estimated; P: Projected*
*Source: Industry, CRISIL Research*

## Domestic demand outlook

The market size of the Indian ceramic tile industry (domestic consumption) is estimated at Rs 285-300 billion for the fiscal 2023. The organised segment accounts for more than ~65% of the total market in value terms, largely because of significant market share gains from the unorganised players post the pandemic. The Indian ceramic tiles industry formed 6-8% of the global ceramic tiles industry in fiscal 2022. According to CRISIL Research overall industry volumes are expected to see ~8% growth in fiscal 2023, value growth seen at ~15% amid increase in realisations as players partially pass on increase in input costs. The organised segment is expected to witness a growth of 16-19% in value terms in the domestic market in fiscal 2023. The organised set witnessed ~22% increase in sales volumes of ceramic tiles and ~28% increase in value terms in fiscal 2022 on-year basis. This healthy performance was also attributed to widening of dealership network, penetration into tier 3/4/5 markets, introduction of a few new products and low base of fiscal 2021 etc.

After posting a sharp de-growth of ~18% in demand over one year i.e., fiscal 2021, due to the pandemic-induced lockdown and demand disruption in the domestic market, the ceramic tiles industry is estimated to exhibit a healthy recovery and growth of ~15% in fiscal 2022, largely on a low base of last fiscal and resumption of real estate project completions and is expected to rise by 6-9% in volume terms in fiscal 2023 and reach 750-780 MSM and breach pre-pandemic levels of fiscal 2020. Pent up demand from the construction segment and replacement demand to drive domestic demand in fiscal 2023, value to grow by ~10-14% to exceed fiscal 2020 levels.

The volume growth will largely be led by strong rebound in real estate construction activities as well as real estate sales across key states and cities. States such as Maharashtra, Karnataka and Gujarat have shown faster-than-envisaged rebound in home sales and completions, thereby leading to higher demand for ceramic tiles. Due to increased affordability following multi-year low interest rates, demand in the real estate sector witnessed a strong revival. Consequently, demand for tiles started gaining momentum. In fiscal 2022, we estimate real estate completions upward of around 320-325 million sq. ft as they got deferred by a year owing to the pandemic. Furthermore, replacement or renovation demand is estimated to continue its upward trajectory in fiscal 2022 as continued work from home in the services sector continues to drive overall demand for tiles.

Also, construction and completion of PMAY Urban units remained buoyant during the period as the government focused on completing the programme before the stipulated timeline. This also partially supported demand recovery in the second half of the fiscal.

Demand from the commercial segment remained moderately healthy as transaction and leasing activities increased moderately through the first half of fiscal 2022. Also, within the commercial segment, co-working or flexi working space gained momentum. Incremental demand from tier 2/3/4 cities as well revived strongly as some portion of the urban workforce chose to work from their hometown and the segment which lived in rented apartments took the advantage of increased affordability to buy a house in fiscal 2022.

A gradual recovery in the macroeconomic environment as well as higher penetration and usage of tile products is likely to bode well for the sector. As a result, CRISIL Research expects the demand for ceramic tiles to increase by 6-9% y-o-y in volume terms to reach close to 750-770 MSM and breach pre-covid levels in fiscal 2023.

With normalcy returning in the near to medium term i.e., fiscals 2023 and 2024, gradual recovery in economic activities, and the PMAY Urban programme reaching the deadline for completions, growth in volumes and value growth are expected to remain firm. Furthermore, low penetration of tiles as an application in India and expected increased propensity to spend on home improvements shall continue to drive growth, going forward. Also, a gradual favourable product mix change i.e., shift to higher value PVT & GVT segments will ensure value growth outpaces volume growth.

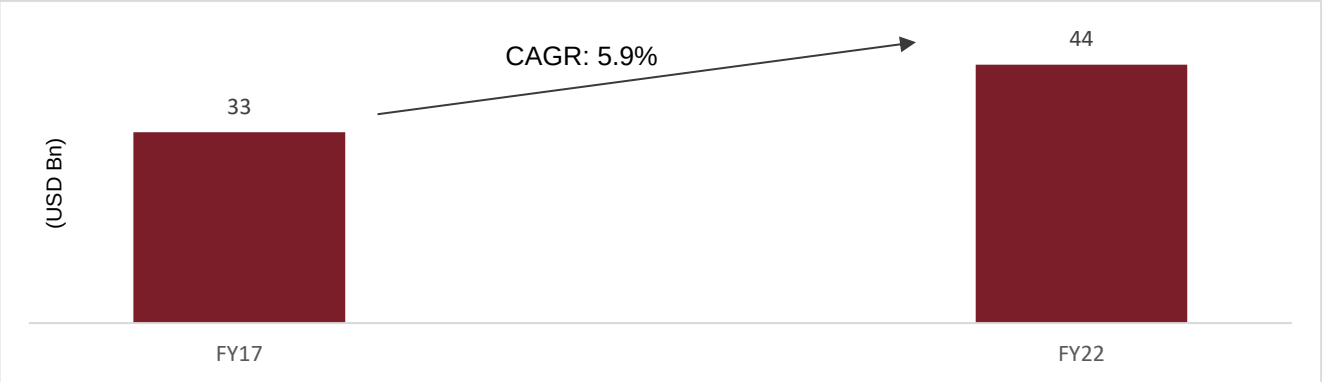
## 5.9 Review and outlook of the Indian pharmaceutical industry

A wide range of cryogenic gases are required by the pharmaceutical industry. These could be used in the synthesis of and producing chemicals used in drugs, sterilisation, and preservation of products by driving out oxygen and moisture that would otherwise reduce the quality of the product in storage or transit.

## Review of the Indian pharmaceutical industry (FY2016 – FY2022)

### Historical production (FY2016 – FY2021)

**Market size of the Indian pharmaceutical industry (FY2017 – FY2022)**




*Source: Industry, CRISIL Research*
*Note: USD INR echange rate assumed to be 80 in FY2022*

Domestic market has shown a high growth of ~15% in fiscal 2022 over a low base of fiscal 2021. Demand for anti-infective and other Covid related drugs helped the industry growth last fiscal. Moving ahead, domestic formulations are expected to grow by 7-9% in fiscal 2023. This will be led by increase in the price. However, volume growth is expected to be muted this fiscal. Exports have grown at ~8% CAGR between fiscal 2017 and fiscal 2022. For fiscal 2022, India's exports were flat on a high base of fiscal 2021. Formulation exports registered ~0% on-year growth for the year in constant currency terms. CRISIL Research expects India's formulation exports to increase by 2-4% in fiscal 2023 in constant currency terms. Growth moderation is expected due to pricing pressure in the US. New product launches, foray into specialty and complex generic products, etc. is likely to support growth in medium to long term.

Exports have been the cornerstone of growth of the Indian pharmaceutical industry, with the global market offering strong opportunities. Healthcare expenditure is spiralling the world over, with developed markets in the US and Europe seeing the steepest rise. These markets traditionally contribute the largest share to global medicine sales. Given India's strengths of cost-competitiveness and advanced process chemistry skills, domestic players are well-placed to tap into this opportunity and increase their presence in the generics market.

### Renewed regulatory interest a positive for the sector

The recent supply disruption in the wake of the pandemic has resulted in the government taking proactive steps to boost domestic manufacturing and bring down costs. A regulatory boost, along with strong process chemistry skills, will continue to help the Indian bulk drugs industry garner a big share of the global bulk drug exports pie. We expect growth to pick up in the coming years on account of product diversification and increased global demand.

The Union Cabinet, on March 21, 2020, approved the below schemes for the development of the Indian bulk drug sector.

| Scheme | Salient features |
|---|---|
| **Production-linked incentive scheme** | • Tenure of scheme – Fiscal 2021 to fiscal 2030<br>• Financial outlay – Rs 69 billion<br>• Applicable for greenfield projects<br>• Financial incentive to be provided for 41 identified key products, which cover all 53 identified active pharmaceutical ingredients (APIs)<br>• The net worth of the applicant (including that of group companies), as on the date of application, should not be less than 30% of the total proposed investment<br>• Maximum number of selected applicants – 136<br>• The incentive under the scheme will be applicable to domestic manufacturers only on the sales of the eligible product |
| **Creation of bulk drug parks** | • Tenure of the scheme – Fiscal 2021 to fiscal 2025<br>• Financial outlay – Rs 30 billion<br>• Three bulk drug parks will be supported under the scheme<br>• Maximum grant-in-aid for one bulk drug park will be limited to Rs 10 billion<br>• Minimum 50% of land area for bulk drug manufacturing units<br>• Three states to be selected through challenge method |

*Source: PIB*

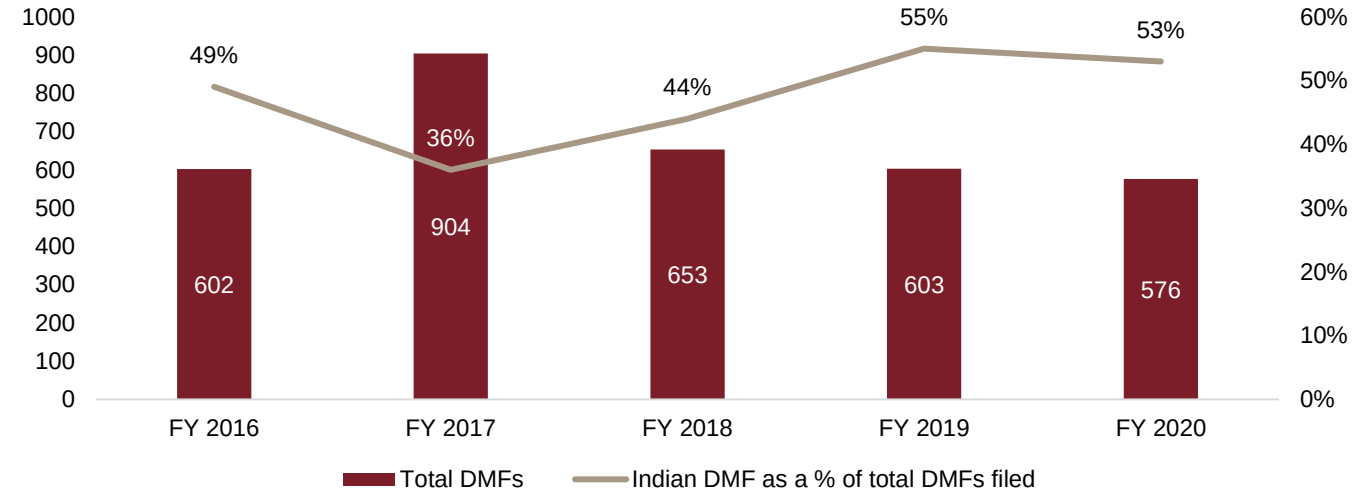
Indian pharma companies are largely clustered in Maharashtra, Gujarat and Andhra Pradesh. However, after the government imposed a maximum retail price-based excise duty system in 2005, many players shifted their manufacturing bases to excise-free zones such as Baddi (Himachal Pradesh), Haridwar (Uttaranchal) and Sikkim.

Unlike commodities, capacity expansion in the domestic pharmaceutical industry does not bunch up due to a low capital-intensity and gestation period. Hence, companies expand capacities in line with demand patterns. Setting up a US Food and Drug Administration (FDA)-approved formulations manufacturing plant costs more than that required for an unapproved facility. Units compliant only to the GMP (good manufacturing practices) have a shorter gestation period. The average gestation period for a US FDA-approved manufacturing facility is 18-24 months compared with 6-12 months for other facilities.

India has the highest number of US FDA-approved facilities outside the US. The country also has skilled manpower and advanced process chemistry skills. Some bulk drug manufacturers have forward integrated into pre-formulations (pelletisation/ granularisation of bulk drugs before they are converted into finished dosages) as well.

Though China is a major destination for bulk drug manufacturing, it has a major share primarily in the manufacturing of bulk drug intermediates. India has consistently maintained its leadership in drug master file (DMF) submissions. This proves the capability of Indian players to meet required export quality standards for regulated markets. A DMF is an indicator of the bulk drug manufacturing capabilities of players (in terms of quality standards maintained at their facilities for processing, packaging, storage of drugs, etc.), which is used by global pharmaceutical companies that are outsourcing production activities (innovators).

**Review of DMFs (FY2016 – FY2020)**

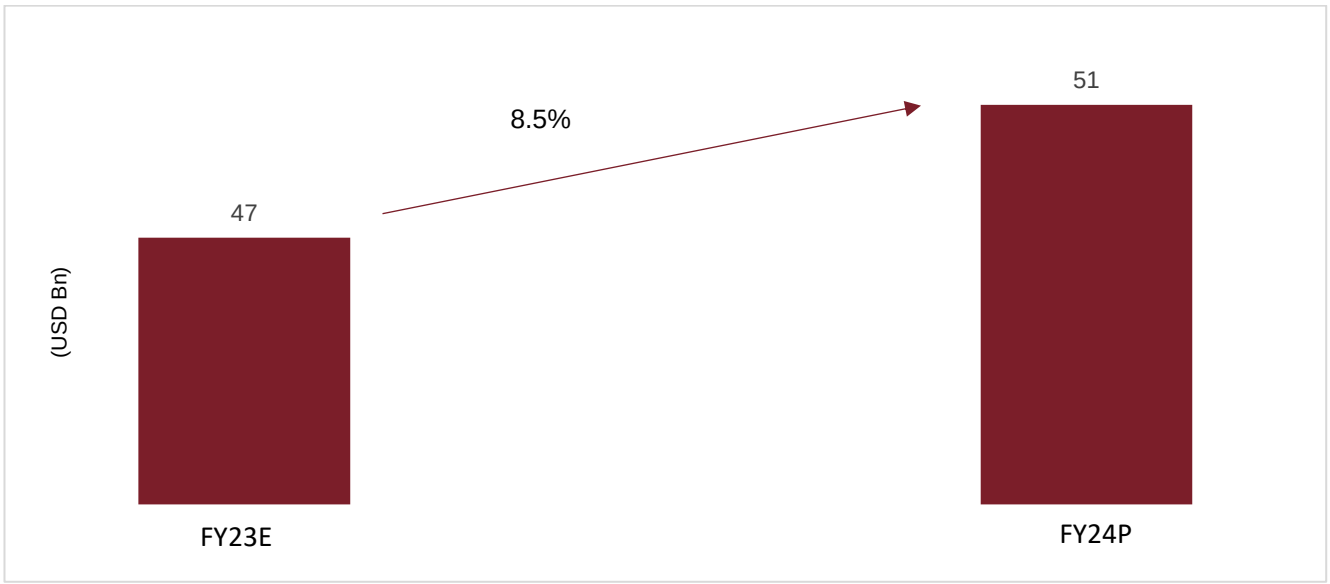



*E: Expected*
*Source: USFDA, CRISIL Research*

India is considerably ahead of its competitors in terms of the total number of DMFs.

## Outlook of Indian pharmaceutical industry (FY2023 – FY2024P)

**Outlook of the market size of the Indian pharmaceutical industry (FY2023 – FY2024)**




*Note: USDINR echange rate assumed to be 80 in FY23 and FY24*
*E: Estimate; P: Projected*
*Source: Industry, CRISIL Research*

The India pharmaceutical industry has shown a high growth of ~15% in fiscal 2022 over a low base of fiscal 2021. High growth in the H1 fiscal 2022 due to high demand for the Covid related drugs like anti-infective and vitamins. Going forward, the industry is expected to grow at a more moderated 8.5% between FY2023 to FY2024.

### Focus on niche and specialty products to aid growth

Indian pharma players have a healthy pipeline of complex generics and limited competition products, which are difficult to manufacture but command a higher premium. The pricing pressure is also expected to normalise in regulated markets in the coming years.

Further, the supply disruption from China is expected to aid business opportunities for bulk drug players in the global market. Also, recent quality issues related to Chinese APIs have slightly dented the country's image globally, which would in turn boost business for India, the next largest and cost-effective API supplier after China. Some multinational corporations (MNCs) are looking at alternative sources for bulk drug procurement following Chinese issues.

### Outsourcing of bulk drugs from MNCs to continue

In view of high operating expenses, CRISIL Research believes MNCs will look at bulk drug outsourcing to control cost and improve profitability. Margins of global innovator players dipped substantially from 2015 to 2018. Going ahead as well, MNCs are likely to continue outsourcing bulk drugs manufacturing to India.

### Major players look to improve capacities to reduce China dependence

Players such as Aurobindo, Divis Labs, and Aarti Industries are looking at expanding their API capacities with an aim to reduce dependence on China.

Recent supply and quality issues in China have resulted in disruptions. Indian players are now looking at capitalising the opportunity as even some global MNCs are moving away from China as they consider alternate sourcing of APIs.

- Divis Laboratories has invested Rs 25 billion in capex since fiscal 2018. The company has announced new capex at Kakinada, with an investment of Rs 6 billion to be spread over 2–3 years. Apart from this, the company has several other investments in line
- Aurobindo made an investment of Rs 150 million in local intermediate maker in fiscal 2020 to ensure continuous supply of intermediates in the event of a disruption in China
- Aarti Industries had announced a capex plan of Rs 23 billion over fiscals 2019-21 in multiple chains to increase market share
- Aarti Drugs has guided for a capex in the range of Rs 10-12 billion annually for next couple of years
- The new production-linked incentive scheme announced by government will also see new greenfield projects coming up, which will boost bulk drug production in the country.

However, dependence on Chinese imports (key starting materials / intermediates) is likely to continue. This is because unless the government provides continued support in the form of infrastructure and tax subsidies, it would be difficult for Indian players to match the manufacturing costs of Chinese counterparts.

## 5.10 Review and outlook of the Indian hospitals and healthcare delivery industry

Apart from pharmaceuticals, cryogenic gases also have applications in medical procedures such as medical oxygen for respiration, liquid nitrogen used in cauterization, helium can be used as a mixture with pure oxygen for respiration, etc. As healthcare facilities improve, demand for cryogenic gases in medical/ pharmaceutical applications will also increase. Use of any product in healthcare applications have more stringent norms over and above regular safety norms. Similarly, gases and equipment used in health care applications are also required to adhere to the higher safety standards.

### Review of the Indian hospitals and healthcare delivery industry (FY2016 – FY2022)

The hospitals sector is capital intensive owing to high per bed cost. Hospitals mainly incur capital expenditure on land and equipment. The capital cost to build a hospital is typically Rs 8-10 million per bed (excluding land cost) for a tertiary care super-specialty hospital, whereas the cost for secondary-care hospitals is lower. High technology and equipment cost keeps the total capital cost of super-specialty tertiary care hospitals at the higher end. Use of imported equipment can further drive equipment cost up. The ratio of beds to individuals in India is, thus, still a meagre 13 beds per 10,000 people (as against a global median of 29).

Hospitals are also highly labour-intensive. They require skilled manpower such as doctors, nurses and para-medical staff comprising lab technicians, radiologists, and therapists. While India has a large medical workforce, the country has just nine physicians per 10,000 people (as against a global median of 18) and 24 nurses and midwives per 10,000 (as against the global median value of 39).

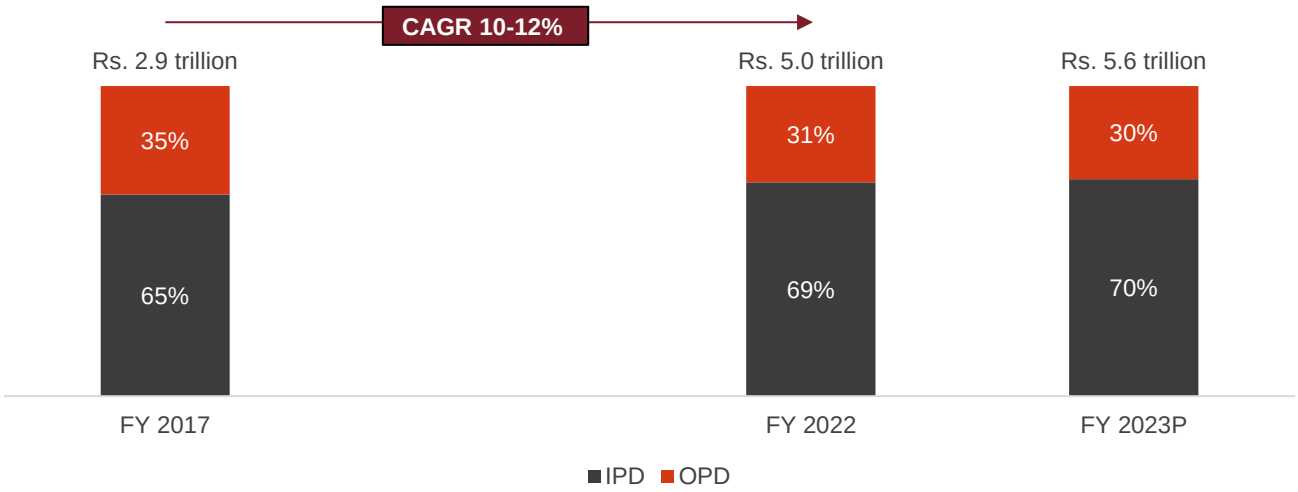
In India, healthcare services are provided by the government and private players, and these entities provide both in-patient department (IPD) and out-patient department (OPD) services. However, the provision of healthcare services in India is skewed towards the private players (both for IPD and OPD). This is mainly due to the lack of healthcare spending by the government and high burden on the existing state health infrastructure.

CRISIL Research estimates the healthcare delivery industry size at ~Rs 5 trillion in fiscal 2022 and at Rs 5.5 - 5.75 trillion in fiscal 2023. This includes both inpatient treatments forming almost 70% in value share and outpatient consultations contributing the rest 30%. In fiscal 2023, while government’s share is estimated at 30-32%, private sector is expected to contribute the lion’s share at 68-70%. Within private sector, large hospitals form only 10-15% of the industry with rest of the market dominated by small and medium hospitals, clearly indicating the fragmented nature of the industry. During the last three years the industry had grown at a CAGR of 9-10%, with major contribution from structural factors like improving penetration of healthcare insurance, increasing incidence of non-communicable diseases, increasing urbanization & awareness, booming medical tourism, etc. Going forward, too, these favourable socioeconomic demographics are expected to continue. However, tailwinds in the form of focused expansion of large corporates with adjusted business models in tier-II locations and demand impetus on account of Ayushman Bharat are expected to aid momentum, leading to an industry growth of 13-14% over the medium term.

In terms of supply creation, major hospital chains are now looking at brownfield expansion at existing facilities and have also expanded into the next level of creamy Tier-2 and -3 locations (with ~70% aggregate bed additions in these areas by the 10 largest hospital players in the past four years). Given the significantly lower revenue per bed in these locations, players had to adjust their business models such as a hub and spoke model of operation, tight control on operating costs with a no-frills model, etc. But a common observation has been that players with focus

on limited specialties have been able to remain region agnostic in terms of locational impact on returns and margins.

**Review of healthcare delivery market (FY2016 – FY2022)**




*P: Projected*
*Source: CRISIL Research*

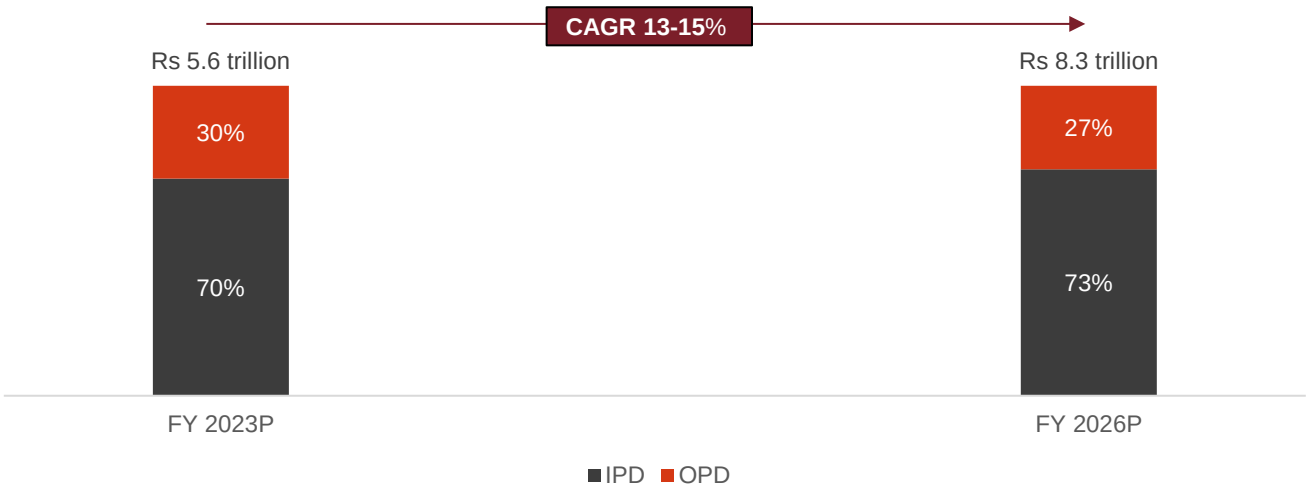
Over the past four years, major hospital chains have added supply (~70% of their incremental supply during the period) in tier II and III locations, to create a referral network into their main centre by tapping into the underserved creamy tier II areas. The government is also expected to augment this via a scheme in the pipeline (PM Atmanirbhar Swasth Bharat) for strengthening primary, secondary and tertiary healthcare infrastructure in the country.

Structural factors such as increase in lifestyle-related ailments, increasing medical tourism and changing demography, etc. are expected to contribute to demand. Also, growth in household incomes, and consequently, disposable incomes, is critical to the overall growth in demand for healthcare delivery services in India. The share of households falling in the income bracket above Rs. 0.2 million is expected to have gone up to 35% in fiscal 2022 from 23% in fiscal 2017, providing potential target segment (with more paying capacity) for hospitals.

## Outlook on Indian hospitals and healthcare industry (FY2022 – FY2026)

Robust growth is expected in fiscal 2023 as the underlying fundamental growth factors remain strong. Regular demand drivers such as OPD, elective surgeries and regular treatments stabilise and demand drivers such as high realisation from the medical tourism business picks up as international travel restarts gradually. Margins are expected to remain rangebound as compared to the previous fiscal. With long term structural factors supporting growth, renewed impetus from PMJAY and government focus shifting onto healthcare sector, the healthcare delivery market is expected to grow at 13-15% compounded annual growth rate (CAGR) and reach Rs 8.3 trillion in fiscal 2026.

**Outlook on healthcare delivery market (FY2023 - FY2026)**




*Source: CRISIL Research*

## Factors affecting demand

A combination of economic and demographic factors is expected to drive healthcare demand in the country. CRISIL Research believes that the PMJAY scheme launched by the government would be an addition to these drivers.

## With improving life expectancy and changing demographic profile, healthcare services is a must

India lags behind the global benchmarks in healthcare infrastructure, both in terms of physical infrastructure as well as personnel. However, the picture is bleak even on the healthcare indicators front. With the Indian population expected to grow to ~1.4 billion by 2026, the need to ensure healthcare services to this vast populace is an imperative. But this also provides a big opportunity to expand into a space that bears huge potential.

## Rising income levels to make quality healthcare services more affordable

Growth in household incomes, and consequently, disposable incomes is critical to the overall growth in demand for healthcare delivery services in India. The share of households falling in the income bracket above Rs. 0.2 million is expected to have gone up to 35% in fiscal 2022 from 23% in fiscal 2017, providing a potential target segment (with more paying capacity) for hospitals.

## Increasing health awareness to boost hospitalisation rate

Majority of the healthcare enterprises in India are more concentrated in the urban areas. With increasing urbanisation (migration of population from rural to urban areas), awareness amongst the general populace regarding presence and availability of healthcare services for both preventive and curative care would increase.

CRISIL Research, therefore, believes that hospitalisation rate for in-patient treatment as well as walk-in out-patients will improve with increased urbanisation and rising literacy.

## Government policies to improve healthcare coverage

The government has raised its healthcare budget in fiscal 2022 to Rs 712.7 billion, although the incremental allocation in fiscal 2021 and fiscal 2022 is more for Covid-related expenditure (emergency aid and vaccination drive). Nonetheless, the focus seems to shift from curative aspect to preventive health and well-being under the ambit of holistic healthcare. The long-term goal is to raise its healthcare spending to 2.5% of GDP by 2025 under the National Health Policy 2017 from the current 1.3% of the GDP.

## Pradhan Mantri Jan Arogya Yojana (PMJAY)

With the intention of providing affordable healthcare, the Pradhan Mantri Jan Arogya Yojana (PMJAY) was launched on September 23, 2018. The scheme primarily has three objectives -

**Upgrading sub-centres under physical health infrastructure:** Upgradation of 0.15 million 'Health and Wellness' centres to provide comprehensive healthcare, including coverage of non-communicable diseases and maternal and child health services. These centres would also provide essential medicines and diagnostic services free of cost. Inclusion of new ailments under the ambit of the scheme would go a long way in ensuring focus on preventive care as opposed to only curative care. A strong referral network is vital in providing a continuum of care.

**Strengthening government hospitals under physical health infrastructure:** Setting up 24 new government hospitals and medical colleges and upgrading existing district hospitals. The intention is to have at least one medical college for three parliamentary constituencies. The government already has a scheme in place - Pradhan Mantri Swasthya Suraksha Yojana (PMSSY) to correct the geographical imbalance in the availability of tertiary healthcare. Six AIIMs, each at Patna (Bihar), Raipur (Chhattisgarh), Bhopal (Madhya Pradesh), Bhubaneswar (Odisha), Jodhpur (Rajasthan) and Rishikesh (Uttarakhand) have been set up and 16 new ones announced by the government are under various stages of construction and are expected to be operational by fiscal 2025. Tackling issues of inadequate physical and personnel infrastructure is targeted via this objective.

**Expansion of health insurance coverage - Ayushman Bharat:** Provision of Rs. 0.5 million assured healthcare coverage to each family that is eligible, selected based on inclusion under the Socio-Economic Caste Census (SECC) list. Nearly 107.4 million families will be covered under the scheme. All existing central and state health insurance schemes will be subsumed under Ayushman Bharat. However, the model of the scheme to be implemented (via insurance company, trust or mixed model) is the prerogative of the states.

However, healthcare delivery at affordable prices would require shift of focus towards capitalising on the volumes (with nearly 1,65 million new people coming under a healthcare scheme) rather than on value (via margins). The government has started an initiative of National Digital Health Mission on the lines of the proposed National Health Stack (NHS). A shared digital framework for both private and public hospitals, it is expected to digitalise all health records and keep track of all details pertaining to healthcare enterprises in the country. The scheme holds huge potential for the healthcare delivery and allied industries but the mechanism for quality control and monitoring along with raising resources for implementation will be a key monitorable.

## Non-communicable diseases: A silent killer

As opposed to the decreasing rate in communicable diseases, lifestyle-related illnesses or non-communicable diseases (NCDs) have been increasing rapidly in India over the last few years. The contribution of NCDs to the disease profile has risen from 30% in 1990 to 55% in 2016. Statistics show that these illnesses accounted for

nearly 62% of all deaths in India in 2016. As per the World Economic Forum, the world will lose nearly 30 trillion USD by 2030 for NCD treatments and India's burden from this will be $5.4 trillion.

### Growing health insurance penetration to propel demand

With health insurance coverage in India set to increase, hospitalisation rates are likely to go up. In addition, health check-ups, which form a mandatory part of health insurance coverage, are also expected to increase, boosting the demand for a robust healthcare delivery platform.

## 5.11 Review and outlook of the Indian paper industry

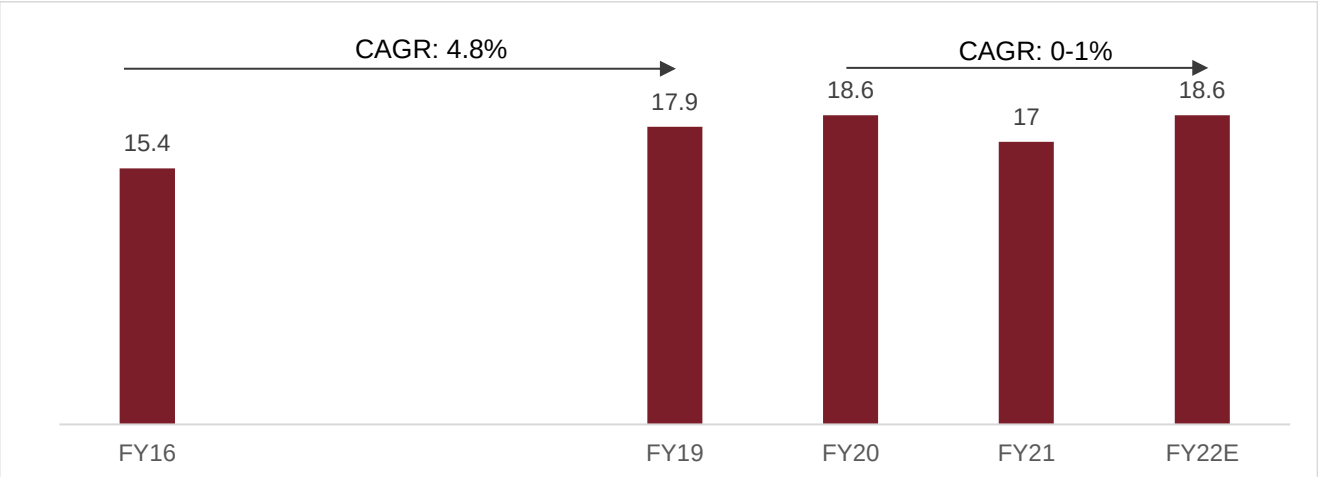
Paper industry requires steam in the production process which uses natural gas.

### Review of the domestic paper industry (FY2016 – FY2022)

The paper industry is categorised into writing and printing (W&P), paperboard and newsprint, of which, paperboard accounts for the largest share of the market in volume terms, while W&P is the largest segment in value terms. This industry is highly fragmented. Wood-based pulp, wastepaper and agri residues are the main raw materials used to manufacture paper. Domestic wood supply is inadequate compared to demand, and the wastepaper recovery mechanism is not very robust. Inadequate raw material availability remains a constraint for the paper industry.

CRISIL Research expects paper demand to grow moderately in fiscal 2023 after witnessing a revival in fiscal 2022. The paperboard segment is expected to drive demand in the near and long term due to healthy demand from end-use industries. W&P paper demand is expected to witness a sharp growth in fiscal 2023 as schools, colleges and office spaces are being opened up. The paper and paperboard (including newsprint) demand is estimated to grow by 6-7% on-year in fiscal 2023, after a rise of 9-10% in fiscal 2022. In fiscal 2023, Segment-wise, W&P segment is estimated to witness a moderate growth of 5-6% on-year owing to the effect of digititalisation of offices and educational institutes in the long run. Whereas the paperboard segment is estimated to grow by a robust 8-9% growth rate on back of healthy demand from the end use industries. The newsprint segment is estimated to witness de-growth of 0-5% in fiscal 2023 after witnessing a steep 17-18% rise in fiscal 2022. Specialty paper is estimated to grow at a healthy pace of 12-13% on-year growth.

**Trend in domestic consumption of paper (FY2016 - FY2022)**




*E: Estimate*

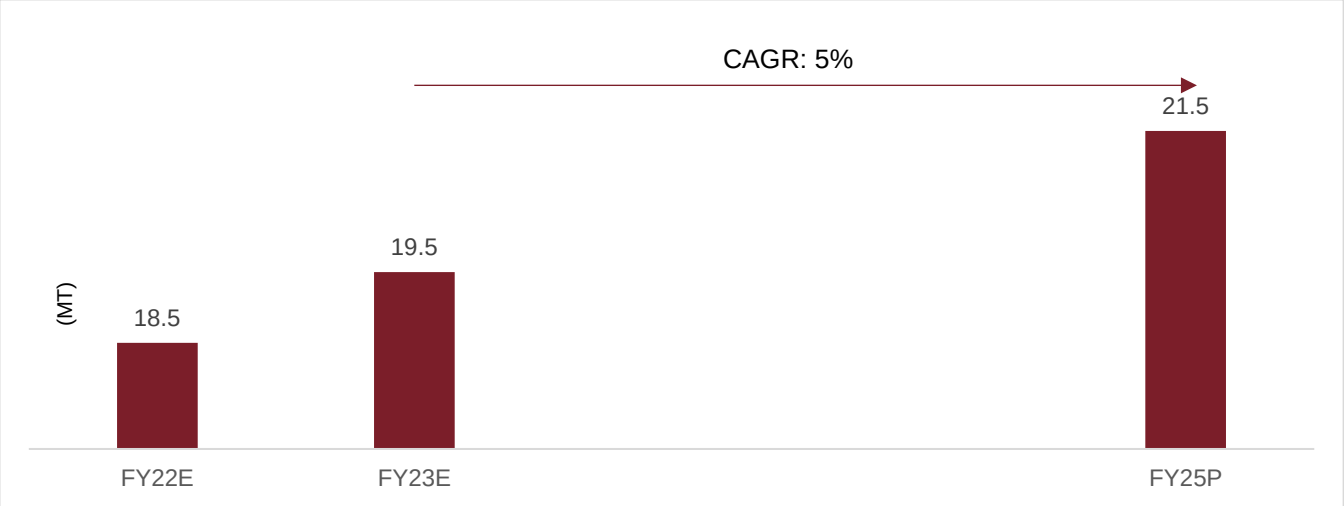
*Source: Industry, CRISIL Research*

Domestic paper demand (including newsprint) is estimated to reach 19-19.5 million tonnes in fiscal 23. The expansion was on the back of increased industrial activity and corporate spending on office stationery and advertisements following improving economic growth. The newsprint segment continues to drag down overall demand due to decline in English paper circulation on account of shift towards digitised versions of newspapers with proliferation of digitisation and smartphones. Even though the domestic W&P segment demand witnessed moderate demand in the fiscal, healthy exports demand is likely to have driven player utilisation. Paperboard players are likely to continue to operate at higher levels due to strong demand recovery from end-use industries. In fiscal 2022, utilisation levels are estimated to have been stable at 76-78% with healthy demand and muted capacity additions. Even though the domestic W&P segment demand witnessed moderate demand in the fiscal, healthy exports demand is likely to have driven player utilisation. Paperboard players are likely to continue to operate at higher levels due to strong demand recovery from end-use industries. In fiscal 2023, overall utilisation levels are expected to reach 80-82% led by higher capacity utilisation of the paper board and W&P segments amid demand recovery.

## Outlook on the domestic paper industry (FY2023 – FY2025)

We expect demand to recover and grow at a healthy four-year CAGR (FY23-FY25) of 5% to 21.5 million tonne by fiscal 2025 driven by paperboard demand. Demand will be led by healthy growth in paperboard volume, which is expected to clock 7-9% CAGR over fiscal 2023 to fiscal 2025. This growth would be driven by increased volumes in end-user segments such as household appliances, fast-moving consumer goods (FMCG), ready-made garments, pharmaceuticals, e-commerce, etc. W&P demand is expected to increase at a modest 3-5% CAGR over fiscal 2023 to fiscal 2025, compared to degrowth of (3-3.5%) over fiscal 2017 to fiscal 2021, on account of steep demand fall owing to pandemic due to closure of educational institutes & offices. Specialty paper (majorly tissue and thermal paper) is expected to continue to log a robust 11-12% CAGR over fiscal 2023 to fiscal 2025. Going forward, over fiscals 2023 to 2025, we expect capacity utilisation to pick up to 91-93% in the paper and paperboard segment, and the newsprint segment to witness utilisation levels of 93-95% as a result of falling installed capacities.

**Outlook on domestic paper consumption (FY2022 – FY2025)**




*E: Expected; P: Projected*
*Source: Industry, CRISIL Research*

CRISIL Research expects paper and paperboard capacity to increase to 29-29.5 MT by fiscal 2027, at a 3-4% CAGR over fiscals 2022-27. Key organised players (ITC, TNPL, West Coast Paper Mill, JK Paper, and Seshasayee

Paper and Boards) are expected to add an aggregate capacity of 1-2 MT over the next five years in the paper and paperboard segment. On account of a sudden plunge in the demand environment in fiscal 2021, some players deferred or postponed their capacity additions. Emami Paper deferred setting up of 0.225 MT of paperboard capacity in fiscal 2021, and Ruchira Papers also went slow on expansion in the fiscal. However, small players are expected to increase kraft paper capacity on the back of strong demand expectation.

Within the paper segment, we expect paperboard and specialty to witness healthier growth compared with other segments, and capacity additions in the paperboard segment are expected to rise through fiscal 2027 due to healthy demand prospects, largely from unorganised players. Moreover, capacity additions in the paperboard segment will be driven by its lower capital intensity and non-requirement of technical expertise.

Along with capacity additions, consolidation in the domestic paper industry has gained traction over the past 2-3 years, with around five cases with stressed liability of about Rs 8.6 billion being resolved under the Insolvency and Bankruptcy Code, 2016. The recovery amount was about Rs 4.3 billion, resulting in a 50% haircut by financial and operational creditors. Further, four cases are awaiting resolution approval by the National Company Law Tribunal. Additionally, West Coast Paper acquired majority controlling stake in International Paper APPM. Mergers and acquisitions among domestic players are expected to result in higher competition and smooth backward integration for raw materials.

## 5.12 Review and outlook of the Indian glass industry

Glass manufacturing is an energy intensive process which uses natural gas as an energy source.

### Review and outlook

Glass is an inorganic product produced by melting a mixture of silica sand, soda ash, limestone and other ingredients by heating the mixture at a very high temperatures and followed by gradual cooling. The glass industry comprises four key segments — flat glass, container glass, fibre glass and specialty glass. The flat glass segment is sub-divided into float glass, solar glass, figured glass and sheet glass. In this report, CRISIL Research has focused on the float glass and solar glass market in India.

Flat glass produced through a float process is known as float glass. The float process was developed and patented in the 1960s, and licensed throughout the world by Pilkington Brothers Ltd, UK. More than 90% of the global flat glass is produced through the float process.

Float glass is produced in wide-ranging dimensions, and is available in sizes of 0.4 mm-25 mm thickness. Apart from aesthetic utility, it serves functional utility, such as privacy, energy conservation, safety, protection against fire, and noise insulation.

Float glass is largely being used as a material in the building and construction industry. It directly or indirectly competes with other building materials such as paints, plywood, and laminates and ceramic tiles.

Float glass is expected to be among the fastest-growing building materials in India.

### Float glass manufacturing process

Float glass is primarily a soda-lime glass manufactured using sand, soda ash, limestone, dolomite and other minor elements. The production of float glass also includes usage of cullet glass, i.e., recycled glass, to reduce energy

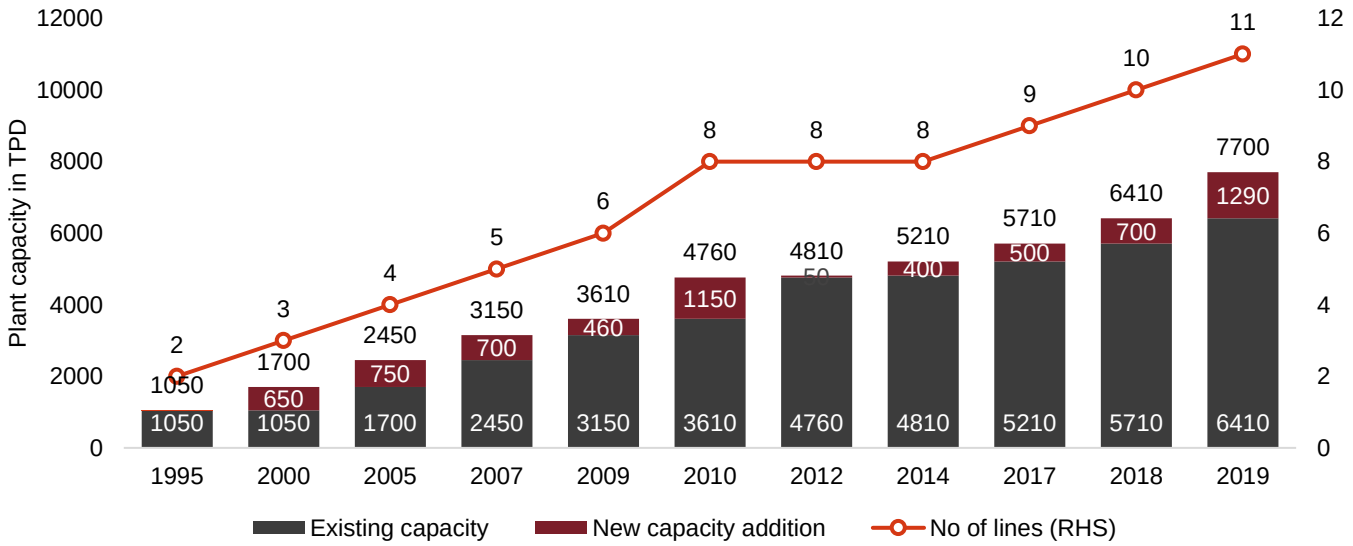
consumption as well as $CO_2$ emissions. Glass manufacturing is a highly energy-intensive process, with natural gas and electricity being major energy sources.

The float glass industry is characterised by high entry barriers because of its capital-intensive nature, long gestation period, need to cater to the entire range of products, and a large distribution network that is required to be set up before the commencement of operations.

### Development of the float glass industry in India

- Pre-1995 – Gujarat Guardian was the first company to set up a float glass line in India. It set up its maiden float glass line with a capacity of 550 TPD.
- Asahi India Glass, since its incorporation, has undertaken expansion projects, and now operates ~1,200 TPD capacity.

**Domestic float glass industry capacity additions**

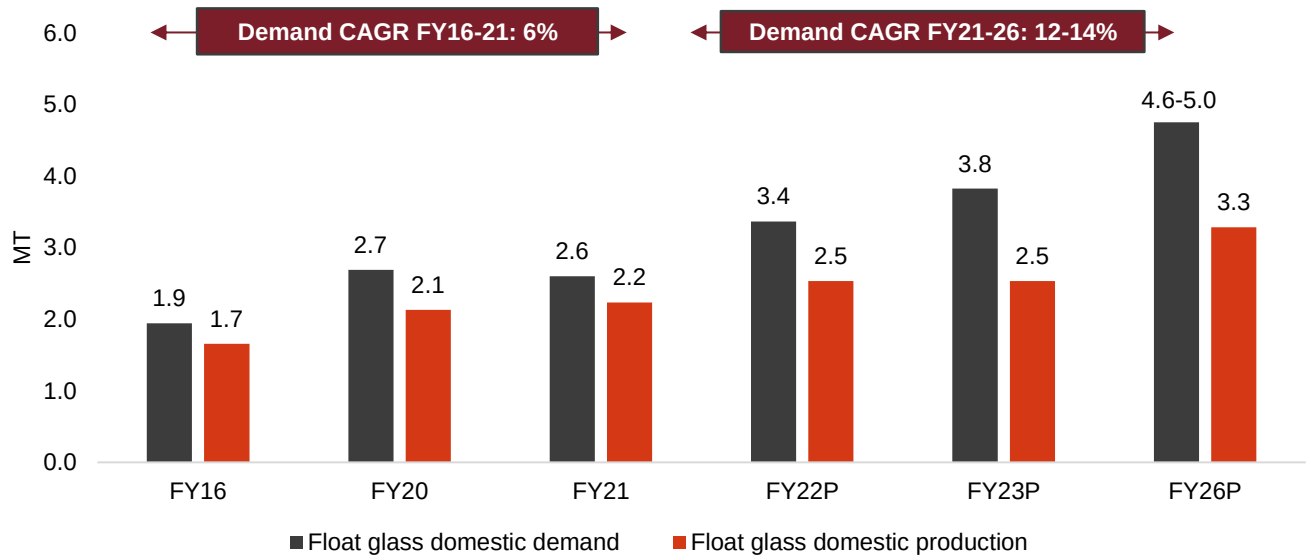



*Source: CRISIL Research*

### Float glass market in India

Indian float glass manufacturing is a highly consolidated industry with only five organised players and no unorganised players. CRISIL Research estimates demand for float glass at 3.4 MT in India in fiscal 2022. CRISIL Research has considered unprocessed, clear, tinted, mirror, reflective, lacquered and frosted glass as part of the float glass market. Demand for float glass is estimated to have grown from 1.9 MT in fiscal 2016 to 2.6 MT in fiscal 2021, at a 6.0% CAGR. The domestic demand is estimated to have logged a healthy 8.5% CAGR over fiscals 2016-20, even as Covid-19 hurt demand sentiment in fiscal 2021, posting a marginal decline of ~4%. Demand is expected to have recovered sharply to 3.4 MT in fiscal 2022, driven by pent-up demand and a faster-than-anticipated recovery in the building and construction segment. Imports form a significant proportion of the domestic demand, indicating scope for expansion of domestic manufacturing capacity. Imports historically have been high due to limitation in domestic capacity. Imports, which typically account for 20-30% of the domestic demand, are expected to have shot up to 34% of the domestic demand in fiscal 2022. A majority of the imports related to clear glass.

**Indian float glass market (MT) (FY2016 – FY2026)**




*Note: The float glass market includes clear and value-added glass*
*Fiscal 2026 production is projected based on capacity expansion plan announced by Gold Plus Glass and Saint-Gobain India*
*Source: CRISIL Research estimates*

Demand for float glass is expected to rise to 4.6-5.0 MT in fiscal 2026 from 2.6 MT in fiscal 2021, at a high CAGR of 12-14%. Demand revival after the pandemic and faster economic growth should support demand for float glass through fiscal 2026 and beyond. Domestic demand is significantly higher than domestic supply, translating into a growth opportunity for domestic manufacturers.

In value terms, demand for float glass is estimated to have increased at a ~2.5% CAGR over fiscals 2016-21, to Rs 81 billion. Value growth for the industry was suboptimal due to the pricing pressures because of cheaper imports from Malaysia. CRISIL Research estimates demand for float glass to expand at a 15-17% CAGR to Rs 165-175 billion by fiscal 2026. Imports are expected to continue to increase due to the continued demand-supply gap even after the proposed capacity additions by key players such as Gold Plus Glass. Imports as a percentage of demand will increase from 26% in fiscal 2020 to 38% by fiscal 2026.

For most part of fiscals 2016-21, demand for float glass from the building and construction sector remained under pressure, with factors ranging from slower pace of execution by developers to events such as demonetisation and the NBFC crisis and general economic slowdown, hurting demand for housing, resulting in an increase in housing inventory. Implementation of RERA and GST, which are expected to have a positive impact over the long term on the real estate sector, slowed down construction activity even as the sector transitioned towards greater transparency. Several government initiatives, including push to affordable housing, GST rate cut, establishment of real estate investment trusts (REITs), interest subsidy, tax rebate and easing of foreign direct investment (FDI) norms in the real estate sector, helped in a recovery in housing demand. Meanwhile, higher demand for office spaces by MNCs, entry of foreign players into the office space, expansion of the e-commerce sector, expansion of commercial retail projects, emergence of the concept of shared office spaces, and growing preference for green buildings supported demand for float glass.

Brownfield capacity expansions across Bangalore, Delhi and Hyderabad airports have provided the boost to float glass demand since fiscal 2019.

## 5.13 Review and outlook of the Indian metal industry

The metallurgy industry is a major consumer of industrial gases. The production of metals from ore is an energy intensive process which can use natural gas for power. Besides, steel making also requires large amounts of oxygen in the process.

### Review and outlook

Aluminium is the most abundant metallic element in the earth's crust and the most widely used non-ferrous metal. It is highly reactive and does not occur in the free metallic form in nature, but its compounds are present in almost all rocks, vegetation and animals. Aluminium is used in numerous applications in a variety of industries, such as transport, food packaging, architecture and electrical applications.

#### Domestic aluminium demand

Domestic demand for secondary aluminium revived by 18.1% in fiscal 2022 after declining 11.6% in fiscal 2021 due to pandemic's impact. However, the growth was higher compared to primary aluminium owing to shifting demand from primary to secondary amid higher primary aluminium prices. Primary aluminium demand logged annualised growth of 3.9% over fiscals 2017-19, before plunging 11% in fiscal 2020 due to slower offtake from the power and automobile segments. Demand plumetted a further 13% in fiscal 2021 because of the Covid-19 pandemic.

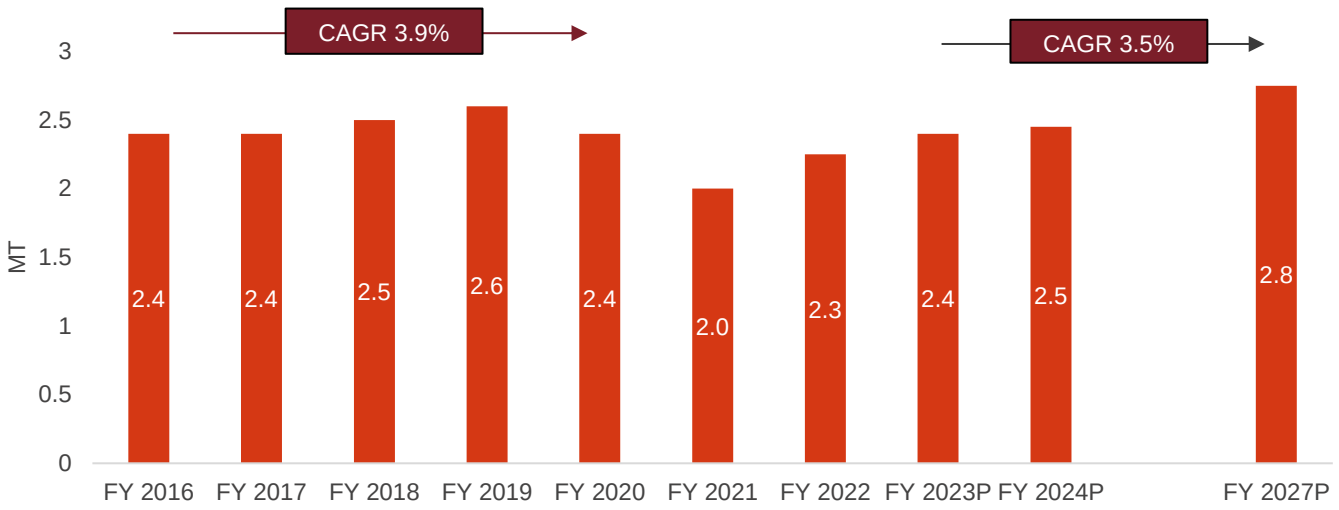
Domestic demand for primary aluminium revived by 9.9% in fiscal 2022 after declining 13% in fiscal 2021 due to the pandemic’s impact. Revival in fiscal 2022 would have been higher if not for the incidence of the second wave, which resulted in lockdowns in all major Indian states in April and May 2021. Moreover, any further increase in domestic demand was limited by semiconductor shortage, which impacted automobile production. In fiscal 2023, domestic aluminium demand is expected to grow a further 6-7% to ~2.35-2.45 MT.

We forecast demand to increase at an annualised growth rate of 2.5-3.5% through fiscals 2023-27, led by higher ordering by PGCIL and a steady addition to transmission lines by state transmission companies, along with a pick-up in growth in key sectors such as automobile (domestic and exports), consumer durables and packaging.Healthy aluminium demand from the construction sector is estimated as aluminium penetration is likely to increase across all segments, which is otherwise currently limited to premium urban projects. Additionally, the real estate segment has seen a healthy pick-up post the Covid-19 blues, as inventory levels are seen reducing across all major cities. Continued growth will be seen in automotive sector demand, as domestic production of cars and two-wheelers is expected to increase 3-4% over 2023-27, led by increase in penetration of primary aluminium in this segment. Also, inreasing acceptance of electric vehicles and government incentives around the same may also help propel demand, as this category has a higher intensity of aluminium than internal comustion engine (ICE) vehicles.

Strong consumer durable demand growth of 4.5-5.5% over fiscal 2023 to 2027. Robust growth in demand from the packaging industry, led by the rising sale of aluminium foil in the wake of restrictions on plastic usage, will also boost the demand for primary aluminium. However, higher usage of secondary aluminium in packaging and limited foil capacity of primary aluminium manufacturers will limit growth from the segment in the near term.

Demand from the power sector will moderate post cutback in capex by PGCIL and state transcos. However, the segment will continue to account for over 50% of primary metal demand due to consistent addition of transmission lines, especially in the 400 kV segment.

**Trend in domestic aluminium demand (FY2016 – FY2027P)**




*Source: CRISIL Research*

## Marginal capacity additions, moderate demand boost global utilisation in 2022

Global primary aluminium production grew 3% on-year in 2021 to ~67 MT, with a utilisation rate of 87%, similar to the 2020 level. The global production was aided by 4.6% on-year growth in Chinese aluminium output and 0.9% on-year growth in the rest of the world.

Aluminium supplies have been under significant pressure since the second half of 2021, and the prices on the London Metal Exchange (LME) have remained elevated. Major production cuts across China and Europe owing to a severe energy crisis after coal shortages and gas price spike have cut supplies. Overall production in China slowed down to 3% on-year in the second half of 2021, compared with 9% on-year in the first half.

This year, we expect global aluminium production to grow slower at 0-1% on-year to 67.5-68.5 MT due to the impact of the ongoing Russia-Ukraine conflict in the first half. Russia produces 6% of global aluminium and Europe ~4%. European smelters have already cut production amid elevated gas prices, thus limiting the production increase from the rest of the world to 0-0.5%. While China has begun ramping up production following the Winter Olympics, production will only increase marginally by 0-0.5% due to subdued domestic demand amid the Covid-19 pandemic.

CRISIL Research expects utilisation rates of global primary aluminium players to gradually increase to 86-88% by 2026, provided capacity expansions are as expected. While China was expected to shift ~3 MT capacity in 2021, it has shifted only ~0.7 MT. Thus, the country is expected to shift the remaining capacity in the next two years. The country has capped capacity at 45 MT. Therefore, these capacity additions are replacement additions. Elsewhere, too, capacity additions are likely to be limited as players have an ESG target and any capacity addition will have to be within that. Thus, capacity additions until 2026 will be 2-2.5 MT as against the 9 MT added between 2015 and 2020.

## Slow capacity additions in China to impact production in 2022

Global aluminium capacity increased from 73 MT in 2016 to ~77 MT in 2021. However, production lagged demand growth during the period, leading to a better utilisation rate. Of the ~4 MT net capacity added, China accounted for ~2 MT, fuelled by the government's incentives to meet the burgeoning demand.

In 2021, global capacity is estimated to have increased by ~1 MT, led by additions in China, Norway (by Norsk Hydro) and Russia (by Rusal). China's net addition is estimated at 0.7 MT, mainly in the Yunnan province. However, it is unlikely to breach the regulatory cap of 45 MT as some of the additions involve swapping decommissioned capacity for new production.

Global utilisation remained stable in 2021 despite the second pandemic wave and supply concerns, such as droughts and power shortage. As a result, global aluminium production grew 2.8% during the year. Production in China, which accounts for more than half of the global capacity, grew 4.6%. This year, China is expected to add 1.4-1.5 MT net capacities. Most of these are replacement capacities as the country is moving capacities to the south-eastern region, where hydro-based power production is higher. The move is aimed at limiting the overall carbon emission.

### India’s utilisation rate to surge due to production ramp-up at Vedanta

Domestic utilisation rate, which hovered between 86% and 89% over fiscals 2016-2021, increased to 97% in fiscal 2022 due to quick production ramp-up at Vedanta. This is primarily on account of a ramp-up in production at Line IV Jharsuguda by Vedanta. The company produced 2.3 MT, compared with 1.9-1.95 MT from fiscal 2018 to fiscal 2021, thus pushing the overall industry production to 4.0 MT compared with 3.6 MT in fiscal 2021.

Domestic utilisation is expected to remain high at 97-99% current fiscal as players are already operating at more than 100% of capacity amid lucrative export opportunities in Q1 fiscal 2023 however the players are expected to marginally slowdown production amid falling exports. Primary aluminium production is expected to reach 4.1-4.1 5 MT current fiscal..

Capacity utilisation in the Indian primary aluminium industry has always been healthy. The industry operated at 90-95% between fiscals 2010 and 2014, driven by healthy domestic demand and tepid capacity addition. However, capacity expansion and ramp-up of existing facilities by Hindalco, Vedanta and Balco led to a fall in capacity utilisation in fiscal 2015, when it reached ~85%. However, as players gradually ramped up production at new facilities, utilisation rates inched up closer to ~88% until fiscal 2019..

However, in fiscal 2020, overall utilisation dipped marginally to 87% due to disruption caused by Cyclone Fani and poor coal supply from Mahanadi Coalfields Ltd, leading to a temporary shutdown of multiple potlines by Nalco. Also, Vedanta was operating at ~80% utilisation as it had not started operating the Line IV smelter at Jharsuguda. The company had lower utilisation rates through fiscals 2019-2021. However, given the higher metal prices and healthy export demand, Vedanta began quickly ramping up its smelter lines. In fact, the company recorded production growth of ~15% on-year in fiscal 2022. Thus, the industry utilisation rate in the fiscal increased to 97%, significantly higher than the 87% seen in fiscal 2021..

Domestic capacity is expected to reach ~5.4 MT by fiscal 2027, led by expansions by Nalco and Balco. Nalco is expected to add brownfield capacity of 0.5 MT at its Angul facility and another 0.1 MT by debottlenecking its existing facility by fiscal 2027. The company has also announced another greenfield smelter of 0.5 MT, the timeline for which has not been provided. While work on the unit is yet to commence, we expect partial addition by the end of fiscal 2024 and completion by fiscal 2025. Any development on this front will be a key monitorable. Balco is expected to add 0.4 MT per annum (MTPA) to reach 1 MTPA by fiscal 2024.

## Review and outlook of the Indian steel industry (FY2016 – FY2027P)

Steel is an alloy containing a high proportion of iron with some carbon. Other alloying elements may also be present in varying proportions. Steel properties are dependent on the proportion of alloying elements and also on the heat treatment the metal is subjected to. Steel is characterised by high strength, low weight, durability, flexibility and corrosive resistance. It is widely used in the construction, automobile and consumer durables industries.

### 5.13.1. Domestic steel demand

After printing a stellar growth of 8-9% in fiscal 2018 and fiscal 2019, the demand momentum fizzled out in fiscal 2020 to 1.4% growth. The domestic steel industry grew a moderate 1.4% in fiscal 2020, with non-alloy steel demand growth of 3.3%. On the contrary, alloy steel consumption declined ~21% during the same period, because of declining automobile production. Flat steel saw a ~3% decline in consumption, while long-steel demand grew 5.5% in fiscal 2020.

Domestic steel demand rose a healthy 8.8% in fiscal 2019, primarily led by a rise in construction activity and modest growth in consumption sectors. Low base of the first half (GST implementation in the preceding year) also cushioned growth to a certain extent.

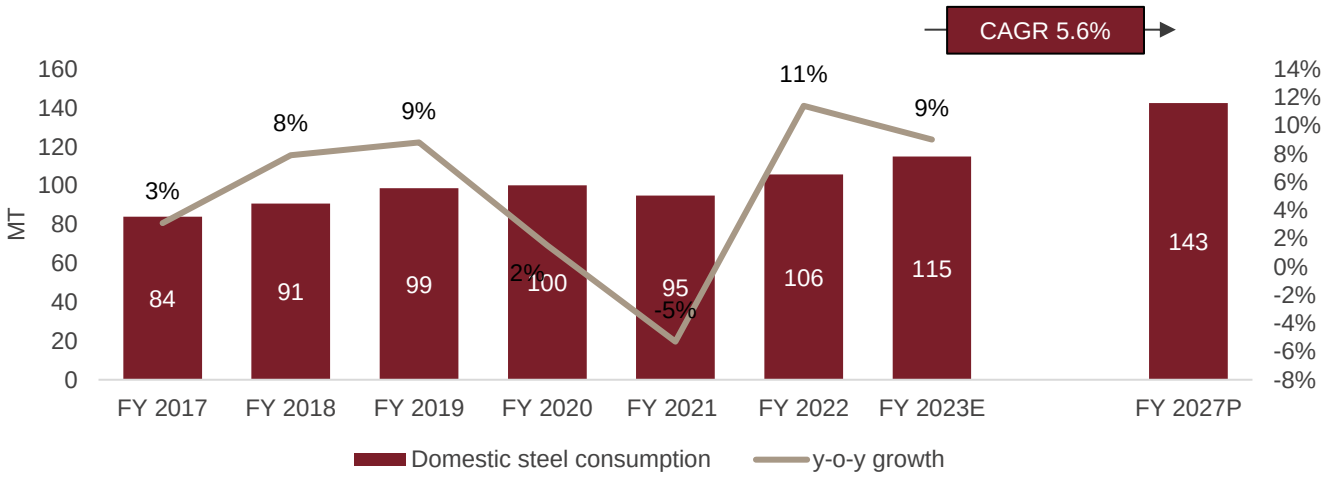
Steel demand in India is set to chart a 8-10% growth in demand in fiscal 2023 after having seen a 11.4% recovery in FY22 on low-base of covid-impacted fiscal 2021. While growth is moderating, demand is already much higher than pre-covid levels. Demand is expected to be spearheaded by infrastrcuture projects and housing and construction demand. Momentum in projects like PMAY and NIP will sustain momentum endsuring steady demand. H1FY22 is expected to remain weak as first quarter saw elevated prices impact demand. Second quarter is seeing the impact of an extended monsoon, with long segment having lower offtake on-year than flat segment. H2 is expected to fare better as lower prices coupled with festive season will benefit the flat segment and post-monsoon pickup will be seen in long segment..

Going ahead, in H2FY23, we will see some sequential deceleration and also high-base impact of last fiscal (when pent-up demand kicked in post slowdown in second-wave of covid19) bringing the growth rate for the entire fiscal to 8-10%.

Long steel segment will augur well on infra push and housing executions as elections approach and flat steel will see relief as semi-conductor shortage steadily alleviates. Further, healthy urban housing progress is ensuring and continue to push flat demand (in applications like railings, doors, staircases and outdoor construction)

The healthy domestic demand growth projected this fiscal is expected to be driven by a 10-12% rise in infrastructure, a decent 6-8% rise in housing driven by government housing construction and private demand.

**Trend in domestic steel demand growth (FY2017 - FY27P)**




*E: Estimated; P: Projected*
*Source: Joint Plant Committee, CRISIL Research*

### 5.13.2. Utilisation to rise on recovery in domestic demand and exports, but new capacities will limit further improvement

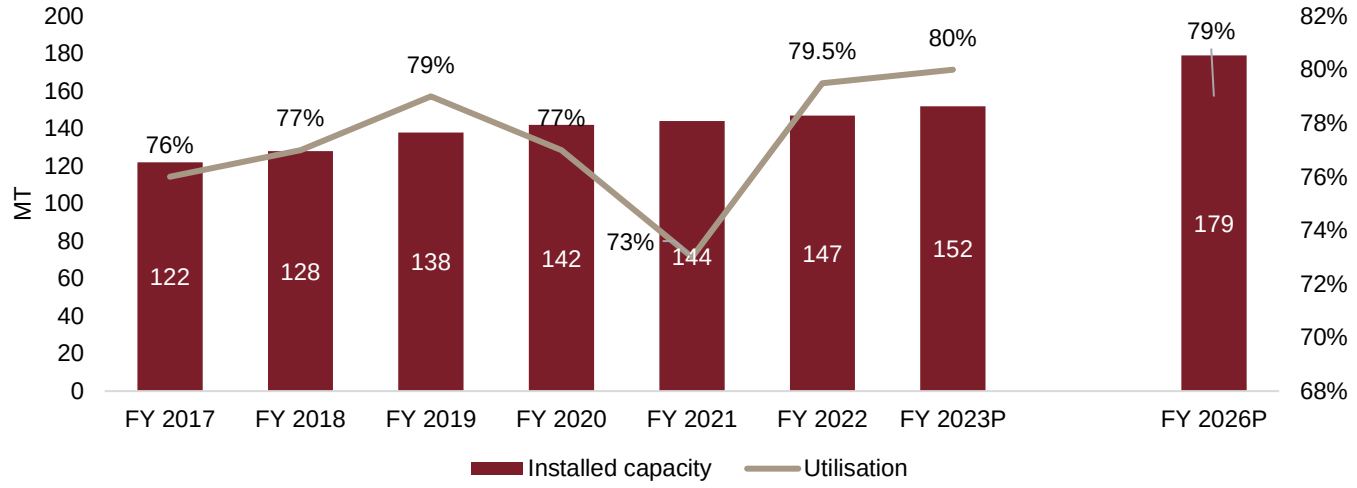
Fiscal 2022 saw a rise in steel exports as ~13.5 MT of finished steel is estimated to have been exported on weak demand in the domestic market and high global realisation. Crude steel production growth was thereby healthy on a low base of the previous year as secondary steel players ramped up production and new capacities came on-stream. We foresee utilisation levels to average at 76-78% this fiscal.

Several new capacities are expected to come on-stream over the next five years (90-95% of capex by large players), the pace of which has been accelerated after blockbuster profitability in the past two quarters. We expect a net capacity addition of 35-37 MT in this period, owing to healthy profitability and debt reduction seen in the past two fiscals. Share of large players is expected to rise from to 65% in fiscal 2026 from 57% in fiscal 2021, driven by increased capex activities on healthy profitability and strong revenue. Ramp-up of acquired assets will also help drive capacities up.

Share of BF/ BOF (Blast Furnace/Blast Oxygen Furnace) through 2026 is expected to rise to 46-48% from 40% currently with greenfield / brownfield capacity expansions of large integrated players like Tata (Kalinganagar), JSW (Dolvi), and NMDC.

With the hit on exports, production of crude steel is expected to see marginal 0-2% growth in fiscal 2023. And with operating capacity rising in fiscal 2023, utilization levels is expected to remain flat with downward bias. CRISIL Research expects utilization level to range between 76-78% in this fiscal.

**Capacity utilisation levels for the Indian steel market (FY2017 – FY2026P)**




*E: Estimated; P: Projected*

*Source: Joint Plant Committee, CRISIL Research*

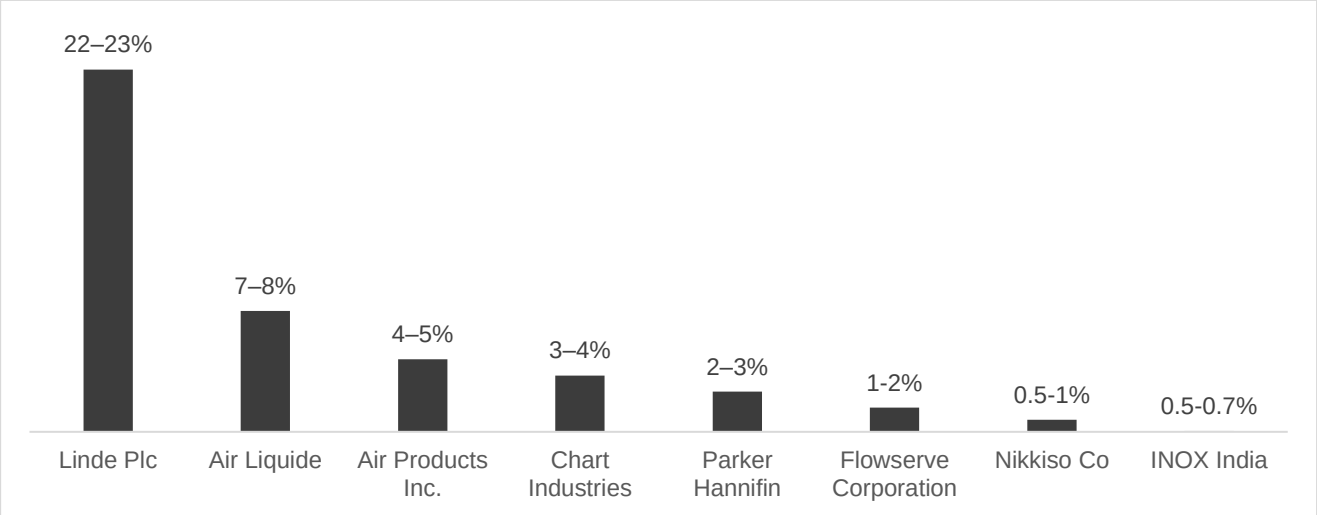
# 6 Competitive Landscape

## 6.1 Global market share of cryogenic equipment

As many cryogenic equipment suppliers have multiple business segments and can also offer a wide range of industrial solutions such as production of cryogenic gases, transport and distribution businesses, the market share of players in the global cryogenic equipment industry is calculated based on estimates of the revenue related to their cryogenic equipment business.

Linde Plc is the largest global player, with a market share of about 22-23%, followed by Air Liquide, which has a market share of 7-8%.g

### Market share of key cryogenic equipment suppliers globally (CY2021):




*Source: Markets and Markets, CRISIL Research*

At the global level top 5 companies account for about 40% of the cryogenic equipment market. Total cryogenic market includes all cryogenic equipment including air separation units, liquefaction plants and LNG bulk carrier ships. INOX India is one of the leading cryogenic equipment manufacturers in the world by revenue in 2021. It is the first Indian company to manufacture trailer mounted hydrogen transport tank designed jointly with Indian Space Rsearch Organisation (ISRO). Other major crygogenic tank manufacturers in India are VRV Asia pacific and Cryolor.

Domestically, INOX India is the largest supplier of cryogenic equipment with a revenue of Rs. 7.84 billion (approx. USD 105 mn) in FY2022. It also designs and manufactures cryogenic equipment which can meet international norms which can be exported to US and Europe. About 34% of its sales in came from exports in FY2022. Inox India is the largest exporter of cryogenic tanks from India. In the LNG tank segment, Inox India has supplied over 60% of the tanks in both the stationary tank segment which includes all LNG applications including LCNG stations and trailer mounted mobile LNG tanks in India which have a valid PESO license as of 4th May 2022, for tanks supplied between 1996 to May 2022. Inox India has also received orders for supply of equipment for multiple auto-LNG dispensing stations from IOCL, BPCL and HPCL between March-2021 and March-2022 for the Phase-I of auto-LNG station rollout.

## 6.2 Player Profiles

### INOX India Private Limited

| Key facts | Brief profile |
|---|---|
| HQ: **Vadodara, Gujrat, India**<br><br>Company type: **Private**<br><br>No. of Employees: **NA**<br><br>Revenue ($ million): **~105** | Incorporated in 1992, INOX India acquired US based Cryogenic Vessel Alternatives Inc., a (CVA), a cryogenic transportation equipment manufacturer in 2009 to form INOXCVA.<br><br>INOX India is a global manufacturer of equipment used for the transportation, storage, and distribution of cryogenic liquid and gases.<br><br>The company engages in design engineering, manufacturing, supply, and commissioning of cryogenic storage, vaporisation, and distribution systems for industrial gases, LNG and cryo-scientific segments. |

**Geographic presence (locations)**

INOX India has three manufacturing plants in India (Gujrat) and a sales office each in India, Brazil and the Netherlands.

**Equipment product portfolio**

INOX India product portfolio includes cryogenic-standard products, cryogenic engineered tanks and systems for industrial gases as well as LNG and hydrogen, cryo-biological products, Cryolines, disposable cylinders, vaporisers and LNG dispensation stations.

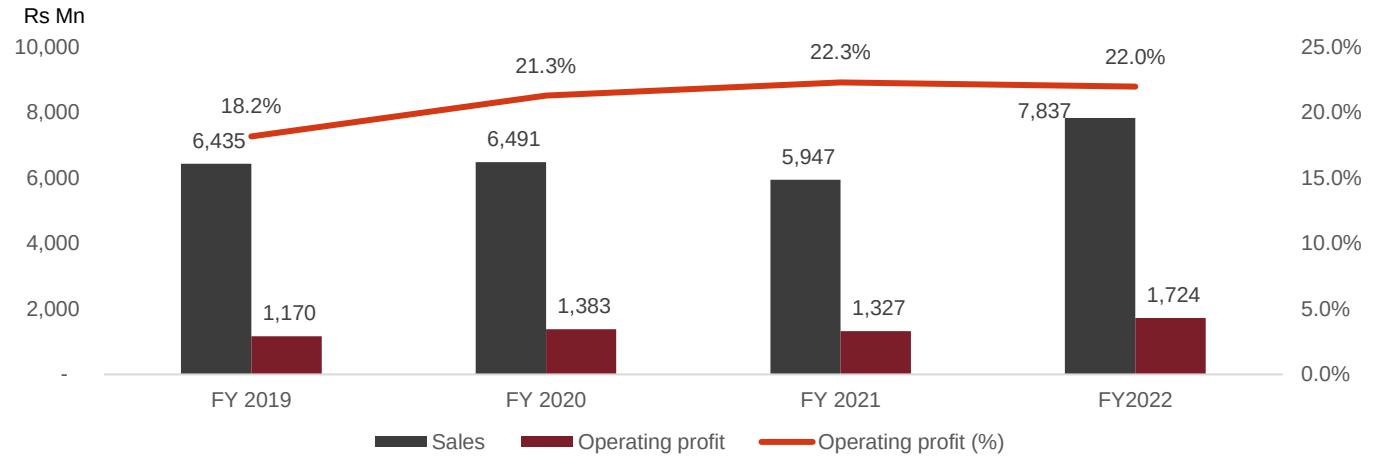
*Source: RoC, Company reports, CRISIL Research*

### Sharp rise in sales, Profit margins remained near stable during fiscal 2022

INOXCVA's revenue rose by about a third during the fiscal 2022. Operating profits also registered nearly 30% y-o-y growth in absolute terms.

Despite a sharp rise in raw material costs, company managed to keep the operating profit rangebound with reduced financing costs and limited increase in employee costs (as a proportion of revenue).

Operating as well as net margins remained near steady during the year.




*Source: Registrar of Companies, Company reports, CRISIL Research*

### Financial parameters (In Mn INR)

| | FY2019 | FY2020 | FY2021 | FY2022 |
|---|---|---|---|---|
| **Revenue** | 6,435 | 6,491 | 5,947 | 7837 |
| **Operating profit** | 1,170 | 1,383 | 1,327 | 1724 |
| **Operating Margin** | 18.2% | 21.3% | 22.3% | 22.0% |
| **Net profit** | 1,934 | 973 | 975 | 1279 |
| **Net profit Margin** | 30.05% | 14.99% | 16.39% | 16.32% |
| **Equity** | 2,096 | 2,794 | 3,721 | 5003 |
| **Debt** | 2,560 | 917 | 604 | 434 |
| **Debt to Equity ratio** | 1.2 | 0.3 | 0.2 | 0.1 |

*Source: Registrar of Companies, Company reports, CRISIL Research*

## Air Liquide Inc.

| Key facts | Brief profile |
|---|---|
| HQ: **Paris, France** | Established in 1902, Air Liquide is a world leader in offering services, technologies, and gases for Healthcare and Industrial End users. |
| Company type: **Public** | The company operates its business through three segments, namely, Gas & Services segment, Engineering & Construction and Global Markets & Technologies. |
| No. of Employees: **66,400** | Under its Engineering & Construction segment Air Liquide design, construct and manufacture plants and equipment's for the group and third-party customers. |
| Revenue ($ million): **27,556** | |

**Geographic presence (locations)**

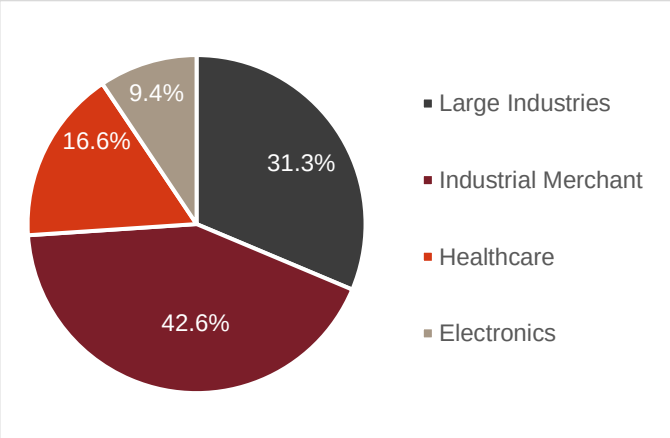
The company operates in approximately 78 countries and serves more than 3.8 million patients and customers.

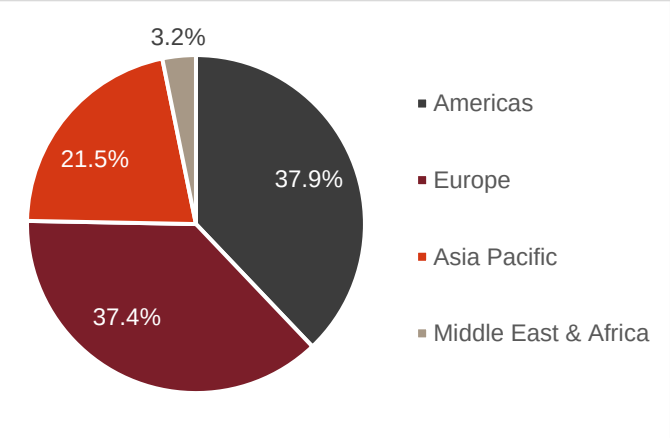
**Equipment product portfolio**

The company offers a wide range of cryogenic equipment, such as Cryocap H2, Cryocap Oxy, Helium Recovery and Liquefaction, Hydrogen, Nitrogen, and Argon Recovery, Large Air Separation Unit.

### The large industries have grown fastest among the business line

In CY2021, Large industries business segment grew by 40% which resulted increase in share from 25% to 31%. Whereas Industrial merchant and electronics grew by just 6% and 5%.

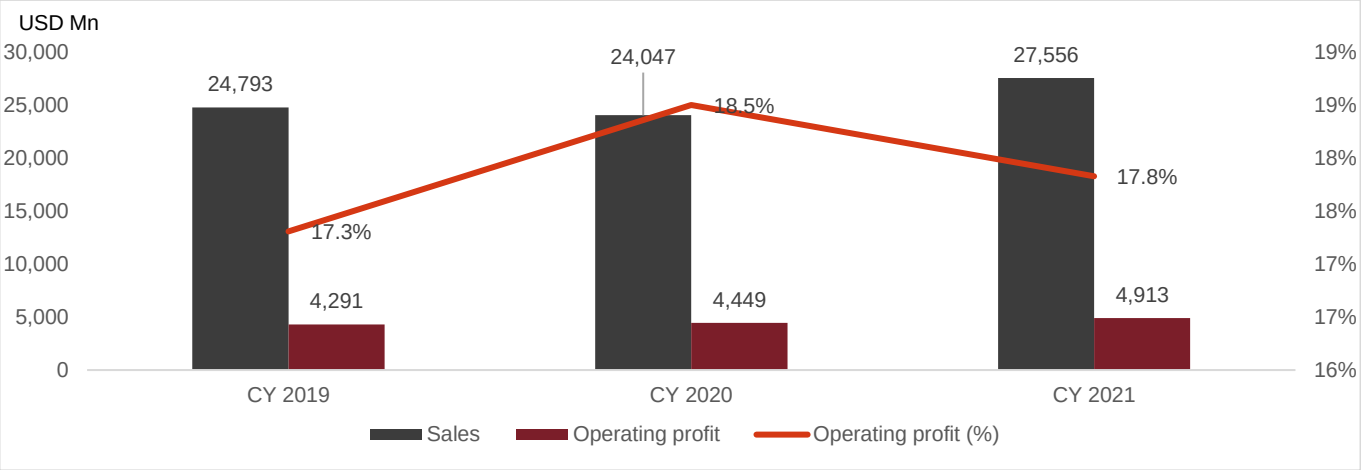



*Source: Company reports, CRISIL Research*

### Air liquide's operating profit grew by 10% but operating margin declined from 18.5% to 17.8%

In CY2021, Air liquide's revenue grew by 14% whereas operating profit grew by 10% only due to rising cost however, Air liquid is able to manage the decent operating margin due to inflation-adapted pricing policy and high efficiency gains.




*Source: Company reports, CRISIL Research*

### Financial parameters (In Mn USD)

| | CY2019 | CY2020 | CY2021 |
|---|---|---|---|
| **Revenue** | 24,793 | 24,047 | 27,556 |
| **Operating profit** | 4,291 | 4,449 | 4,913 |
| **Operating Margin** | 17.3% | 18.5% | 17.8% |
| **Net profit** | 2,536 | 2,858 | 3,037 |
| **Net profit Margin** | 10.23% | 11.89% | 11.02% |
| **Equity** | 21,874 | 22,341 | 26,026 |
| **Debt** | 13,995 | 12,454 | 12,338 |
| **Debt to Equity ratio** | 0.64 | 0.56 | 0.47 |

*Source: Company reports, CRISIL Research*

## Linde Plc

| Key facts | Brief profile |
|---|---|
| HQ: **Dublin, Ireland** | Established in 1879, Linde plc is global industrial gas and engineering company. |
| Company type: **Public** | The principal business activities of the company are production of industrial gases along with designing, engineering, and manufacturing of the equipment used in the production of industrial gases. |
| No. of Employees: **74,207** | The company operates its business through segments, namely, healthcare, manufacturing, chemicals and refining, metals, electronics, food and beverage, and others along with an engineering division named Linde Engineering. |
| Revenue ($ million): **~30,793** | |

**Geographic presence (locations)**

Linde Plc operates in more than 100 countries. The company has facilities across the globe, but its cryogenic equipment manufacturing facilities are in China and Germany.

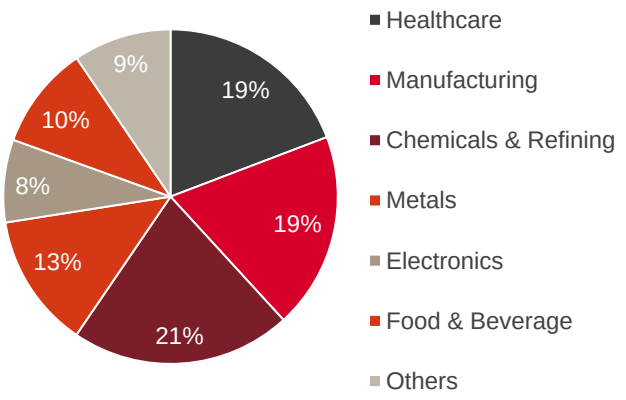
**Equipment product portfolio**

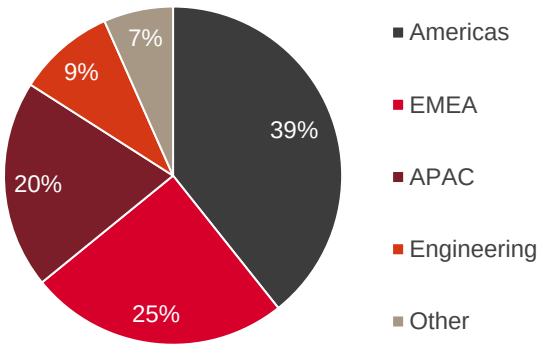
The cryogenic equipment manufactured includes plant components, such as cryogenic tanks, cryogenic portable tanks, vaporisers, pipes, and heat exchangers.

*Source: Company reports, CRISIL Research*

### Engineering segment's revenue is $2.8 bn, which includes the manufacturing of cryogenic tanks (CY2021)

The engineering segment, which accounts for 9% of global revenue, includes products such as cryogenic tanks, cold boxes, packaged units, and cryogenic columns, plate-fin heat exchangers, coil-wound heat exchangers and water bath vaporisers.

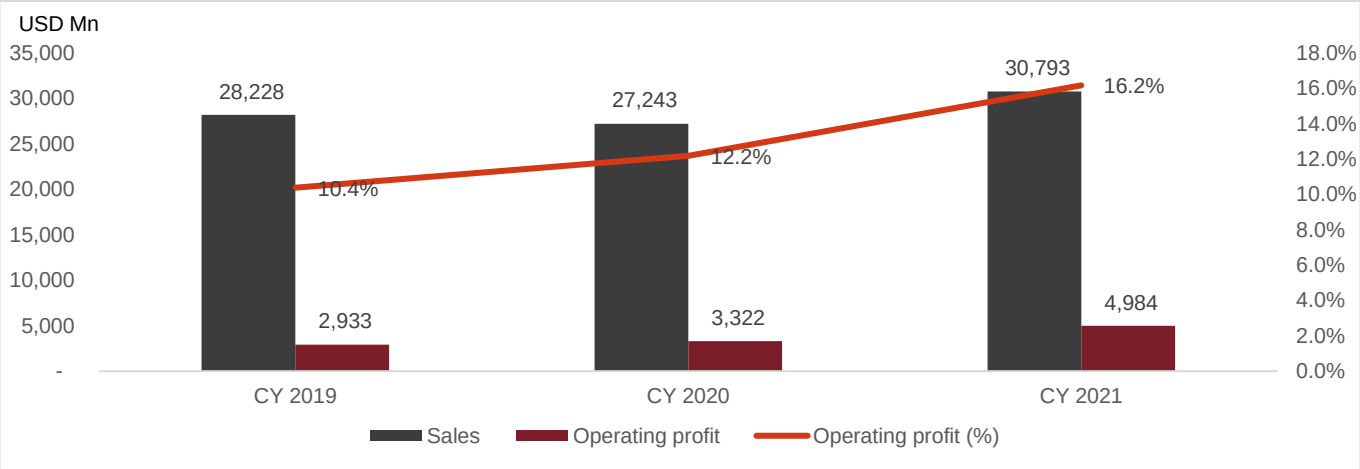



*Source: Company reports, CRISIL Research*

### Linde Plc has been improving its revenue and margin gradually

Linde Plc being the largest player in the sector, it has been improving its revenue along with operating margin. In last couple of years, operating margin improved from 10.4% to 16.2%.




*Source: Company reports, CRISIL Research*

### Financial parameters (In Mn USD)

| | CY2019 | CY2020 | CY2021 |
|---|---|---|---|
| **Revenue** | 28,228 | 27,243 | 30,793 |
| **Operating profit** | 2,933 | 3,322 | 4,984 |
| **Operating Margin** | 10.4% | 12.2% | 16.2% |
| **Net profit** | 2,285 | 2,501 | 3,826 |
| **Net profit Margin** | 8.09% | 9.18% | 12.42% |
| **Equity** | 51,522 | 49,569 | 45,428 |
| **Debt** | 34,977 | 38,647 | 36,164 |
| **Debt to Equity ratio** | 0.6 | 0.78 | 0.80 |

*Source: Company reports, CRISIL Research*

## Chart Industries, Inc.

| Key facts | Brief profile |
|---|---|
| HQ: **Georgia, US**<br><br>Company type: **Public**<br><br>No. of Employees: **4,318**<br><br>Revenue ($ million): **1,300** | Established in 1992, Chart Industries is a manufacturer of cryogenic equipment, which are used across the liquid-gas supply chain.<br><br>The company operates its business through four segments, namely, cryogenic-tank solutions, heat-transfer system, specialty products, repair, services and leasing.<br><br>Its distribution & storage west segment is involved in designing, manufacturing, and services related to the storage and delivery of cryogenic liquids used in industrial gas and LNG applications. |

**Geographic presence (locations)**

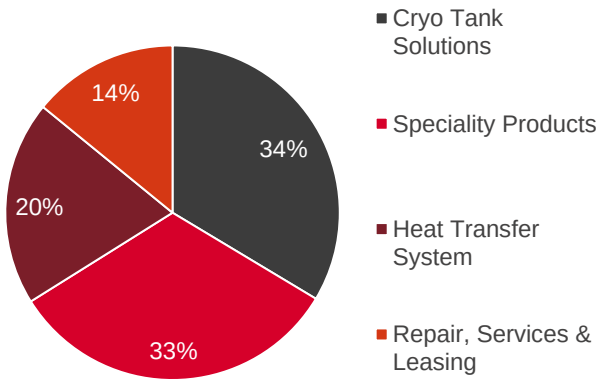
The company has offices in more than 10 countries in Asia-Pacific, Europe, and North America. Chart's engineering and manufacturing facilities are located in China, the Czech Republic, Italy, Germany, and France.

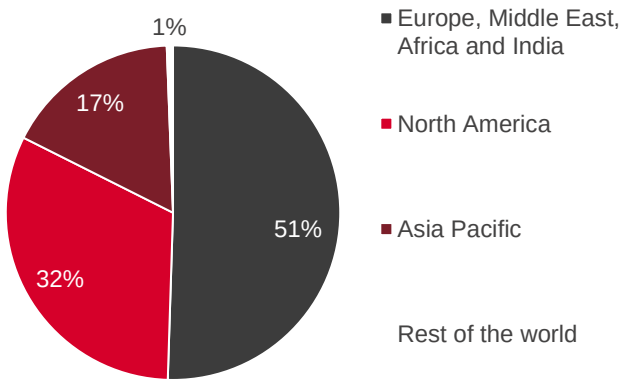
**Equipment product portfolio**

The company offers a wide range of cryogenic equipment, such as heat exchangers, vacuum-insulated containment vessels, liquefaction process units, other cryogenic components, gas processing equipment, cold boxes, and ambient temperature fans.

### Cryogenic-tank solutions account for a third of the revenue for the company

Revenue from the cryogenic-tank solutions revenue accounts for $400 million, which includes manufacturing of tanks for bulk $CO_2$, bulk storage tanks, cannabis and CBD oil, and cryogenic transport trailers.

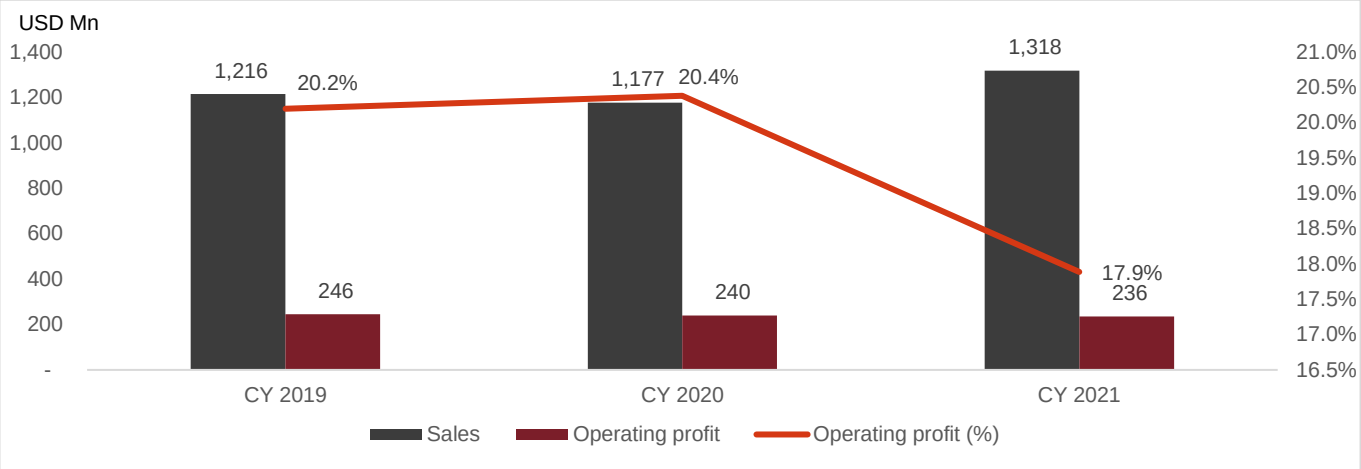



*Source: Company reports, CRISIL Research*

## Chart industries operating margin dipped in CY2021

Chart industries operating margin declined due to Heat transfer systems and Repair, service and leasing. For Heat transfer systems operating profit declined from 3% in calendar year 2020 to operating loss of 4.7% in calendar year 2021. On the other hand, repair, service and leasing business operating margin reduced from 19% to 12% in calendar year 2021. In absolute terms as well, operating profit reduced from $240 million to $236 million.




*Source: Company reports, CRISIL Research*

## Financial parameters (In Mn USD)

| | CY2019 | CY2020 | CY2021 |
|---|---|---|---|
| **Revenue** | 1,216 | 1,177 | 1,318 |
| **Operating profit** | 246 | 240 | 236 |
| **Operating Margin** | 20.2% | 20.4% | 17.9% |
| **Net profit** | 32 | 70 | 61 |
| **Net profit Margin** | 2.62% | 5.97% | 4.60% |
| **Equity** | 1,232 | 1,579 | 1,625 |
| **Debt** | 1,249 | 991 | 1,419 |
| **Debt to Equity ratio** | 0.87 | 0.63 | 1.01 |

*Source: Company reports, CRISIL Research*

## Air Products and chemicals, Inc.

| Key facts | Brief profile |
|---|---|
| HQ: **Pennsylvania, US**<br><br>Company type: **Public**<br><br>No. of Employees: **20,000**<br><br>Revenue ($ million): **10,323** | Established in 1940, Air products is global industrial gases company that is principally involved in the development, engineering, building, owning, and operating of industrial gas projects.<br><br>The company has five business segments, namely, Industrial Gases - Americas, Industrial Gases - EMEA, Industrial Gases - Asia, Industrial Gases - Global, and corporate and others.<br><br>Under its industrial gases equipment segment, the company designs and manufactures storage and transportation cryogenic equipment for air separation, hydrocarbon recovery and purification, natural gas liquefaction, liquid helium, and liquid hydrogen. |

**Geographic presence (locations)**

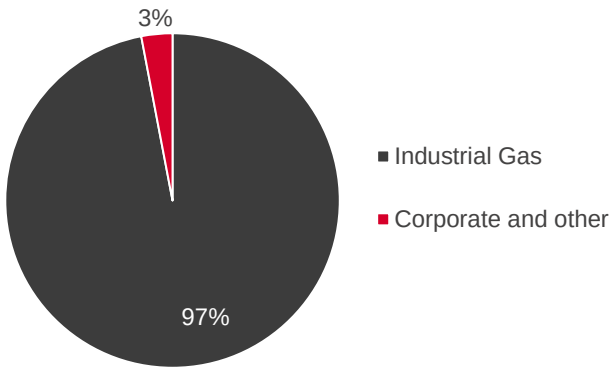
Air Products has manufacturing facilities for industrial gases equipment in the US. The company has presence in 52 countries.

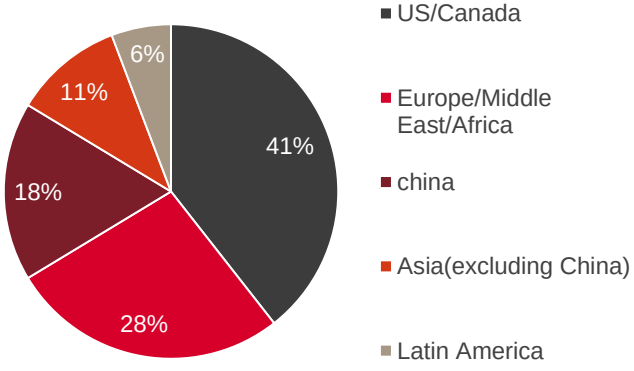
**Equipment product portfolio**

The cryogenic equipment product portfolio of the company includes tanks, vaporisers, and pressure regulators.

### Limited presence in the cryogenic market (CY2021)

Air Products is mainly focused on industrial gases, which accounts for 97% of global revenue, whereas corporate and others segment includes cryogenic equipment.

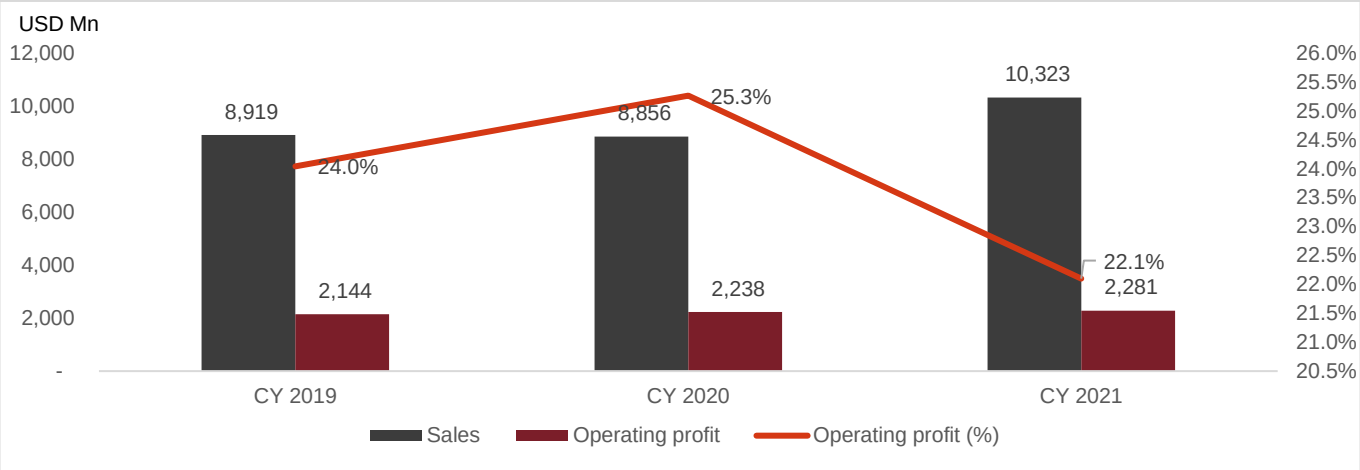



*Source: Company reports, CRISIL Research*

## Operating margin declined however operating profit increased marginally

Air Products operative margin declined in CY2021 to 22.1% from 25.3%. The recent marginal decline in operating margin was observed across all the regions.




*Source: Company reports, CRISIL Research*

## Financial parameters (In Mn USD)

| | CY2019 | CY2020 | CY2021 |
|---|---|---|---|
| **Revenue** | 8,919 | 8,856 | 10,323 |
| **Operating profit** | 2,144 | 2,238 | 2,281 |
| **Operating Margin** | 24.0% | 25.3% | 22.1% |
| **Net profit** | 1,809 | 1,931 | 2,115 |
| **Net profit margin** | 20.29% | 21.81% | 20.49% |
| **Equity** | 11,388 | 12,443 | 14,088 |
| **Debt** | 7,555 | 12,725 | 12,771 |
| **Debt to Equity ratio** | 0.91 | 1.02 | 0.66 |

*Source: Company reports, CRISIL Research*

## Emerson Electric Co.

| Key facts | Brief profile |
|---|---|
| HQ: **Missouri, USA** | Established in 1890, Emerson Electric Co. is a manufacturer and solution provider for industrial and commercial markets. |
| Company type: **Public** | The company operates through two business segments, namely, automation solutions and commercial and residential solutions. |
| No. of Employees: **83,500** | The company offers cryogenic equipment under its valves category of products. The principal business activities of the company are production of industrial gases, along with designing, engineering, and manufacturing of the equipment used in the production of industrial gases. |
| Revenue ($ million): **~18,236** | The company operates its business through segments, namely, healthcare, manufacturing, chemicals and refining, metals, electronics, food and beverage, and others. |

**Geographic presence (locations)**

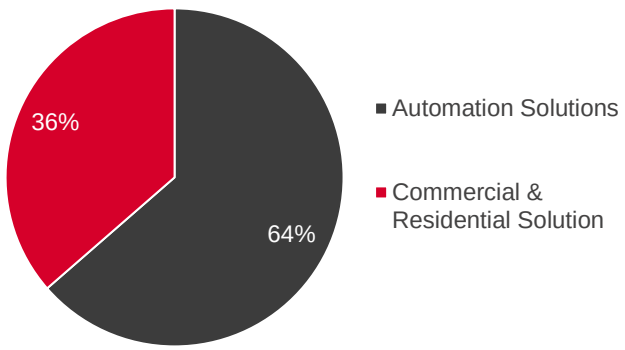
The company has strong presence in Asia, Latin America, Eastern Europe, and the Middle East and Africa.

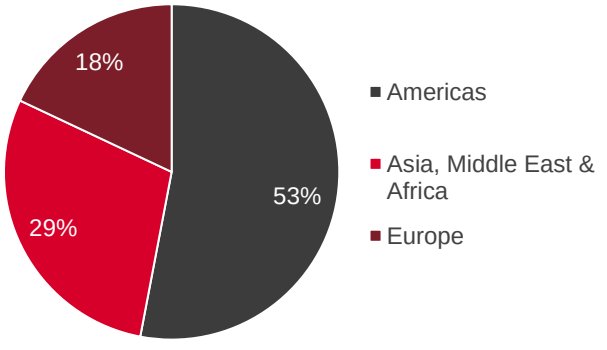
**Equipment product portfolio**

Emerson Electric Co. has a wide range of cryogenic valves that are used at air-separation plants, LNG terminals, aerospace engines, and other cryogenic applications.

### Emerson Electric is more focused in American market (CY2021)

Emerson Electric gets around 53% of revenue from the Americas, whereas Asia, Middle East and Africa cumulatively account for 29% of revenue.

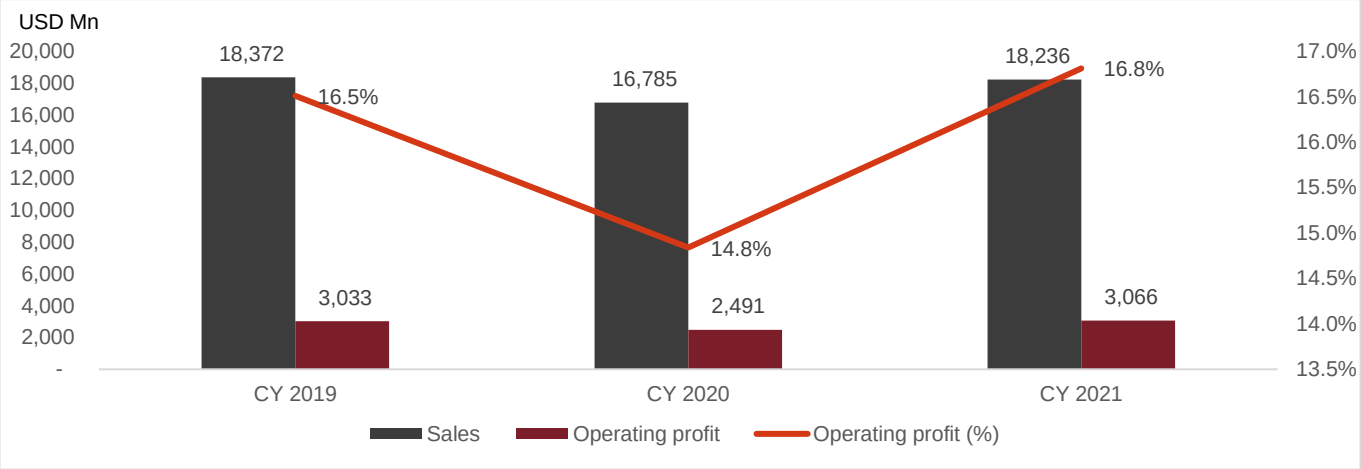



*Source: Company reports, CRISIL Research*

### Emerson Electric operating margin improved to pre-covid level (CY2021)

Emerson Electric operating margins improved to 16.8% from 14.8%.




*Source: Company reports, CRISIL Research*

### Financial parameters (In Mn USD)

| | CY2019 | CY2020 | CY2021 |
|---|---|---|---|
| **Revenue** | 18,372 | 16,785 | 18,236 |
| **Operating profit** | 3,033 | 2,491 | 3,066 |
| **Operating Margin** | 16.5% | 14.8% | 16.8% |
| **Net profit** | 2,328 | 1,990 | 2,327 |
| **Net profit margin** | 12.67% | 11.86% | 12.76% |
| **Equity** | 8,273 | 8,447 | 9,923 |
| **Debt** | 6,248 | 8,650 | 8,546 |
| **Debt to Equity ratio** | 0.9 | 1.02 | 0.76 |

*Source: Company reports, CRISIL Research*

## Shijiazhuang Enric Gas Equipment Company Ltd.

| Key facts | Brief profile |
|---|---|
| HQ: **Shijiazhuang, China** | Established in 1970, CIMC ENRIC is a global leading manufacturer of high-pressure and cryogenic pressure vessel manufacturer. |
| Company type: **Public** | The company serves storage and transportation requirements for clean-energy industries of CNG/LNGs and hydrogen, semiconductor and photovoltaics industries, and petrochemical industry. |
| No. of Employees: **~9,900** | ENRIC designs and manufactures products by complying with the standards or regulations of GB, ISO, EN, PED/TPED, ADR, USDOT, KGS, PESO, OTTC to meet the tailored requirement of target counties. |
| Revenue ($ million): **2,857** | |

**Geographic presence (locations)**

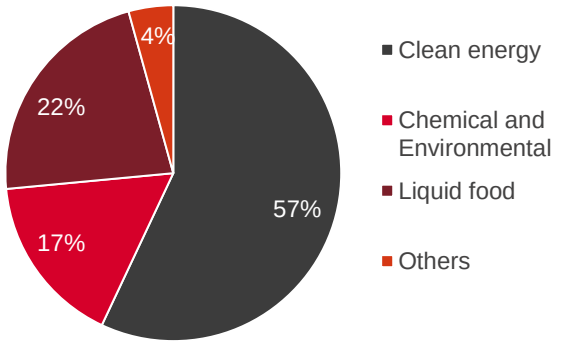
The company produces in China and exports to almost 40 countries across the globe.

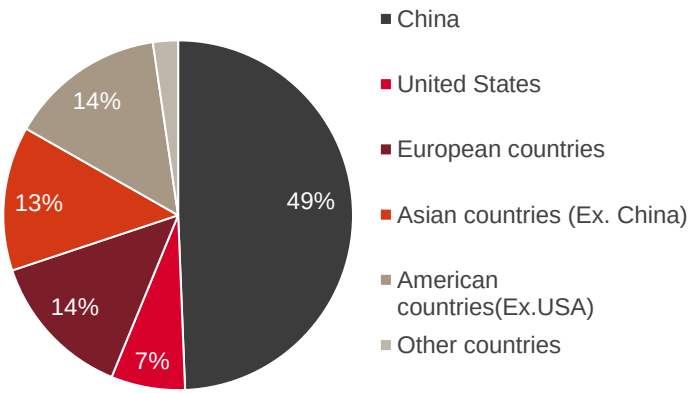
**Equipment product portfolio**

CIMC ENRIC has been innovatively developing and manufacturing high-quality seamless steel cylinders and various types of storage tanks and trailers for gas energy and petrochemicals.

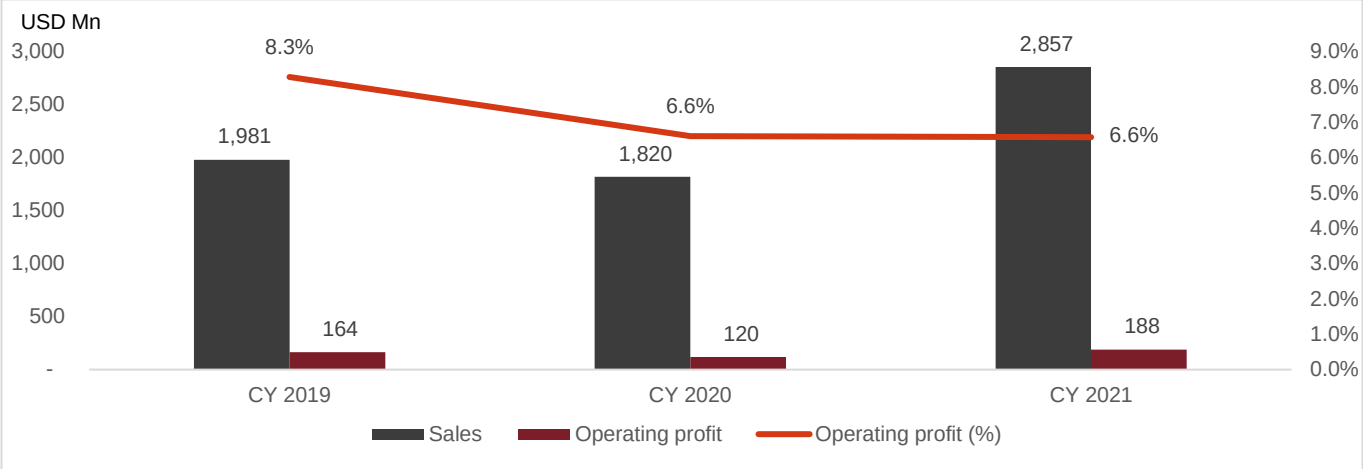
## CIMC ENRIC is more focused in domestic market (CY2021)

About 49% of revenue is generated from China; only additionally, 13% of revenue is generated from other Asian markets. The American countries (including USA) contribute about 21% of overall revenue.




*Source: Company reports, CRISIL Research*




*Source: Company reports, CRISIL Research*

### Financial parameters (In Mn USD)

| | CY2019 | CY2020 | CY2021 |
|---|---|---|---|
| **Revenue** | 1,981 | 1,820 | 2,857 |
| **Operating profit** | 164 | 120 | 188 |
| **Operating Margin** | 8.3% | 6.6% | 6.6% |
| **Net profit** | 130 | 84 | 141 |
| **Net profit** | 6.56% | 4.61% | 4.93% |
| **Equity** | 1,065 | 169 | 1,318 |
| **Debt** | 1,228 | 195 | 1,632 |
| **Debt to Equity ratio** | 1.2 | 1.2 | 1.2 |

*Source: Company reports, CRISIL Research*

## Taylor-Wharton

| Key facts | Brief profile |
|---|---|
| HQ: **Texas, US**<br><br>Company type: **Private**<br><br>No. of Employees: **NA**<br><br>Revenue ($ million): **NA** | Established in 1742, as a metal working company, it entered the cryogenic equipment space in 1925. However, the company ran into trouble and filed for Chapter 11 bankruptcy protection in 2009 in the US. It emerged from bankruptcy protection in 2010 but five years later had to file for bankruptcy protection again in 2015. Air Water Inc., an industrial gasses company, acquired Taylor-Wharton; however, Air Water decided that Taylor-Wharton would operate in its brand name.<br><br>Taylor-Wharton manufactures a wide range of cryogenic storage, transportation, and regasification equipment for industrial gases, life sciences, and LNG applications.<br><br>The company operates its business through three segments, namely, mega tanks and transports, commercial cryogenic storage, and cryogenic freezer applications. |
| **Geographic presence (locations)**<br><br>The company has presence in the US, Belgium, Poland, the UAE, Malaysia, Japan, Australia, and Colombia.<br><br>**Equipment Product Portfolio**<br><br>The cryogenic equipment products portfolio of the company includes bulk-storage vessels, micro-bulk tanks, liquid cylinders, transport vessels, LNG vessels, vaporizers, freezers, and vacuum insulated piping. | |

*Source: Company reports, CRISIL Research*

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