Market Intelligence
& Analytics

CRISIL
An S&P Global Company

# Industry report on infrastructure, utilities and consumer sectors

Adani Enterprises Limited

**January 2023**

Research

# Glossary

| Sr No. | Abbrevation | Full Form |
|---|---|---|
| 1 | AAI | Airports Authority of India |
| 2 | ADB | Asian Development Bank |
| 3 | AERA | Airports economic regulatory authority |
| 4 | AFV | Armoured Fighting Vehicles |
| 5 | ALMM | Approved List of Module Manufacturers |
| 6 | AMRUT | Atal Mission for Rejuvenation and Urban Transformation |
| 7 | ARR | Aggregate revenue requirement |
| 8 | ATF | Aviation Turbine Fuel |
| 9 | ATM | Air Traffic Movement |
| 10 | BALCO | Bharat Aluminium Company Ltd |
| 11 | BFSI | Banking, Financial Services and Insurance |
| 12 | BOT | Build Operate Transfer |
| 13 | BPCL | Bharat petroleum |
| 14 | BTKM | Billion Tonne Kilometres |
| 15 | CAGR | Compound Annual Growth Rate |
| 16 | CAGR | Compounded annual growth rate |
| 17 | CAGR | Compounded Annual Growth Rate |
| 18 | CDP | Comprehensive Development Plan |
| 19 | CIL | Coal India Limited |
| 20 | COD | Commercial Operation Date |
| 21 | Comp.H2 | Compressed hydrogen |
| 22 | DAC | Defence Acquisition Council |
| 23 | DAP | Di ammonium phosphate |
| 24 | DAP | Defence Acquisition Procedure |
| 25 | DFC | Dedicated freight corridor |
| 26 | DFI | Development finance institution |
| 27 | DGCA | Directorate general of civil aviation |
| 28 | DIO | Defence Innovation Organization |
| 29 | DPU | Defence Public Sector Undertakings |
| 30 | DTIS | Defence Testing Infrastructure Scheme |
| 31 | ECLGS | Emergency Credit Line Guarantee Scheme |
| 32 | E-Comm | Electronic Commerce |
| 33 | EDFC | Eastern dedicated freight corridor |
| 34 | EPC | Engineering Procurement Construction |
| 35 | EV | Enterprise Value |
| 36 | EV | Electric Vehicles |
| 37 | FDI | Foreign direct investment |
| 38 | FSA | Fuel Supply Agreements |
| 39 | FSC | Full Service Carrier |
| 40 | GAIL | Gas Authority of India Ltd |
| 41 | GB | Gigabyte |
| 42 | GCV | Gross Calorific Value |

| | | |
|---|---|---|
| 43 | GDP | Gross domestic product |
| 44 | GH | Ground Handling |
| 45 | GSL | Goa Shipyard Ltd |
| 46 | GST | Goods & Service Tax |
| 47 | GW | Giga Watts |
| 48 | HAL | Hindustan Aeronautics Limited |
| 49 | HAM | Hybrid Annuity Model |
| 50 | HCL | Hindustan Copper Ltd |
| 51 | HD | High Definition |
| 52 | IATA | International Air Transport Association |
| 53 | ICAO | International Civil Aviation Organisation |
| 54 | ICOL | Indian Oil Corporation Ltd |
| 55 | iDEX | Innovations For Defence Excellence |
| 56 | IEBR | Internal and Extra Budgetary Resources |
| 57 | IHHL | Individual Household Latrines |
| 58 | IL &FS | Infrastructure Leasing & Financial Services |
| 59 | InvIT | Infrastructure Investment Trust |
| 60 | IOT | Internet of Things |
| 61 | IRM | Integrated Resource Management |
| 62 | IRR | Internal Rate of Return |
| 63 | IT | Information Technology |
| 64 | JJM | Jal Jeevan Mission |
| 65 | JSW | Jindan Steel Works |
| 66 | JV | Joint Venture |
| 67 | KRDCL | Karnataka Road Development Corporation Limited |
| 68 | KSHIP | Karnataka State Highways Improvement Project |
| 69 | KTPA | Kilo Tonne Per Annum |
| 70 | L &T | Larsen and Tourbo |
| 71 | L&T | Larsen and Toubro Ltd |
| 72 | LCC | Low Cost Carrier |
| 73 | LOHC | Liquid organic hydrogen carrier |
| 74 | LOI | Letter of Intent |
| 75 | MBT | Main Battle Tanks |
| 76 | MDL | Dock Shipbuilders Ltd |
| 77 | MDO | Mine Developer and operator |
| 78 | MNC | Multi National Companies |
| 79 | MoCA | Ministry of Civil Aviation |
| 80 | MoD | Ministry of Defence |
| 81 | MoRD | Ministry of Rural Development |
| 82 | MoRTH | Ministry of Road Transport and Highways |
| 83 | MOSPI | Ministry of Statistics and Programme Implementation |
| 84 | MOU | Memorandum of Understanding |
| 85 | MPRDC | Madhya Pradesh Road Development Corporation |
| 86 | MRO | Maintenance, Repair and Overhaul |

| | | |
|---|---|---|
| 87 | MSME | Micro, small and medium enterprises |
| 88 | MW | Mega Watt |
| 89 | NALCO | Natioanal Aluminium Company Ltd |
| 90 | NCAP | National Civil Aviation Policy |
| 91 | NEP | National Electricity Plan |
| 92 | NHAI | National Highways Authority of India |
| 93 | NHDP | National Highways Development Program |
| 94 | NHIDCL | National Highways and Infrastructure Development Corporation |
| 95 | NIIF | National Investment and Infrastructure Fund |
| 96 | NIP | National Infrastructure pipeline |
| 97 | NMP | National monetisation pipeline |
| 98 | NPK | Nitrogen-phoporous-Potassium |
| 99 | NTPC | National Thermal Power Corporation |
| 100 | O&M | Operation & Maintenance |
| 101 | OFB | Ordnance Factory Board |
| 102 | PCI | Pulverised Coal Injection |
| 103 | PCOD | Provisional Commercial Operation Date |
| 104 | PE | Polyethylene |
| 105 | PEM | Proton exchange membrane |
| 106 | PGCIL | Power Grid Corporation of India |
| 107 | PLF | Plant Load Factor |
| 108 | PMAY | Pradhan Mantri Awas Yogna |
| 109 | PMGSY | Pradhan Mantri Gram Sadak Yojana |
| 110 | PPP | Public Private Partnership |
| 111 | PPP | Public private partnership |
| 112 | PSE | Public Sector Enterprise |
| 113 | PSU | Public Sector Undertaking |
| 114 | PVC | Polyvinyl Chloride |
| 115 | PWD | Public Works Department |
| 116 | RCS | Regional Connectivity Scheme |
| 117 | RE | Renewable Energy |
| 118 | RFP | Request for proposal |
| 119 | RIL | Reliance Industries Limited |
| 120 | ROFR | Right of First Refusal |
| 121 | RoW | Right of Way |
| 122 | SBM | Swachh Bharat Mission |
| 123 | SCCL | Singareni Collieries Company Limited |
| 124 | SEZ | Special Economic Zone |
| 125 | SHAKTI | Scheme for Harnessing and Allocating Koyala (Coal) Transparently in India |
| 126 | SMR | Steam methane reforming |
| 127 | SOE | Solid oxide electrolyzer |
| 128 | SPM | Strategic Partnership Model |
| 129 | SPV | Special Purpose Vehicle |
| 130 | T&D | Transmission and Distribution |

| | | |
|---|---|---|
| 131 | TIDCO | Tamil Nadu Industrial Development Corporation |
| 132 | TNDIC | Tamil Nadu - Tamil Nadu Defence Industrial Corridor |
| 133 | TNPCB | Tamil Nadu Pollution Control Board |
| 134 | TOT | Toll Operate Transfer |
| 135 | TRAI | Telecom Regulatory Authority of India |
| 136 | UDAN | Ude Desh ke Aam Nagrik |
| 137 | UDF | User Development Fee |
| 138 | UPDIC | Uttar Pradesh - Uttar Pradesh Defence Industrial Corridor |
| 139 | UPEIDA | Uttar Pradesh Expressways Industrial Development Authority |
| 140 | VAP | Value Added Products |
| 141 | WDFC | Western dedicated freight corridor |

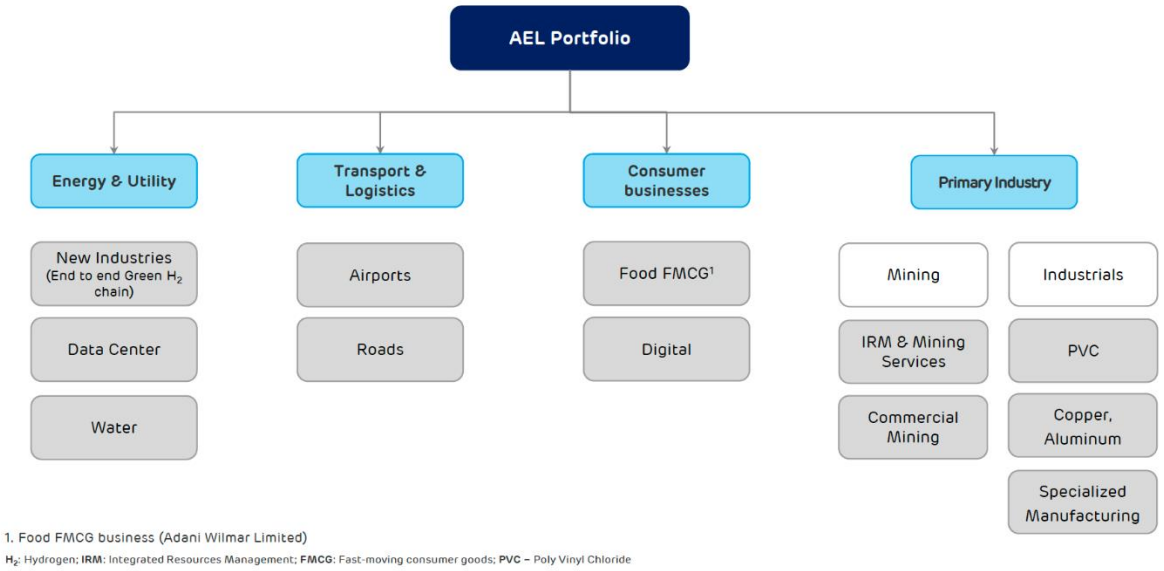
# Contents

# Background

This report has been prepared by CRISIL Research for Adani Enterprises Limited, which plans to raise funds via an FPO (Follow on public offer).

The Adani group is among India's top business houses. Its interests span transport and logistics (seaports, airports, logistics, shipping, road transport and rail), energy and utilities (power generation, transmission and distribution, renewable energy, gas, datacentres), primary industries, (including natural resources, mining services, copper, petrochemicals and direct to consumer, edible oil, food products, digital), real estate, defence and aerospace.

Adani Enterprises Limited is the flagship company of the group which is in the business of incubating large scale businesses in the above sectors. Example, Energy and utility (Adani new industries limited, Adani Connex), Transport and logistics (Adani airport holdings limited, Adani road transport limited), Primary industries( PVC, copper, aluminum) and direct to consumer (digital). The business portfolio of AEL is as under:




1. Food FMCG business (Adani Wilmar Limited)

$H_2$: Hydrogen; **IRM**: Integrated Resources Management; **FMCG**: Fast-moving consumer goods; **PVC** – Poly Vinyl Chloride

# Global economic overview

## Limping economy hit again, post recovery from the Covid-19 impact

- The world economy was on a recovery in calendar 2021, post speedbumps due to the Covid-19 pandemic in calendar 2020. The pandemic not only became a public health crisis in calendar 2020, but also a financial one
- The pandemic-induced lockdowns, closure of businesses, and trade and movement disruption wreaked havoc on the global economy. All the major economies of the world de-grew in calendar 2020, except China (up 2.2%). However, green shoots were visible, as economies adapted to new ways of working despite reduced mobility. Additional fiscal support in large economies, particularly in the developed world, also improved the overall outlook. The International Monetary Fund (IMF) expected the global economy to bounce back and grow 6.1% in 2021.
- The recovery in calendar 2021 on a low base followed a major setback in calendar 2022 with increasing risks, due to geopolitical tensions coupled with higher-than-expected inflation worldwide and surging costs of fossil fuel derived products. The growth is thus projected to slow from 6.1% last year to 3.2% in the current year majorly due to disruptions caused by spill over effect of the Russia-Ukraine war, energy crisis in Europe and lockdown & real estate crisis in China.

**Table 1: Real GDP growth**

| y-o-y, % | CY2016 | CY2017 | CY2018 | CY2019 | CY2020 | CY2021E | CY2022P | CY2023P |
|---|---|---|---|---|---|---|---|---|
| **World** | **3.3** | **3.7** | **3.6** | **2.9** | **-3.1** | **6.1** | **3.2** | **2.9** |
| Advanced economies | 1.8 | 2.5 | 2.3 | 1.7 | -4.5 | 5.2 | 2.5 | 1.4 |
| Emerging and developing economies | 4.4 | 4.7 | 4.6 | 3.7 | -2.0 | 6.8 | 3.6 | 3.9 |
| - Euro area | 1.9 | 2.6 | 1.8 | 1.6 | -6.1 | 5.2 | 3.1 | 0.5 |
| - South East Asia | 5.1 | 5.4 | 5.3 | 4.7 | -3.2 | 3.1 | 5 | 4.6 |
| - US | 1.7 | 2.3 | 2.9 | 2.3 | -3.4 | 5.7 | 1.6 | 1 |
| - UK | 2.3 | 2.1 | 1.7 | 1.7 | -9.3 | 7.4 | 3.6 | 0.3 |
| - Germany | 2.2 | 2.7 | 1.1 | 1.05 | -4.6 | 2.6 | 1.5 | -0.3 |
| - Japan | 0.8 | 1.7 | 0.6 | -0.2 | -4.5 | 1.7 | 1.7 | 1.6 |
| - China | 6.9 | 6.9 | 6.7 | 6.0 | 2.2 | 8.1 | 3.2 | 4.4 |
| - India*^ | 8.3 | 6.8 | 6.5 | 3.7 | -6.6 | 8.7 | 7 | 6 |

Note: * India is on Fiscal year basis

^ CRISIL MI&A Research projections

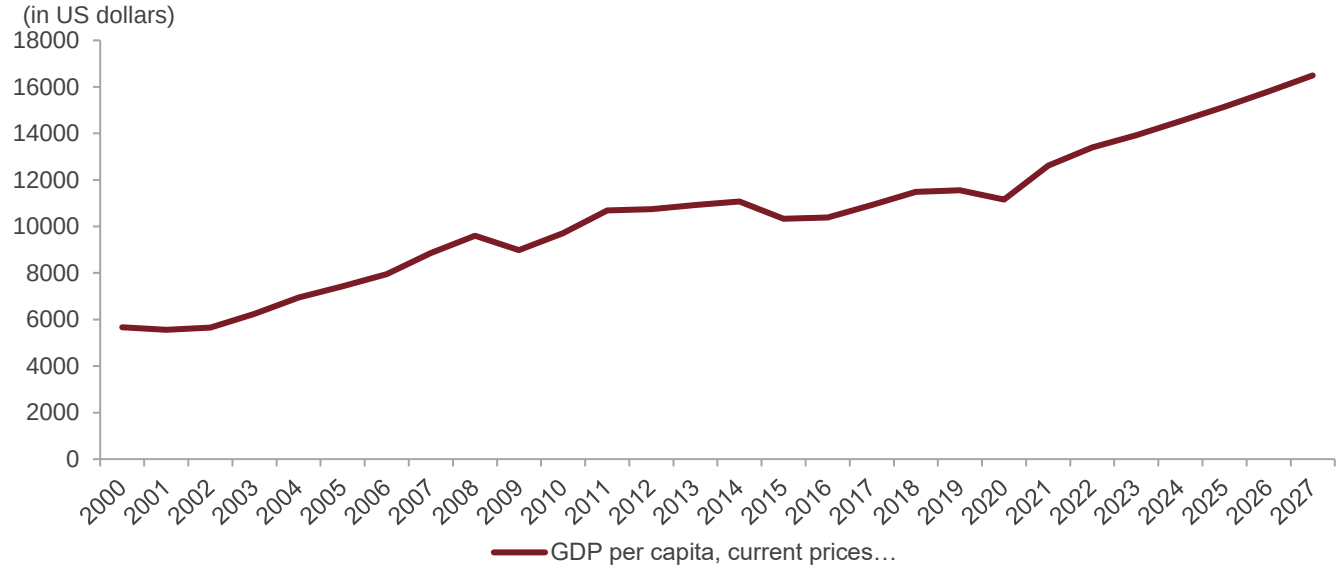
& - First revised estimate,

*Source: IMF World Economic Outlook, 2022*

## Global per-capita income on a rebound after the bump in pandemic-induced calendar 2020

Historical data shows that global per-capita income has been rising despite some aberrations. For example, 2020 per-capita declined due to the Covid-19 impact, but has recovered and is projected to rise in calendars 2022 and 2023, implying growth in the standard of living.

**Figure 1: GDP per capita in US dollars at current prices**

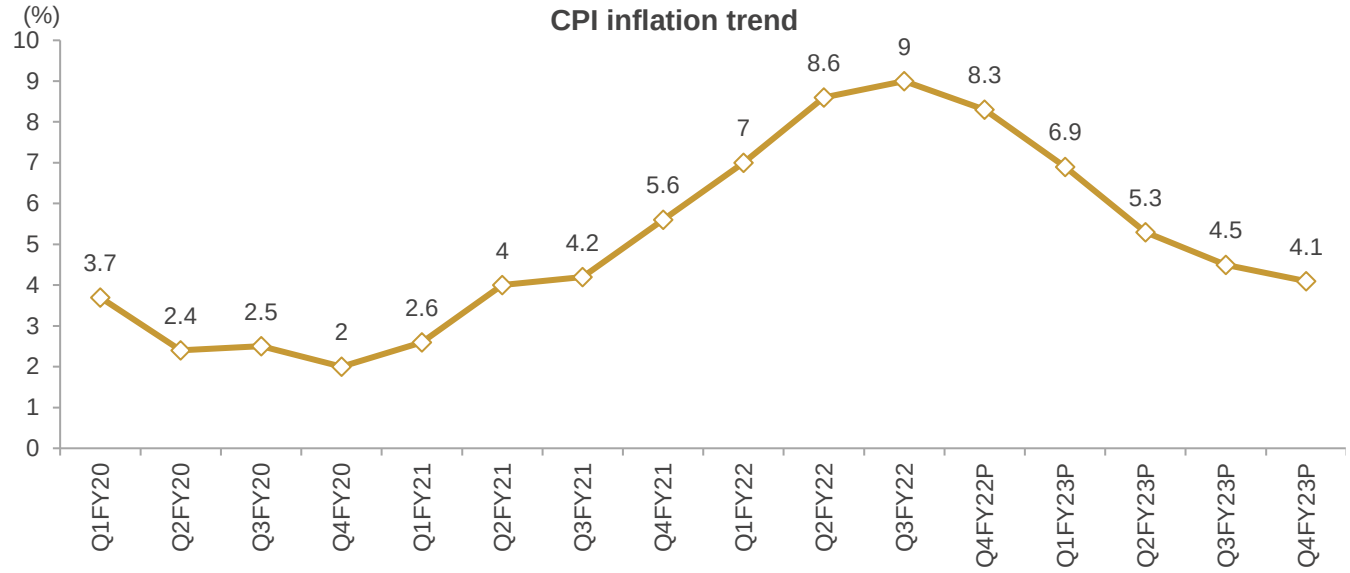



*Source: IMF World Economic Outlook, 2022*

## Global inflation on an ascent amid global crisis

Quarterly data suggests a rise in global inflation, because of record-high prices of food and energy brought about the Russia-Ukraine war, impacting energy as well as food-grain supply. Sanctions imposed on Russia have led to the realignment of crude oil supplies, coupled with the disruption of gas supplies to the European region, leading to increased demand for gas in spot market and sending rates soaring. The Black Sea region, known as the breadbasket of the world, has seen disruption of exports, sending food grain prices soaring. Easy monetary policy and quantitative easing in the aftermath of the pandemic led to excess liquidity driving up demand, with pandemic-impacted supply chain yet to get back to normalcy, leading to the onset of high inflation. Soaring inflation impacted purchasing power of consumers, while global central banks have resorted to unprecedented rate hikes to control soaring inflation. Although inflation is estimated to moderate in the coming quarters, uncertainties prevail due to geopolitical tensions and interest rate tightening.

**Figure 2: Global inflation movement across quarters**




*Source: IMF World Economic Outlook, 2022*

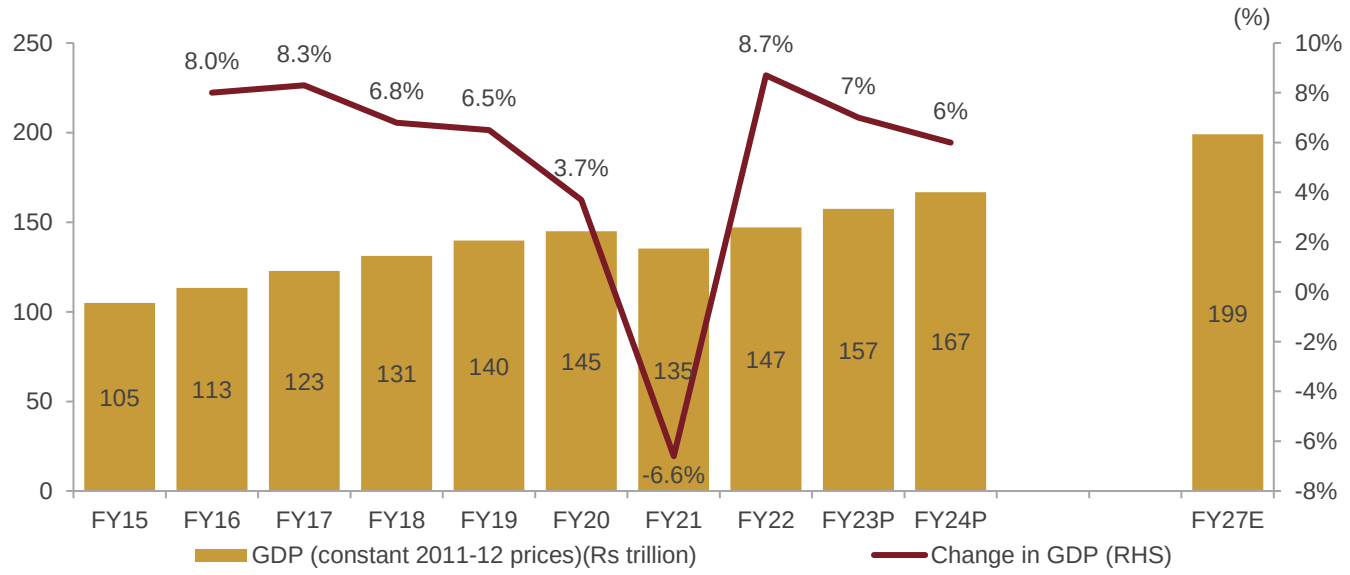
# An overview of the macroeconomic scenario in India

## Review and outlook of GDP growth in India

Before the pandemic, India was one of the fastest-growing economies in the world with a CAGR of 6.6% between fiscals 2015 and 2020. GDP is estimated to have shot up from Rs 105 trillion in fiscal 2015 to Rs 145 trillion in fiscal 2020 based on 2011-12 prices.

The outbreak of the Covid pandemic and the subsequent imposition of the lockdown March 25, 2020, onwards sent the Indian economy reeling, leading to an estimated 6.6% decline to Rs 136 trillion in fiscal 2021. While the economy was under pressure in the first half of the fiscal, due to the pandemic-induced, lockdown-led demand shocks and weak global demand, low oil and commodity prices provided some respite. The second half saw an uptick in mobility and in economic activity, as sentiment improved, coupled with people learning to live in the post-pandemic world. The opening up of vaccinations in the fourth quarter, albeit for a smaller section of the population, further boosted the sentiment, containing the contraction to 6.6% in fiscal 2021. The Indian government unleased a slew of measures during the pandemic-impacted fiscal under the Atma Nirbhar Bharat Abhiyan to boost the economy with the Production-Linked Incentive (PLI) scheme the standout tying in with the Make in India programme.

**Figure 3: Movement of Indian GDP across years**




*Source: MOSPI, CRISIL MI&A Research*

GDP grew 8.7% in fiscal 2022 to ~ Rs. 147 trillion on a low base, just surpassing the pre-Covid-19 level of fiscal 2020. Growth in fiscal 2022 would have been higher but for the brutal second wave in the first quarter, which impacted consumer sentiment and hurt demand in contact-intensive services sectors. The resurgence of Covid-19 infections since March 2021 forced many states to implement localised lockdowns and restrictions to prevent the spread of the infection. In the beginning of May, the country reported the highest number of daily cases. The second round of lockdowns were less restrictive for economic activity than last year. Manufacturing, construction, agriculture, and other essential activities had been permitted to continue in most states while travel too was permitted unlike the first wave where all travel services were shut. The third wave in the fourth quarter of fiscal 2022

had minimal impact on the economy attributable to high rates of vaccination and people having learned to live with the pandemic.

CRISIL Research expects the Indian economy to record a 7% on-year growth in real GDP in fiscal 2023 reaching about Rs ~157 trillion. While the economic recovery continues to gather pace, it faces multiple risks. Global growth is projected to slow, as central banks in major economies withdraw easy monetary policies to tackle high inflation. This would imply lower demand for our exports. Together with high commodity prices, especially oil, this translates into a negative in terms of a trade shock for India. High commodity prices, along with depreciating rupee, indicate higher imported inflation.

While most of the international commodity prices have come off their peaks and a weaker global demand could imply the downward trajectory in prices would continue, they would continue to be high on-year. Moreover, firms would continue to pass on high input costs to end consumers domestically as pass through to the retail end remains incomplete.

Uncertainty due to the Russia-Ukraine conflict could put some of the private capex plans on the back burner which could curtail overall investment growth.

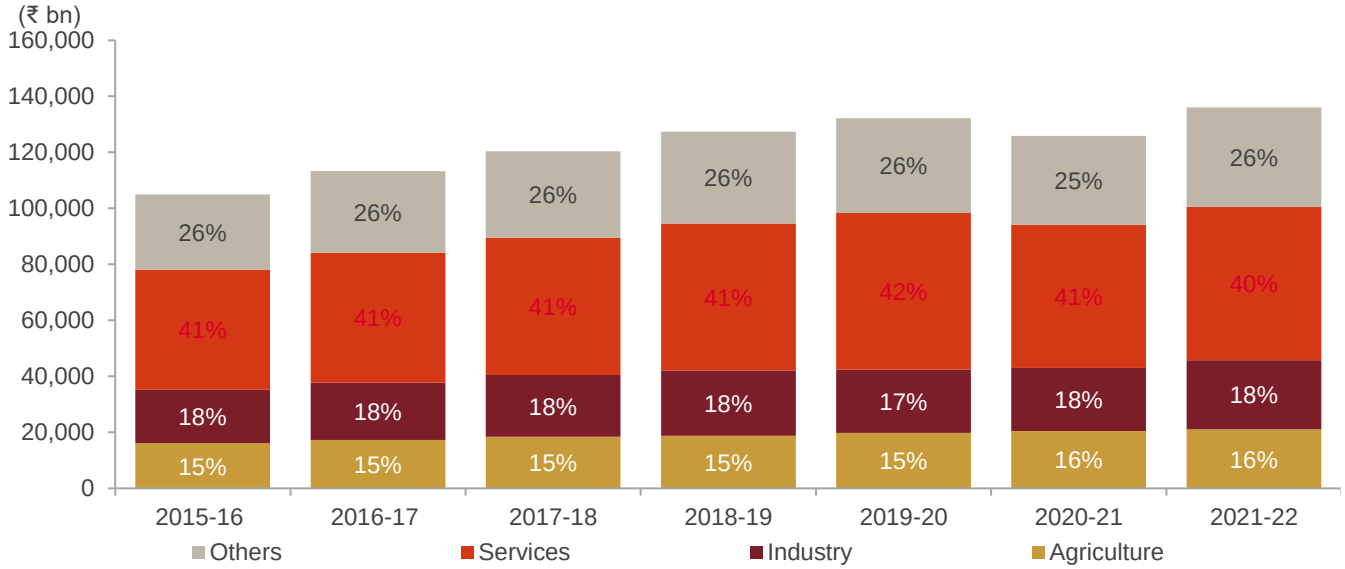
At the same time, uneven monsoon progress has impacted kharif sowing in key crops such as rice and pulses.

That said, there is a silver lining as well. Recent RBI surveys indicate improving consumer sentiments which bode well for consumption demand and the first quarter GDP print does corroborate that. Rise in capacity utilisation rates in the manufacturing sector is favourable for private capex in pockets. This is especially true in case of infrastructure-linked sectors such as steel and cement and some Production Linked Incentive scheme-linked sectors. We also expect the growing momentum in contact-intensive services to be broad based and support growth. That said, slower-than-expected growth in the first quarter has increased the downward bias to our real GDP growth projection of 7.0% for fiscal 2023. Over the medium term, the Indian economy is projected recording a 6-7% on year growth boosted by healthy capital expenditure by the government, domestic consumption led growth, China + 1 strategy boosting manufacturing in India coupled with the PLI scheme. Slowing global economies would drag Indian exports restricting India’s GDP growth.

## An overview of the contribution of key sectors to GVA

Analysis of GVA shows it has been on constant growth across years except fiscal 2021, which was impacted because of the Covid-19 pandemic induced lockdown. Services have been the highest contributor in overall GVA over the years. Growth in Manufacturing GVA at CAGR of 3% from FY17 to FY22 is attributable to various government led initiatives such as Atmanirbhar Bharat, Make in India, PLI schemes. The services sector is majorly driven by financial, real estate and professional services, thereby aiding growth at 3% CAGR across five years. Agriculture being the major source of income for majority of Indian population grew at a CAGR of 3% on account of subsidy support given by the government to farmers and various other government initiatives such as Pradhan Mantri Krishi Sinchayi Yojana (PMKSY) aiding the sector growth

**Figure 4: Contribution of GVA of Key Sectors (Industry, Agriculture and Services)**



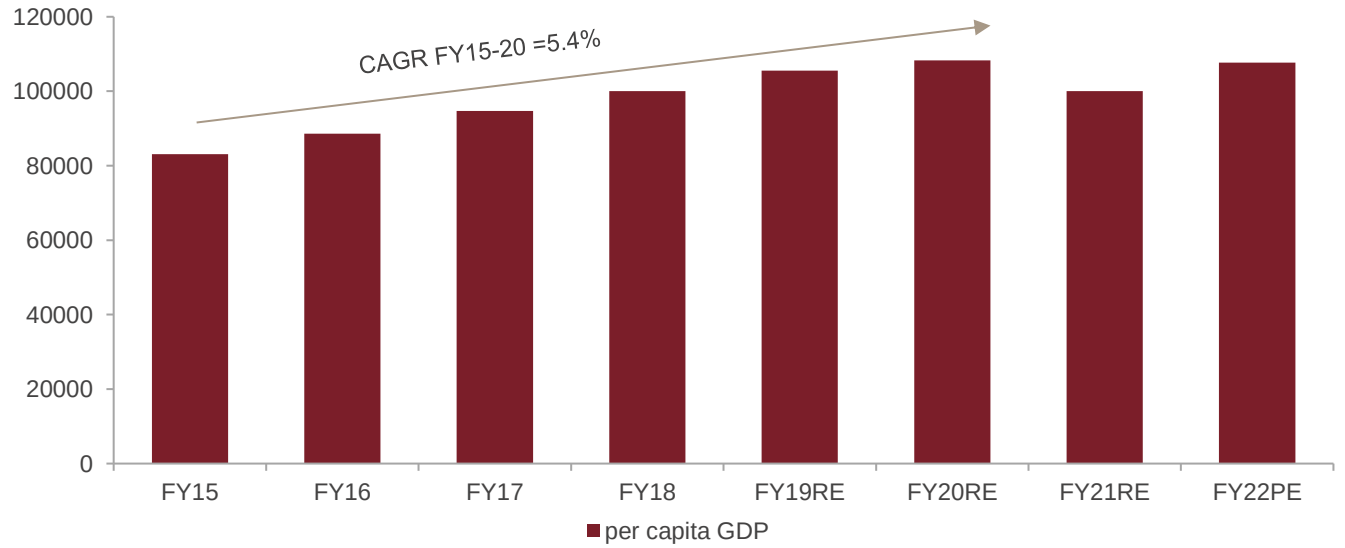

Note : Industry accounts for manufacturing GVA, Services accounts for addition of Trade, hotels, transport, communication and services related to broadcasting and Financial , real estate & prof servs GVA, Others include Mining & quarrying, Electricity, gas, water supply & other utility services, Construction and Public Administration, defence and other services GVA

*Source: Ministry of Statistics and Programme Implementation, CRISIL MI&A Research*

## Per-capita GDP

India's GDP per capita recorded a 5.4% CAGR over fiscals 2015 to 2020, on a real basis, rising from Rs 83k to Rs 108k. The Covid-19 pandemic-induced lockdown led to declining income and widespread loss of temporary jobs, pushing per-capita GDP lower by 7.6% on year to Rs 100k in fiscal 2021, back to fiscal 2018 levels. On this low pandemic impacted base, per capita GDP recorded a 7.6% growth in fiscal 2022, rising to Rs 108k, marginally lower than pre-Covid-19 levels of fiscal 2020.

**Figure 5: Per-capita GDP for India**

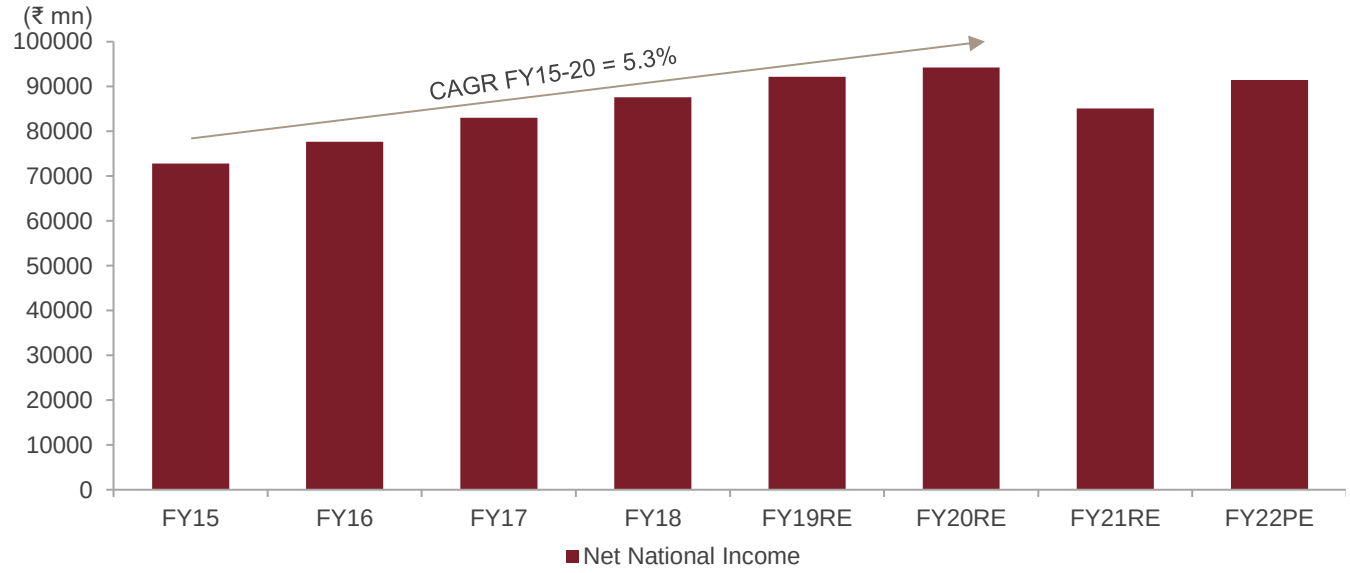



Note: Based on constant prices, 2011-12 base.

*Source: National account statistics, CRISIL MI&A Research*

India's National Income per capita recorded a 5.3% CAGR over fiscals 2015 to 2020 on a real basis rising from Rs 72k to Rs 91k. The Covid-19 pandemic induced lockdown led to declining income and widespread loss of temporary jobs pushing per Capita National Income lower by 9.7% on year to Rs 85k in fiscal 2021, back to fiscal 2018 levels. On this low pandemic impacted base, per capita National Income recorded a 7.4% growth in fiscal 2022, rising to Rs 91k, marginally lower than pre-Covid-19 levels of fiscal 2020.

**Figure 6: Net National Income across years for India**




Note: Based on constant prices, 2011-12 base.

*Source: National account statistics, CRISIL MI&A Research*

## Per-capita consumption of key commodities

The per capita consumption of key commodities such as electricity, steel, copper and aluminium lags those of other countries. With increasing economic activities, infrastructure spends, focus on capital expenditure and increasing manufacturing, the consumption of these commodities has opportunities to catch up.

**Table 2: Per capita consumption of Electricity and Steel of key economies**

| Countries | Electricity ( kwhr/capita) | Steel (kg / capita) | Copper ( kg/ capita) |
|---|---|---|---|
| Base Year | **2019** | **2020** | **2021** |
| India | 945 | 65 | 0.8 |
| **Developing peers** | | | |
| China | 5082 | 708 | 9.8 |
| Russia | 6952 | 290 | 3.0 |
| Brazil | 2585 | 101 | 1.3 |
| **Developed peers** | | | |
| USA | 12752 | 239 | 5.3 |
| Germany | 6606 | 375 | 11.4 |
| Australia | 9897 | 201 | - |
| Spain | 5417 | 247 | 7.7 |
| Italy | 5260 | 342 | 8.4 |

*Source: IEA, World steel association, International Copper Study Group, CRISIL MI&A Research*

# Green Hydrogen

## Introduction

As per the International Energy Agency's (IEA) energy outlook for the Indian market (India Energy Outlook 2021, IEA) under its Stated Policies Scenario (STEPS), India is expected to overtake the EU as the world's third-largest global energy consumer by 2030 and will account for nearly a quarter of global energy demand growth over 2019-2040. Under the same scenario,the IEA expects the country's primary energy consumption to reach 1,123 million tonne of oil equivalent by 2040. However, dependence on conventional sources alone to meet this requirement will not only result in higher import bills but also higher emissions.

In line with this, during the COP 26 summit, the Government of India presented the following five nectar elements of India's climate action known as 'Panchamrit'

- Reach 500GW non-fossil energy capacity by 2030.
- 50 per cent of its energy requirements from renewable energy by 2030.
- Reduction of total projected carbon emissions by one billion tonnes from now to 2030.
- Reduction of the carbon intensity of the economy by 45 per cent by 2030, over 2005 levels.
- Achieving the target of net zero emissions by 2070.

Further, in COP 27, India submitted its long-Term Low Emission Development Strategy to the United Nations Framework Convention on Climate Change (UNFCCC), in which importance of hydrogen along with electric vehicles and ethanol to achieving decarbonization has been emphasized

Hydrogen is becoming increasingly crucial to achieving decarbonisation, especially in hard-to-abate sectors such as steel, fertilisers, refining, shipping, etc. This has resulted in increased momentum around the globe for deploying clean hydrogen-based projects, with the global investment pipeline surpassing $500 billion in mid-2021, as per the Hydrogen Council.

More than 40 countries around the globe have set up or are in the process of setting up national strategies or roadmaps for hydrogen adoption.

The surge in volatility of commodity prices, especially over the past three years owing to the pandemic and more recently due to the Russia-Ukraine war has further exacerbated the urgency of the major economies to reduce fossil fuel dependence. This has fuelled the governments to incentivise hydrogen adoption.

Despite the active interest in hydrogen adoption by governments and corporates alike, major challenges remain. The cost of low carbon hydrogen production is at least 2-6 times higher than that of fossil-based hydrogen production. For instance, our estimates indicate that the cost of producing renewable hydrogen in India currently varies from $3 to $6 per kg, compared with $1-2.5 per kg for the natural gas-based process. However, declining renewable prices as well as electrolyser capex costs promise to make green hydrogen economical in the future.

Until there is cost parity between low carbon hydrogen and fossil based hydrogen, the industry will need handholding by the governments to achieve decarbonisation.

Another major challenge for hydrogen adoption is supply chain complexity as transporting hydrogen involves safety risks.

## Production and colours of Hydrogen

Most hydrogen currently comes from natural gas or coal, which use a process called steam methane reforming (SMR) or gasification. While being the most cost-effective, these methods generate CO2 emissions. As a result, there is a renewed global push to adopt blue and green hydrogen production methods in order to reduce or eliminate CO2 emissions.

**Blue hydrogen production** relies on the same process as grey hydrogen production, with provisions for carbon capture and storage (CCS). This eliminates grey hydrogen emissions, reducing the environmental impact of hydrogen.The CO2 produced during hydrogen production is not released into the atmosphere because it is deposited and stored underground before being used in other processes.

**Green hydrogen production** relies entirely on water and renewable electricity to create hydrogen through a process called electrolysis, which is a chemical reaction where an electric current is passed through metal conductors, known as electrodes, in contact with water. This separates water into two elements: hydrogen and oxygen. Thus, if the whole process uses only renewable electricity, it is entirely free of CO2, at least in theory.

There are other methods for producing hydrogen, like turquoise hydrogen, that are seeing some research and development interest; however, the technology is relatively nave and has seen few commercial deployments.

**Figure 7: Different colors of hydrogen**

| | GREY | BLUE | GREEN | Pink | Turqoise |
|---|---|---|---|---|---|
| **Process** | Steam methane reforming (SMR) | SMR+CCUS | Electrolysis | Electrolysis | Methane pyrolosis |
| **Inputs** | Natural gas (Methane) | Natural gas (Methane) | Water + Renewable energy | Water + Nuclear energy | Natural gas |
| **Cost** | $ 1-2.5 per kg | $ 3-4 per kg | $ 3-6 per kg | NA | NA |
| **Commerciali -sation stage** | Widely used | Focus area | Focus area | Technology established but low usage | Nascent technology and yet to be explores |

Note: Natural gas priced between $8-13 / mmbtu, Electrolyser priced between $ 700-1000 per kw

*Source: IEA, CRISIL MI&A Research*

The choice of blue or green hydrogen largely depends on varied factors. Countries like the United States, the Gulf, and some regions in Europe, etc., which have abundant gas resources, infrastructure, and CO2 storage facilities, are likely to initially pursue the blue hydrogen route along with the green.

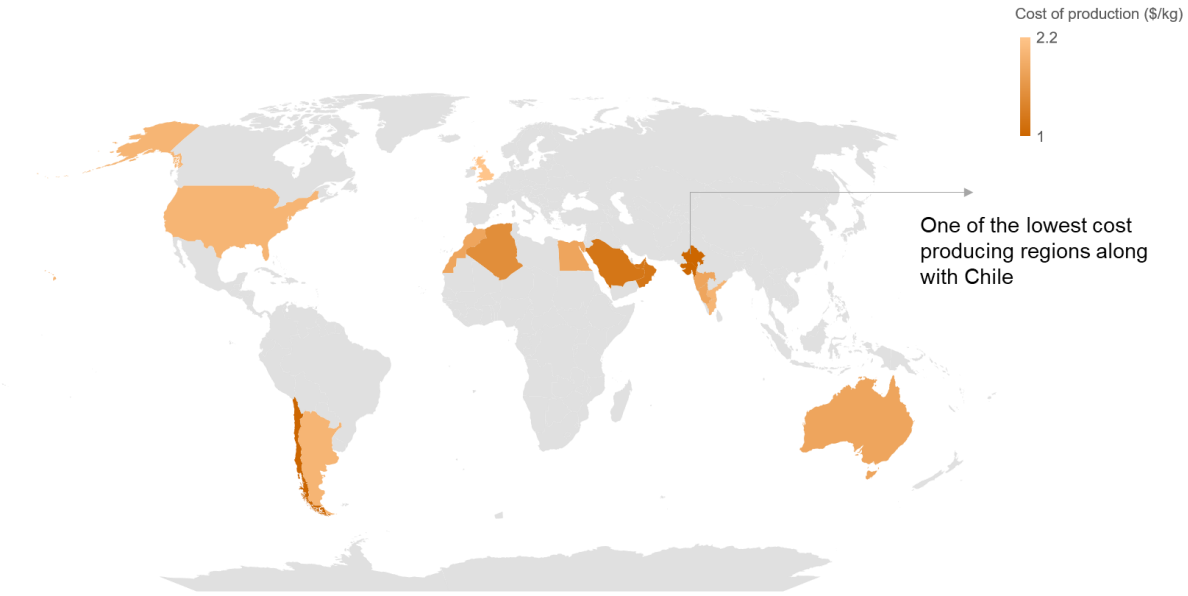
**Figure 8: Resources and merits that dictate the choice of low-carbon adoption**


*Source: CRISIL MI&A Research*

While India does have opportunity in various industries for carbon capture but has a significant competitive edge in Green Hydrogen due to the tremendous strides it has made in renewable energy over the past few years. This combined with capital, land resources, large grid system makes it an ideal candidate to make a quick transition to green hydrogen.

Among the regions, Gujarat and Rajasthan have one of the highest solar radiation levels resulting in a potential to become one of the lowest costs Green hydrogen producing regions.

**Figure 9: Potential low cost green hydrogen producing regions over the long term**



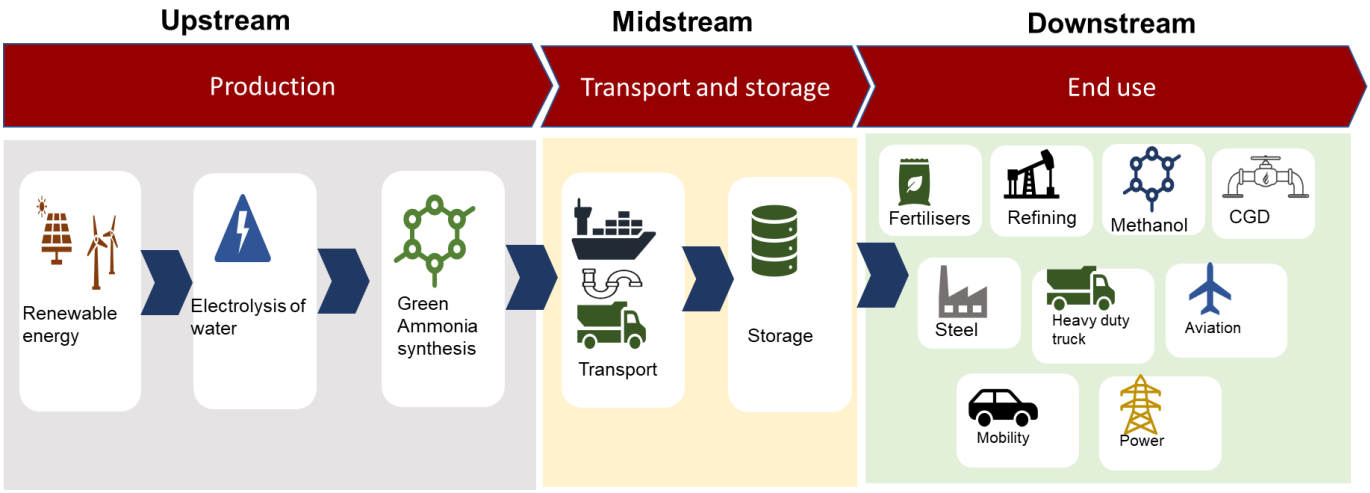

*Source: IEA, CRISIL MI&A Research*

## Green hydrogen value chain development

The hydrogen value chain can be broadly categorised into three parts:

- Upstream
- Midstream
- Downstream

**Figure 10: Green hydrogen value chain**




*Source: CRISIL MI&A Research*

### Upstream-the production of hydrogen

Most of the hydrogen produced today comes from fossil fuels, which, without mitigation measures such as carbon capture, will not meet the carbon neutrality requirements set out in the EU and UK strategies. The International Energy Agency (IEA) estimates that only 0.1% of total hydrogen production today derives from water electrolysis, which is the most common method for green hydrogen production using renewable power sources.

Water electrolysis is an old technique but has found few commercial takers due to its higher cost and cheaper alternatives to produce hydrogen using coal and natural gas. However, in the current decarbonization trend, electrolysis has made a comeback due to its zero-emission merit if powered through renewable energy.

There are four types of electrolysers: Alkaline and polymer electrolyte membranes (PEM) are already commercial, while anion exchange membranes (AEM) and solid oxide, now at the R&D stage, promise a major step forward.

**Alkaline**: Alkaline electrolysers are the most used hydrogen generators in the industry. In alkaline technology, the water is split into its constituents in the presence of a caustic electrolyte solution. This leads to a reaction between two electrodes. And when sufficient voltage is applied, water molecules take electrons to make OH ions and a hydrogen molecule. The OH ions travel through the solution toward the anode, where they combine and give up their extra electrons to make water, hydrogen, and oxygen. Recombination of hydrogen and oxygen at this stage is prevented by means of an ion-exchange membrane, which was historically made of porous white asbestos. However, membranes have advanced significantly in recent years.

**PEM**: Polymer Electrolyte Membrane (PEM) technology is the electrolysis of water in a cell equipped with a solid polymer electrolyte (SPE) to separate hydrogen and oxygen. PEM electrolysis creates a reaction using an ionically conductive solid polymer rather than a liquid. When voltage is applied between two electrodes, negatively charged oxygen in the water molecules produces protons, electrons, and oxygen at the anode. The H+ ions travel through a polymer membrane towards the cathode, where they take an electron and combine to make hydrogen. The electrolyte and two electrodes are sandwiched between two bipolar plates, which transport water to them or gases away from them, conduct electricity, and circulate a coolant fluid to cool down the process.

**Solid oxide electrolysis**: These operate at high (700–850 °C) temperatures, which enables the favourable kinetics that allow the use of relatively cheap nickel electrodes, a lower electricity demand, and the potential for reversibility (for operating as a solid oxide fuel cell). On the downside, thermo-chemical cycling, especially during shutdown or ramping periods, leads to faster degradation and shorter lifetimes. Other issues related to stack degradation include challenges related to sealing at higher differential pressures, electrode contamination by silica used as sealants, and other additional contaminant sources from piping only deployed at the kW-scale, although some current demonstration projects have already reached 1 MW.

**Anion Exchange Membranes (AEM):** This is the latest technology, with only a few companies commercialising it and limited deployment. It's a combination of a less harsh environment from alkaline electrolysers with the simplicity and efficiency of a PEM electrolyser. Also, it allows the use of non-noble catalysts and titanium-free components and, as with PEM, operation under differential pressure. However, AEM membrane has chemical and mechanical stability problems, leading to unstable lifetime profiles and lower-than-expected performance, mostly due to low AEM conductivity, poor electrode architectures, and slow catalyst kinetics. Performance enhancement is typically achieved by tuning the membrane conductivity properties or by adding a supporting electrolyte. Such tuning could lead to decreased durability.

**Table 3: Characterisation of different types of electrolysis**

| | Alkaline | PEM | AEM | Solid oxide |
|---|---|---|---|---|
| Operating temperature | 70-90 °C | 50-80 °C | 40-60 °C | 700-850 °C |
| Operating pressure | 1-30 bar | < 70 bar | < 35 bar | 1 bar |
| Electrolyte | Potassium hydroxide (KOH) | PFSA membranes | DVB polymer support with KOH or NaHCO3 | Yttria-stabilized Zirconia (YSZ) |
| Separator | 5-7 molL-1 | Solid electrolyte | Solid electrolyte | Solid electrolyte |
| Electrode / catalyst (Oxygen side) | ZrO2 stabilized with PPS mesh | Iridium oxide | High surface area Nickel or NiFeCo alloys | Perovskite-type (e.g. LSCF, LSM) |
| Electrode / catalyst (hydrogen side) | Nickel coated perforated stainless | Platinum nanoparticles on carbon black | High surface area nickel | Ni/YSZ |
| Porous transport layer anode | Nickel mesh | Platinum coated sintered porous titanium | Nickel foam | Coarse Nickel-mesh or foam |

| | | | | |
|---|---|---|---|---|
| Porous transport layer cathode | Nickel mesh | Sintered porous titanium or carbon cloth | Nickel foam or carbon Cloth | None |
| Bipolar plate anode | Nickel-coated stainless steel | Platinum-coated titanium | Nickel-coated stainless steel | |
| Bipolar plate cathode | Nickel-coated stainless steel | Gold-coated titanium | Nickel-coated Stainless steel | Cobalt-coated stainless steel |
| Frames and sealing | PSU, PTFE, EPDM | PTFE, PSU, ETFE | PTFE, Silicon | Ceramic glass |

*Source: International Renewable Energy Agency (IRENA), CRISIL MI&A Research*

**Table 4: Non-exhaustive list of electrolyser manufacturers**

| Company | Country | Alkaline | PEM | AEM | SOEC |
|---|---|---|---|---|---|
| Cummins | Germany, Belgium USA | ✓ | ✓ | | |
| ITM power | UK | | ✓ | | |
| Plug power | USA | | ✓ | | |
| Giner ELX Inc | USA | | ✓ | | |
| Ohmium | USA, India | | ✓ | | |
| Nel ASA | USA, Norway | ✓ | ✓ | | |
| Enapter srl | Italy | | | ✓ | |
| Areva H2Gen Gmbh Elogen | Germany, France | | ✓ | | |
| Green H2 systems | Germany | | ✓ | | |
| Green Hydrogen Denmark | Denmark | ✓ | | | |
| Steisdal | Denmark | ✓ | | | |
| IPS-FEST Gmbh | Germany | ✓ | | | |
| Kraftanlagen Munchen Gmbh | Germany | ✓ | ✓ | | |
| Thyssenkrupp Uhde Chlorine Engineers Gmbh | Germany | ✓ | | | |
| Hoeller Electrolyzer Gmbh | Germany | | ✓ | | |
| Siemens | Germany | | ✓ | | |
| HyGear | Netherlands | ✓ | | | |
| McPhy | France | | | | |
| PERIC | China | ✓ | | | |
| Suzhou Jingli Hydrogen | China | ✓ | | | |
| CETH2 | France | | ✓ | | |
| H2e | India | | | | ✓ |
| John Cockerill | Belgium | ✓ | | | |
| Cavendish Renewable Technology (CRT) | Australia | | | ✓ | |

*Source: Company websites, CRISIL MI&A Research*

After hydrogen is produced using any of the technologies, it can either be transported directly (which is a risky and costly affair) or converted to ammonia, which would be referred to as “green ammonia”. Conversion to ammonia has two main advantages: A) It can be used as a feedstock to manufacture urea and complex fertilisers. B) Or it can be exported to other countries, where it can be directly used or reconverted to Hydrogen.

The production of green ammonia will need the following two additional steps after Hydrogen is produced:

- **Air separation:** It is the most common process used to extract one or all of the main constituents of atmospheric air. The three main components are Nitrogen (78.1%), Oxygen (20.9%) and Argon (.9%). Nitrogen is created in a cryogenic air separation unit, which utilizes the differing condensing/boiling points of the components of air to enable separation by distillation at cryogenic temperatures.
- **Habers-bosch process**: It is is basically one of the most efficient and successful industrial procedures to be adopted to produce ammonia. The Haber Bosch process converts nitrogen to ammonia by a reaction with hydrogen using a metal catalyst. A tonne of ammonia requires nearly 176kg of hydrogen and 824kg of nitrogen.

After the production of ammonia, which is usually in anhydrous form, it is converted to liquid to be stored in tanks or transported in anhydrous form

## Midstream-Transport and storage

In addition to manufacturing, investment in Hydrogen infrastructure is a key enabler to decarbonisation and bolstering trade activity.

### Transport

Currently, transportation of hydrogen is a risky and expensive affair. Hydrogen liquefies at -253° C, which is difficult to achieve on an industrial level. Thus, globally, most hydrogen is produced and consumed on-site these days, and only a certain quantity is transported, by trucks or via pipelines, in its gaseous form.

Hydrogen can also be transported in the form of ammonia, methanol, and liquid organic hydrogen carriers (LOHCs). Although easier to transport, if not used directly (ammonia and methanol), these fuels would need to be processed further to release hydrogen before their final consumption, which would lead to extra energy and costs.

The cost of transporting hydrogen in various scenarios is shown in the table below.

- **For smaller volumes of <100 tonne/day**, transporting compressed hydrogen in trucks is the most economical option for shorter distances of <1000 km; however, for larger distances of >1000 km, transportation in the form of Liquid organic **hydrogen** carriers (**LOHC**) is the most economical option.
- **For larger volumes (100-1000 tonne/day),** transportation of compressed gaseous hydrogen via pipelines is more economical as pipeline construction requires significant capital investment, making it suitable for large volumes.
- In both scenarios, for very large distances of > 10,000 km, transporting hydrogen in the form of ammonia by ship is the only option currently available. However, this whole segment is seeing rapid advancements, and cost estimates given in the table below may change dynamically.

**Table 5: Cost of hydrogen transportation in various scenarios ($/kg)**

| Cost of hydrogen transportation in various scenarios ($/kg) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Volume (10-100 tonnes/day) | | | | Volume (100-1000 tonnes/day) | | | |
| Distance (in kms) | Trucks | Pipelines | Ships | Distance (in kms) | Trucks | Pipelines | Ships |
| 1-10 | 0.65-0.75 (Comp. H2) | Unviable | Unviable | 1-10 | Unviable | 0.05-0.06 (Comp.H2) | Unviable |
| 10-100 | 0.68-1.73 (Comp. H2) | Unviable | Unviable | 10-100 | Unviable | 0.06-0.22 (Comp.H2) | Unviable |
| 100-1000 | 0.96-3.87 (Comp. H2/ LOHC) | Unviable | Unviable | 100-1000 | Unviable | 0.1-1.5 (Comp.H2) | Unviable |
| 1000-10,000 | 0.96-3.87 (LOHC) | Unviable | Unviable | 1000-10,000 | Unviable | 0.5-3 (Comp.H2) | >3 (Ammonia) |
| >10,000 | Unviable | Unviable | >3 (Ammonia) | >10,000 | Unviable | Unviable | >3 (Ammonia) |

*Source: BloombergNEF, Crisil MI&A Research*

Companies in the industry-rich eastern states of the country currently face the difficult choice of transporting either renewable energy or hydrogen. Renewable-rich regions are largely located in the western or southern regions, while heavy industries such as steel, and refineries and non-urea-fertiliser industries are located in the eastern region. For industries in the eastern region, transporting renewable energy will be easier and more economical as the government has granted a full waiver on inter-state transmission charges for green hydrogen production. Furthermore, we expect states to gradually lower open access charges for intra-state transmission, further lowering the landed tariff costs.

This goes to show that until hydrogen transportation cost and safety challenges are overcome, companies in India will most likely prefer on-site consumption of hydrogen and transporting hydrogen only over small distances.

**Storage**

Hydrogen has three main avenues for storage, each with their own use cases and challenges:

**Storage Tanks**: They are the simplest and, at times economical way to store and transport hydrogen, usually in the form of compressed and cryo-compressed hydrogen. However, the challenge for compressed hydrogen storage is that hydrogen's low-density which results in the need for large containers, resulting in higher material costs. Liquefaction of hydrogen is another way to increase density, but liquefaction also has higher energy costs—up to 30% of the energy content of the fuel compared with 4%–7% for compressed hydrogen.

**Chemical storage**: It is in in the form of compounds such as liquified organic hydrogen carriers (LOHCs) like methanol and toluene, and hydrides such as ammonia (NH3 ) are also gaining prominence given the high energy cost of liquefaction and material inefficiencies of compression. Each mode of chemical storage, however, comes

with its own uses and hurdles, including energy conversion costs and chemical characteristics that require careful handling.

**Natural underground storage** in salt caverns and salt domes are large volume, low-cost, natural storage options, but local availability can be a challenge.

### Downstream-End-users

Hydrogen has an advantage over conventional fuels, with a potential to decarbonise various sectors. Traditionally, industrial usage of hydrogen leads the demand across the globe. Refineries, fertilizers, and methanol contribute to the majority of the demand.

**Refineries**: Hydrogen is currently used in desulphurisation of crude oil for refined products. The sulphur levels of these refined products are based on the prevailing regulatory requirements. Stringent policy measures to maintain lower levels of sulphur would be a driving factor for sectoral demand for hydrogen. Hydrogen is already produced as a by-product during the refining process; however, the quantity produced is inadequate to meet the total demand. Currently, natural gas is used for producing additional hydrogen on-site using the steam reforming process, typically referred to as “grey hydrogen”.

**Fertilisers:** Hydrogen is used as a feedstock to manufacture ammonia, which is largely used to produce fertilisers such as urea, DAP, NPK, etc. Urea production plant usually has a captive set-up for production of Hydrogen and ammonia, which are used as an intermediates. Rising usage of fertilisers especially across emerging and underdeveloped economies, will be a key driver for this industry.

With the rapid growth of the economy and increasing domestic demand, these sectors will continue to lead hydrogen usage, both in India and globally. Hence, it crucial to adopt low carbon sources to cater to the additional demand to the extent possible.

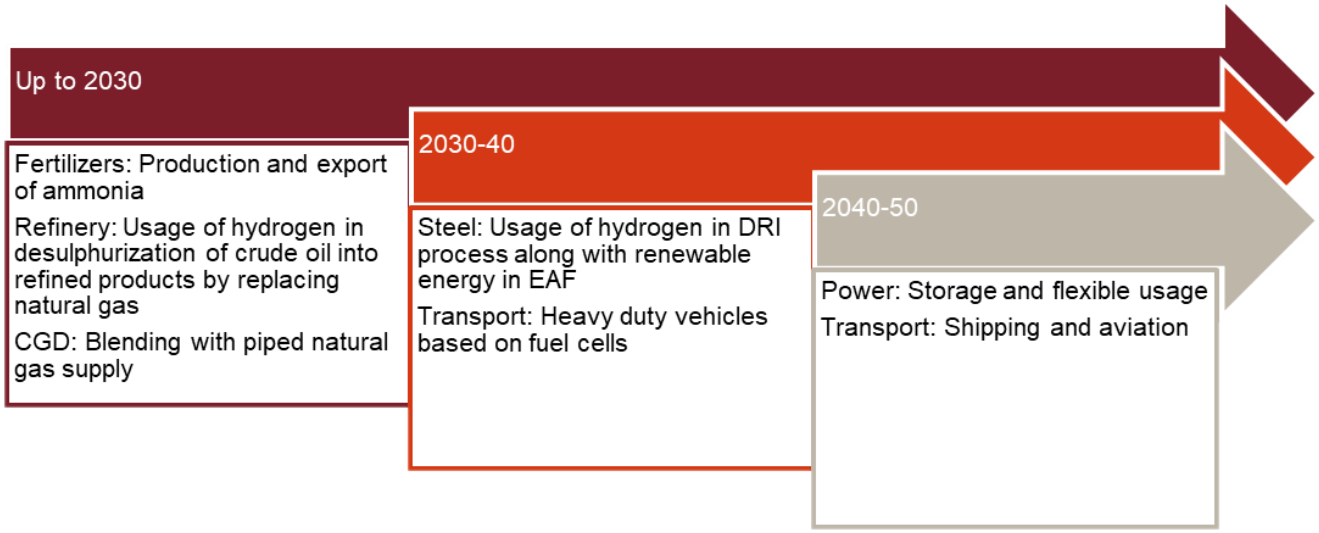
Further, usage of hydrogen also looks promising in hard-to-abate iron and steel sector which is one of the largest contributors to global emissions. Typically, steel is produced primarily using three different technologies:  coking coal-based Blast Furnace - Basic Oxygen Furnace (BF-BOF), coal or natural gas-based Direct Reduced Iron (DRI) and Electric Arc Furnace or Induction Furnace (EAF / IF). Over the medium term, Hydrogen is projected to replace coal or natural gas as a reducing agent in DRI based steel manufacturing.

In addition, hydrogen can be used to replace fossil fuels in transport.

The shift in hydrogen usage from grey to green across sectors will be driven by cost competitiveness, improved efficiencies, and technological advancement. In the short term, by 2025, government-aided measures such as incentive schemes and waivers of charges to play a crucial role in lowering costs and adopting green hydrogen usage.

In the long run, by 2030, the decline in cost for both electrolysers and renewable energy, coupled with improved efficiency, and policy measures will enable transition to green hydrogen.

**Figure 11: Projected timeline of adoption of green hydrogen by various end-use segments**

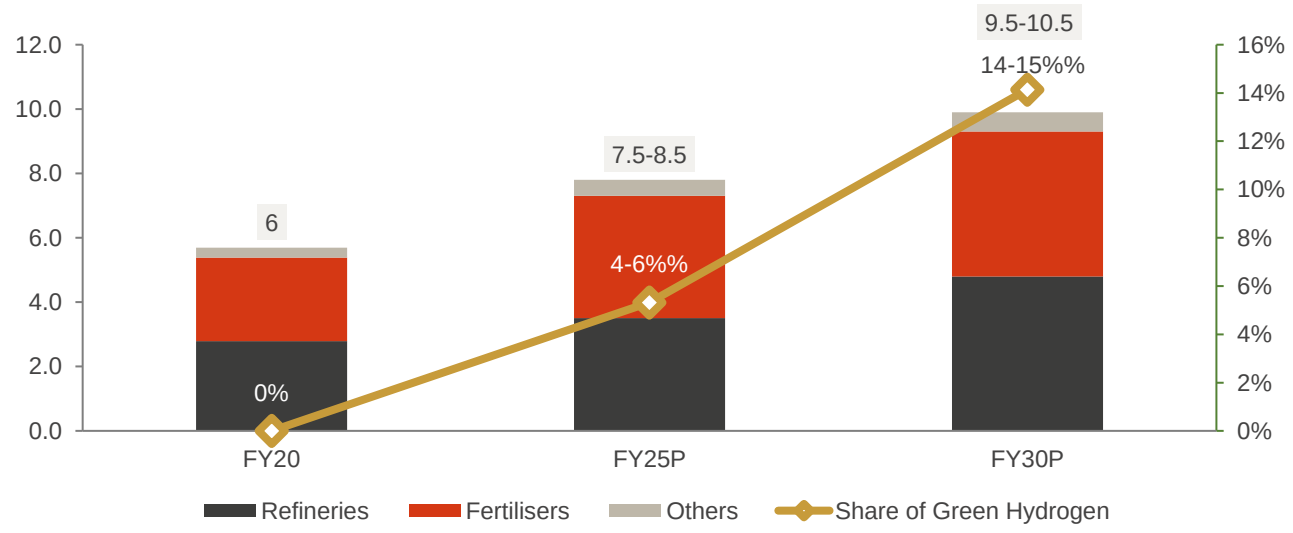



*Source: Crisil MI&A Research*

## Domestic demand

Currently, India's hydrogen demand is ~6 million tonne, mainly contributed by the fertilisers and refining sectors. Almost all the hydrogen produced uses fossil fuels, mostly natural gas, along with other sources such as coal and naphtha. Additionally, a small quantity of hydrogen is also used in methanol production.

**Figure 12: Green hydrogen to account for nearly 15% of total hydrogen consumption in FY30**




*Source: CRISIL MI&A Research*

Hydrogen demand is expected to reach 8 million tonne and 10 million tonne by fiscal 2025 and 2030, respectively, due to expansion in the fertiliser sector and increased demand for hydrogen in refining.

### Fertilisers

Hydrogen demand in the fertilisers industry will largely be driven by India's push to attain self-sufficiency in fertilisers by 2025, which will lead to capacity expansions in the urea, DAP, and NPK segments. The government has already initiated the process of commissioning seven new urea plants by 2025, which will add about 8 million metric tonnes of new capacity.

Hydrogen is used as a feedstock to manufacture ammonia, which is largely used to produce fertilisers such as urea, DAP, NPK, etc. Domestic ammonia demand from the fertiliser industry is expected to be 17 million tonne in fiscal 2020, with urea production accounting for nearly 82%.

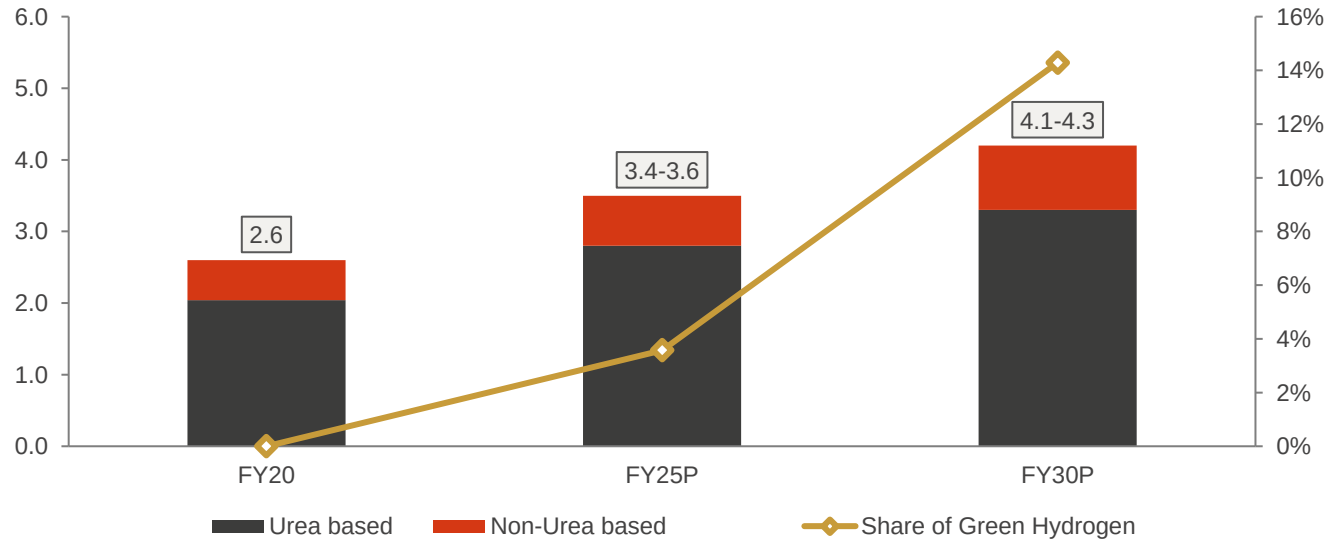
Hydrogen is a feedstock to manufacture ammonia. Typically, this is produced in-house through conventional methods such as SMR or coal gasificationntional methods such as SMR or coal gasification. Further CO2, released during the conventional process, is recovered and combined with ammonia to form urea (CH4N2O). Thus, in switching to green hydrogen, an external source of CO2 is required as an additional process, which will push up the cost of production. Thus, hydrogen production is an integral part of the urea manufacturing process, and a switch to green hydrogen is some time away.

However, ammonia required for other fertilisers (18% of ammonia demand) is mostly imported from the Middle East and is ideal for green ammonia substitution.

Hydrogen demand from the non-urea segment is expected to increase from 0.5 million tonnes in fiscal 2020 to 0.9 million tonnes in fiscal 2030. We expect at least 90% of this to be met by local green hydrogen production.

***Break-up of hydrogen demand from fertilisers***

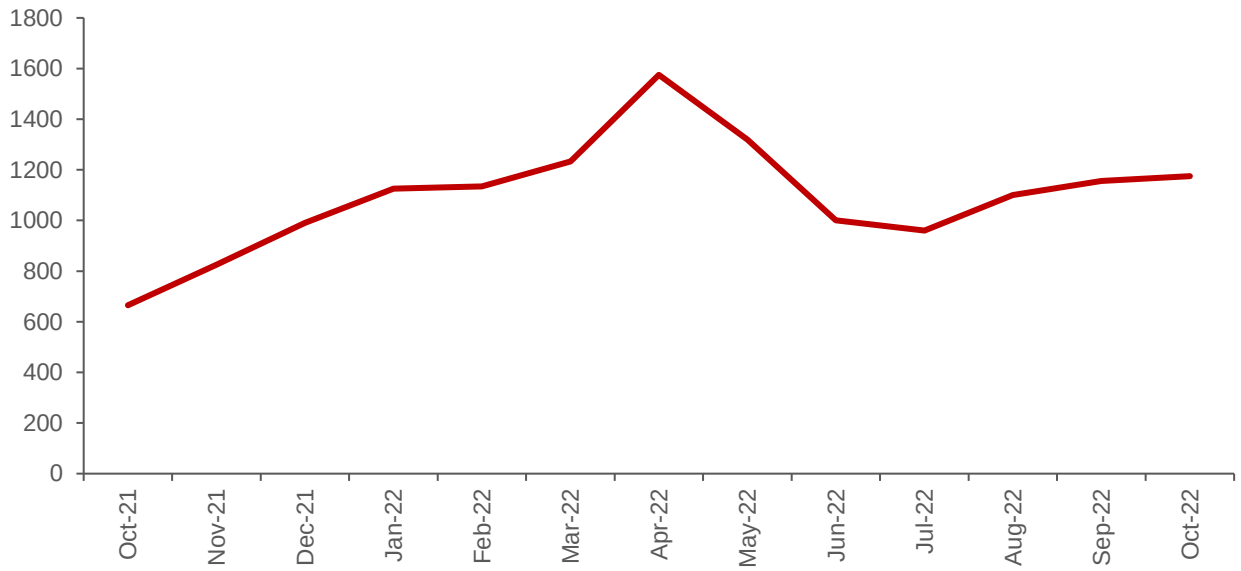
**Figure 13: Non-urea-based fertilisers to be the ideal segment for green hydrogen adoption**




*Source: CRISIL MI&A Research*

Currently, the imports of ammonia are largely from regions like Saudi Arabia, Qatar, Oman, Egypt, Iran, etc., which have abundant and cheap gas resources. However, natural gas prices have recently surged and remained extremely volatile post the Russia-Ukraine war, leading to ammonia prices rising by 77% over the past year.

**Figure 14: Trend in Ammonia CFR prices ($/MT) over the past year**




*Source: Department of fertilisers, CRISIL MI&A Research*

With the current price of ammonia above 1000 $/MT, switching to green ammonia can be immediately competitive, as we estimate the green ammonia production cost to be between 900 and 1000 $/MT. This will find an immediate uptake from the non-urea-based fertiliser segment, which has an estimated ammonia demand of 0.5–0.6 mt and is poised to further rise as the government seeks to achieve self-sufficiency in fertilisers.

Further, the production of green ammonia also presents a lucrative opportunity for exports to regions like Europe, Japan, Singapore, South Korea, etc.

### Refining

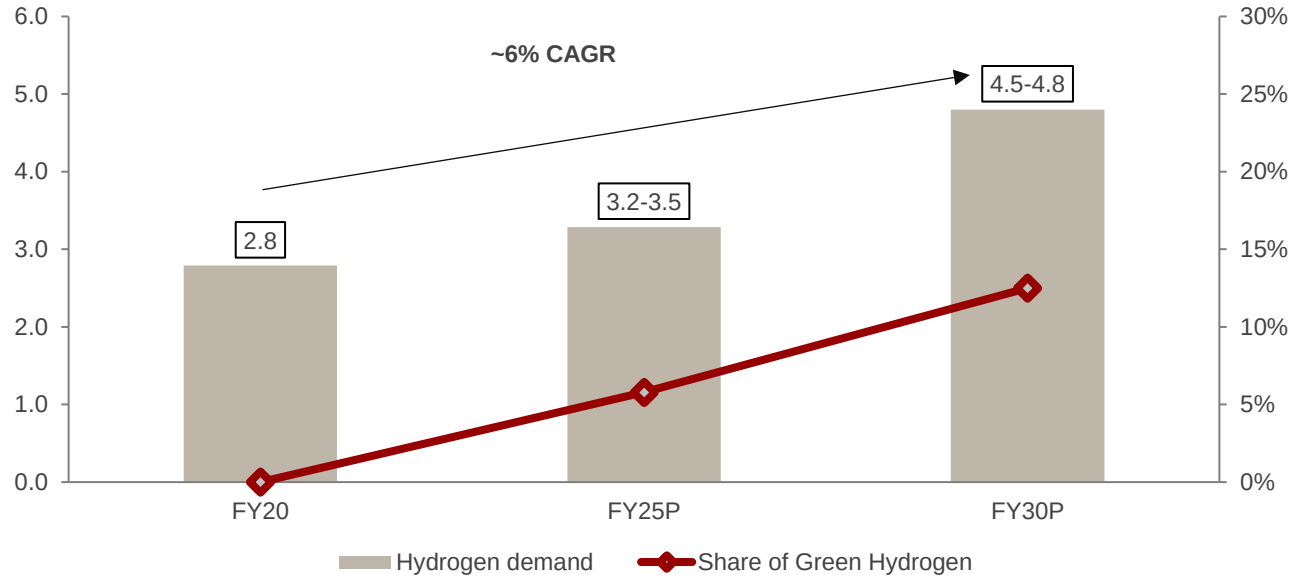
Production and the recovery of hydrogen in the context of refining operations are essential to processes that convert crude oils into light, high-quality products. The product slate of a refinery, therefore, is closely correlated with the availability and consumption of hydrogen. Recent years have seen higher demand for hydrogen from the oil refineries owing to declining crude quality as well as stricter emission norms.

In refineries, some hydrogen is produced as a by-product during the refining process, but in most cases, it is insufficient to meet total refinery hydrogen demand. Hence, additional on-site hydrogen production is often required, using natural gas or naphtha reforming. The natural gas reforming units are typically built on-site to meet the overall demand for hydrogen at the refinery over the course of its lifetime.

Hydrogen consumption in the refineries was estimated at 2.8 million metric tonnes in fiscal 2020. This is expected to grow at a CAGR of 6% until fiscal 2030 to reach 4.5–4.7 million metric tonnes, driven by lower crude quality as well as stricter emission norms.

**Hydrogen demand from refining**

**Figure 15: Share of green hydrogen in the refining segment to be over 10% by FY30**




*Source: CRISIL MI&A Research*

In refining, the overall share of green hydrogen is expected to reach 15% by fiscal 2030, driven by lowering cost parity between green and grey and a higher regulatory push.

The lowering of green hydrogen costs will be due to lower electrolyser capex costs as well as further reductions in renewable energy tariffs.

## Other sectors

Apart from fertilisers and refining, a small amount of hydrogen is also required in methanol production. This segment in India is relatively small, with a demand of 1.5–2 million metric tonnes, of which nearly 90% is imported. This is the result of a large portion of methanol production coming from natural gas, which is abundantly available in the Middle East at extremely low prices.

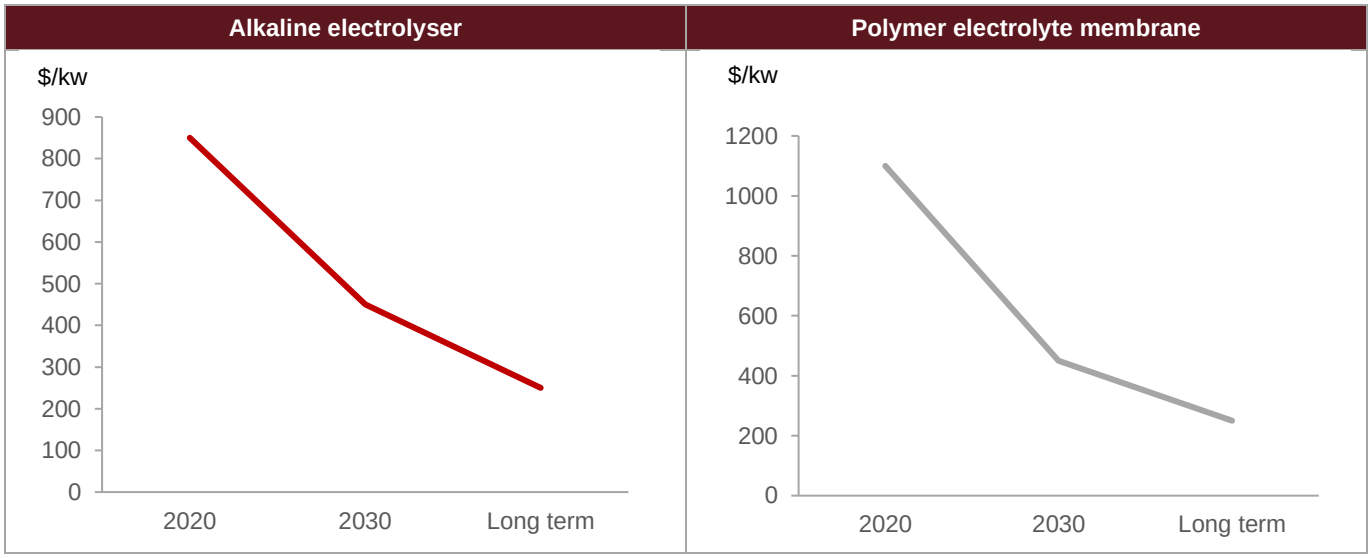
However, the Indian government is rapidly pushing coal-based methanol production not only to reduce imports but also to displace other oil products across major end-use sectors such as transport and residential. Additionally, green hydrogen-based methanol production can also be explored as a low-carbon-intensive option. However, as with urea production, this process requires an external CO2 source. Thus, green hydrogen adoption in the methanol segment is some time away.

## Cost of Green hydrogen

A major hindrance for the uptake of green hydrogen is the cost of production, which is estimated at $3–6 per kg, nearly twice that of grey hydrogen. Major cost drivers in the manufacturing process are electrolysers and renewable energy.

While electrolysis as a technology is not a new phenomenon, deployments of the same have been relatively scarce due to more cost-effective alternatives using coal and natural gas. However, in the current decarbonization trend, electrolysis has made a comeback due to its zero-emission merit if powered through renewable energy. The cost of electrolyser deployment is expected to fall over the next few years, driven by technological development and economies of scale.

**Figure 16: Exponential cost decline for electrolyser capex**




*Source: International Energy Agency (IEA), Bloomberg New Energy Finance (BNEF), CRISIL MI&A Research*

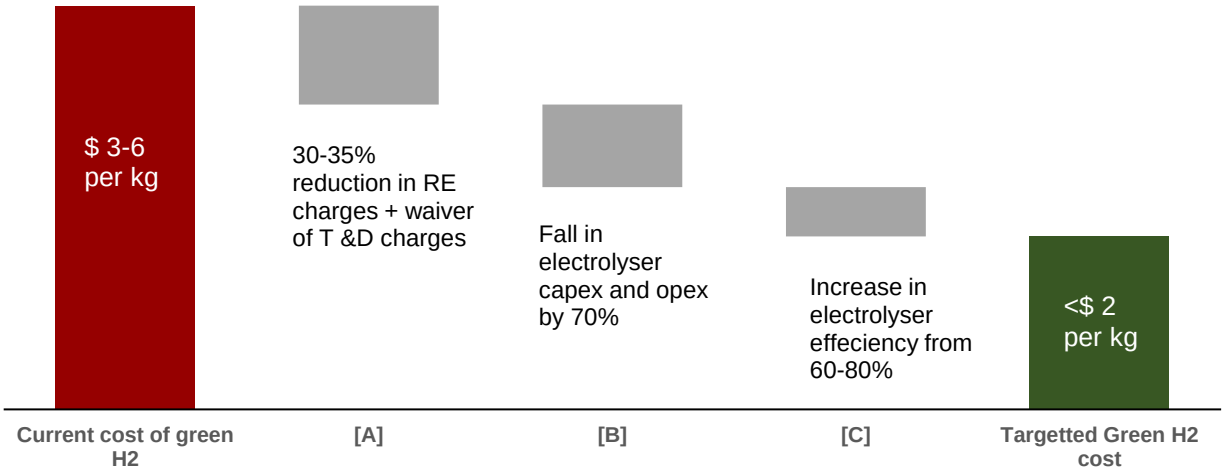
This is like renewable energy tariffs declining over the past decade due to technological breakthroughs and large-scale deployments to lower PV costs. Despite this, the landed tariffs are inflated by nearly 50–75% due to transmission and distribution charges, leading to higher renewable energy costs. The central government has already waived the central transmission charges for a period of 25 years for green hydrogen projects. However, state T&D charges remain, and these are expected to be gradually reduced as state governments implement their own hydrogen policies.For instance, Uttar Pradesh recently launched its draught hydrogen policy, where it has proposed a waiver of 50% exemption in wheeling and transmission charges and 100% exemption in cross-subsidy and distribution charges.

However, for colocated plants, renewable energy transmission charges are nearly zero, resulting in an even lower cost of production.

Thus, we expect that over the next decade the industry will see a renewed focus on regulatory handholding, which in combination with technological advancements and economies of scale will lead to the cost of production going below $2/kg.

***Pathway to lower the cost of green hydrogen***

**Figure 17: Lowering to RE landed costs, increase in electrolyser efficiency and lowering of capex crucial to achieve green hydrogen cost target**




*Source: CRISIL MI&A Research*

## Review and expectations of policy announcements

Globally, more than 30 countries have launched national hydrogen strategies. Local availability of renewable energy and ease of access to hydrogen are keys to determining the potential opportunities and challenges a country will face.

This includes a country's unique potential to become a large-scale energy exporter or importer. Thus, the degree of focus on hydrogen strategies varies across countries based on their positioning in the overall hydrogen value chain.

For instance, Japan's hydrogen policy is shaped around the country becoming a large clean hydrogen importer due to its low renewable energy generation capabilities. Hence, the focus is on direct investments in electrolyser technology development, fuel-cell technologies, and overcoming challenges in hydrogen transportation and storage, with almost negligible focus on green hydrogen production. Similarly, Chile's hydrogen strategy is almost entirely focused on becoming a green hydrogen manufacturing and export hub due to its high solar power potential.

**Table 6: Key features of global hydrogen strategies**

| Region | Market's focus | Target | | | Incentives | Capital outlay ($ billion) | Other comments |
|---|---|---|---|---|---|---|---|
| | | Supply | Demand | Price | | | |
| EU | Domestic and imports | 6 GW by 2024, 40 GW by 2040, 10 mtpa H2 by 2030 | NA | NA | NA | ~609 | **Demand** focus on chemical feedstock, refining, transport, gas blending; **other** aspects such as market development, direct investments, supply chain development |
| Chile | Majorly Exports | 5 GW by 2025, 25 GW by 2030 | NA | < $ 1.5 per kg | NA | ~0.05 | Major focus on hydrogen price target, market development timeline |
| US | Domestic and exports | 10 mt by 2030, 20 mt by 2040, 50 mt by 2050 | NA | <1-2 per kg | Tax credit up to $3 per kg | >15 | **Demand** focus on refining, transport, aviation, heating, power, gas blending; other aspects such as price targets, R&D, direct investments, etc |
| Australia | Majorly Exports | n.a | NA | NA | NA | ~0.49 | **Demand** focus on chemical feedstock, transport and heating; other features such as price target, market development, direct investments, R&D, standards setting, etc |
| UK | Domestic and exports | 10 GW of low carbon Hydrogen by 2030; of which at least half is green | | | | ~1.5 | **Demand** focus on transport, industry, heating, power, aviation, etc; other focus areas such as hydrogen business model, market creation, and R&D |
| South Korea | Imports | | 3.9 mtpa by 2030, 27 mtpa by 2050 | | | ~0.66 | **Demand** focus on transport; R &D, price target, standards setting, supply chain development |
| Japan | Imports | | 3 mtpa by 2030 20 mtpa by 2050 | | | ~0.66 | **Demand** focus on transport; R &D, price target, standards setting, supply chain development |

Note: mtpa means million tonne per annum

*Source: Hydrogen strategy documents, NITI Aayog, CRISIL MI&A research*

## India's hydrogen policy

The National Hydrogen Policy was launched on India's 75th Independence Day (August 15, 2022), and the first green hydrogen policy framework was launched on February 17, 2022.

The salient features of the policy are as follows:

- Green hydrogen and green ammonia are hydrogen and ammonia produced by electrolysis of water with renewable energy, including stored renewable energy, as well as hydrogen and ammonia produced from biomass.
- A waiver of interstate transmission charges for a period of 25 years to the producer of green hydrogen and green ammonia from the projects commissioned before June 30, 2025.

- Green hydrogen or green ammonia can be produced by a developer using renewable energy from a nearby renewable energy plant or sourced from a distant renewable energy plant, whether set up by the same developer, a third party, or obtained from the power exchange.Green hydrogen and green ammonia plants will be granted open access for sourcing renewable energy within 15 days of receipt of a complete application.
- Banking shall be permitted for a period of 30 days for renewable energy used for making green hydrogen or green ammonia.
- The charges for banking shall be as fixed by the State Commission and shall not be more than the cost differential between the average tariff of renewable energy bought by the distribution licensee during the previous year and the average market clearing price (MCP) in the Day Ahead Market (DAM) during the month in which the renewable energy has been banked.
- Connectivity, at the generation end and the Green Hydrogen/GGreen Ammonia manufacturing end, to the ISTS for Renewable Energy capacity set up for the purpose of manufacturing Green Hydrogen/GGreen Ammonia shall be granted on a priority basis under the Electricity (Transmission System Planning, Development, and Recovery of Inter-State Transmission Charges) Rules 2021.
- Land in renewable energy parks can be allotted for the manufacture of green hydrogen and green ammonia.
- A green hydrogen or green ammonia production plant can be set up in any of the manufacturing zones.
- Manufacturers of green hydrogen and green ammonia shall be allowed to set up bunkers near ports for storage of green ammonia for export or use by shipping. The land for storage purposes shall be provided by the respective port authorities at applicable charges.
- Renewable energy consumed to produce green hydrogen or green ammonia shall count towards the RPO compliance of the consuming entity. The renewable energy consumed beyond the obligation of the producer shall count towards the RPO compliance of the DISCOM in whose area the project is located.
- Distribution licensees may also procure and supply renewable energy to the manufacturers of green hydrogen and green ammonia in their states. In such cases, the distribution licensee shall only charge the cost of procurement as well as the wheeling charges and a small margin as determined by the State Commission.
- The Ministry of New and Renewable Energy (MNRE) will establish a single portal for all statutory clearances and permissions required for the manufacture, transportation, storage, and distribution of green hydrogen and green ammonia. The concerned agencies and authorities will be requested to provide the clearances and permissions in a time-bound manner, preferably within a period of 30 days from the date of application.
- To achieve competitive prices, MNRE may aggregate demand from different sectors and have consolidated bids conducted for procurement of green hydrogen and green ammonia through any of the designated implementing agencies.

Furthermore, in July 2022, the government notified the green energy open access rules, which limit increasing cross-subsidy surcharges and eliminate additional surcharges.

Finally, in January 2023, the Union Cabinet approved the National Green Hydrogen Mission. The initial outlay for the mission will be Rs. 19,744 crore, including an outlay of Rs. 17,490 crore for SIGHT (Strategic Interventions for Green Hydrogen Transition Program), Rs. 1,466 crore for pilot projects, Rs. 400 crore for R&D, and Rs. 388 crores for other mission components. The mission has enlisted the following likely outcomes:

- Development of green hydrogen production capacity of at least 5 MMT (Million Metric Tonne) per annum with an associated renewable energy capacity addition of about 125 GW in the country
- Over Rs. eight lakh crores in total investments
- Creation of over six lakh jobs
- Cumulative reduction in fossil fuel imports over Rs. one lakh crore
- Abatement of nearly 50 MMT of annual greenhouse gas emissions

Under the Strategic Interventions for Green Hydrogen Transition Programme (SIGHT), two distinct financial incentive mechanisms—targeting domestic manufacturing of electrolysers and production of Green Hydrogen – will be provided. Further, the mission also emphasises on enabling policy framework to support the establishment of Green Hydrogen ecosystem.

Both the national hydrogen policy and the national hydrogen mission have significantly addressed the issues of higher renewable energy tariffs as well as lowering electrolyser costs through incentive schemes. The mission has also clearly stated the capital outlay for each of the sub-segments along with R & D to encourage indigenous manufacturing. In addition, the following policy initiatives will further boost the green hydrogen industry.

- Incentives for Green hydrogen producers in electrolyser procurements or direct subsidies on cost of production along the lines of US tax credit system
- Demand creation such as setting up mandatory share of green hydrogen targets across key end-use industries such as fertilisers, refining, and steel to ensure offtake

The above two policy moves will broadly address the major concerns of green hydrogen producers. In the medium term, state governments are also expected to offer incentives on open access charges for transporting renewable energy, as landed costs of renewable energy tariffs remain high despite the waiver of interstate transmission charges. Uttar Pradesh has already offered incentives on transmission charges in its draft version of the green hydrogen policy released in October 2022. Some of the salient features of the said policy are as follows:

**Targets**

- Reduce green hydrogen cost to 2.0 USD/Kg in the policy period and make efforts to decline it further to 1 USD/Kg in long-term.
- Achieve 20 percent green hydrogen blending in total hydrogen consumption of the state by 2028 for existing fertiliser and refinery units, reaching 100 percent by 2035.
- Set up state centre of excellence (CoE) to lead research, development, and techno-economic innovation activities.

- Achieve the number one rank in the ease of doing business index based on the Business Reform Action Plan (BRAP) recommended by the Department of Industrial Policy and Promotion (DIPP)

To achieve the above forementioned targets, the policy has announced a slew of fiscal incentives such as below:

- 100 percent exemption from payment of land tax, stamp duty, etc; 50 percent exemption from industrial water consumption charges if the water consumption is to produce green hydrogen
- Capital Expenditure (CAPEX) subsidy is applied for electrolyser deployment in the state, equal to 60% of the electrolyser's cost. The minimum capacity needed to be eligible for the subsidy is 50 MW or more. The financial incentive from the state government will be cut to 20% by 2027 and eventually phased out in 2028.
- 100 percent reimbursement of the state's Goods and Services Tax (SGST) for green hydrogen and ammonia production
- 50% exemption from wheeling and transmission charges; 100% exemption for cross-subsidy and distribution charges

In addition to this, states like Gujarat, Karnataka, Tamil nadu are also expected to launch polices for green hydrogen in 2023

## Renewable energy demand estimation

As of September 2022, renewable energy sources had a combined installed capacity of 165 GW in India.

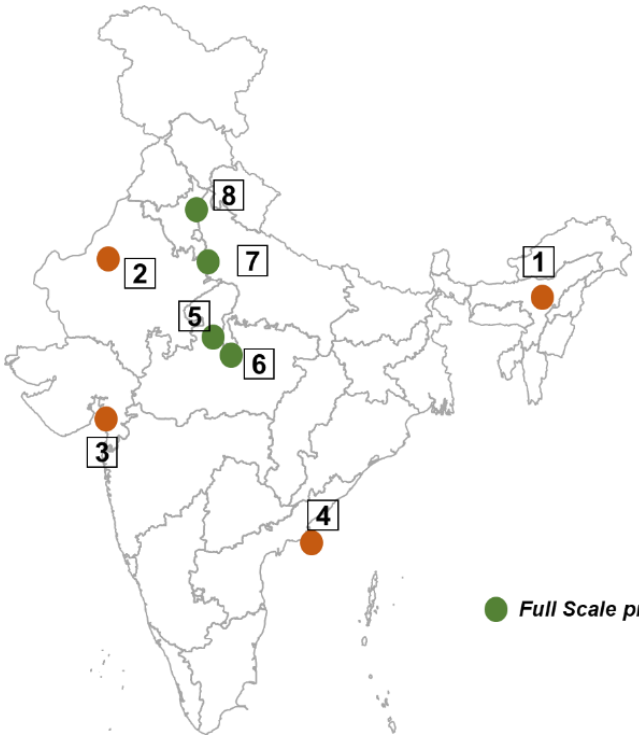
For green hydrogen, the Government of India has set a production target of 5 mtpa by 2030. This will require an electrolyser installation capacity of 27–30 GW and nearly 110–130 GW of renewable capacity.

However, given the favourable regulatory policy as well as aggressive announcements by the players, hydrogen production by 2030 may exceed the target, in which case there are significant upside risks to renewable capacity requirements.

## Key announcements in the green hydrogen space in India

India has witnessed a slew of announcements over the past two years in the hydrogen space by PSUs as well as private companies. The current project pipeline calls for 5.5 GW of electrolyzer capacity installations, with an investment of more than Rs 5 trillion crore over the next decade. However, this is significantly lower than the NITI Aayog's demand estimation of 20 GW of electrolysers by 2030. Thus, we expect more announcements in the hydrogen ecosystem in the coming days.

**Figure 18: Major hydrogen projects in the pipeline**




| No. | Company | Capacity (MW) | Status | Product | Location |
|---|---|---|---|---|---|
| 1. | Oil India | 0.1 | Commissioned | Green H2 | Jorhat |
| 2.. | ACME | 1.5 | Commissioned | Green ammonia | Bikaner |
| 3. | L & T | 0.8 | Commissioned | Green H2 | Hazira |
| 4.. | NTPC | 0.24 | Contract awarded | Green H2 | Simhadri |
| 5. | GAIL | 10 | Tender awarded | Green H2 | Guna |
| 6. | BPCL | 20 | Announced | Green H2 | Bina |
| 7. | IOCL | 40 | Tender notice | Green H2 | Mathura |
| 8. | IOCL | 16 | Tender notice | Green H2 | Panipat |

*Source: Company reports, CRISIL MI&A Research*

In addition to the above, there are other large announcements as listed below:

- Adani and TotalEnergies, have entered a new partnership to jointly create the world's largest green hydrogen ecosystem. In this strategic alliance, TotalEnergies will acquire 25% minority interest in Adani New Industries Ltd (ANIL) from Adani Enterprises Ltd (AEL). ANIL's ambition is to invest over USD 50 billion over the next 10 years in green hydrogen and associated ecosystem. In the initial phase, ANIL will develop green hydrogen production capacity of 1 million ton per annum before 2030
- ACME Cleantech Solutions and the Karnataka government have signed a MOU of ~Rs 52,000 crore to set 1.2 mtpa green hydrogen and green ammonia plant associated with captive solar power unit at Mangaluru. The project is planned between 2022 and 2027
- ACME Cleantech Solutions announced a project entailing an investment of Rs 52,000 crore in Tamil Nadu to set up 1.5 GW of electrolyser and 1.1 million tonne of ammonia production facility
- Avaada Group has announced investments of Rs 40,000 crore to build an integrated 1 mtpa green hydrogen and ammonia plant with captive renewable energy capacity in Rajasthan

## Strategic tie-ups

Despite large-scale announcements in this evolving sector, India's electrolyser ecosystem is at a nascent stage as we need significant investments in R&D in improving the electrolyser technology to make it more efficient and economical. A few PSUs in India possess the manufacturing capability for producing balance of plant (BoP) components, but the domestic production of electrochemical stacks remains insignificant. In addition to R&D, companies have been actively engaging in strategic tie-ups with global players to bridge the technology gaps.

**Table 7: Major strategic tie-ups announced**

| Tie-ups | Electrolyser production/supply | H2 Production | H2 Transport | End-use | Comments |
|---|---|---|---|---|---|
| L&T and HydrogenPro | ✓ | | | | Manufacture gigawatt-scale manufacturing of alkaline water electrolysers based on HydrogenPro technology. |
| Greenko-John Cockerill | | ✓ | | ✓ | John Cockerill to supply 2 GW electolysers to Greenko for its green ammonia plant of 1 mtpa production |
| IOCL-L&T-Renew | ✓ | ✓ | ✓ | ✓ | Develop green hydrogen sector in India in addition to manufacturing and selling electrolysers |
| Reliance Industries-Steisdal | ✓ | | | | Agreement for technology development and manufacture Steisdal's HydroGen Electrolysers |
| Adani-TotalEnergies | ✓ | ✓ | ✓ | ✓ | Invest ~$5 billion in a 2 GW electrolyser fed by renewable power from a 4 GW solar and wind farm to manufacture 1.3 mtpa of urea derived from green hydrogen |
| NTPC-Bloom Energy | ✓ | | | | NTPC has awarded Bloom Energy to supply 240 kW solid oxide electrolyser (SOE) for its micro-grid project |
| JSW-Fortescue | | | | | Conduct scoping work for green hydrogen production-related projects for use in green steel-making, hydrogen mobility, green ammonia, etc |

*Source: Hydrogen strategy documents, NITI Aayog, CRISIL MI&A Research*

Adani Enterprises incorporated a subsidiary, Adani New Industries Limited (ANIL) with the objective to incubate, build, and develop a large integrated platform to produce green energy through end-to-end supply and value chain development. ANIL will focus on the Mundra special economic zone (SEZ), given it is a strategically located large land parcel with developed supporting infrastructure, which is expected to become one of the world's largest integrated green hydrogen hubs.

**Risks and challenges to green hydrogen adoption in India**

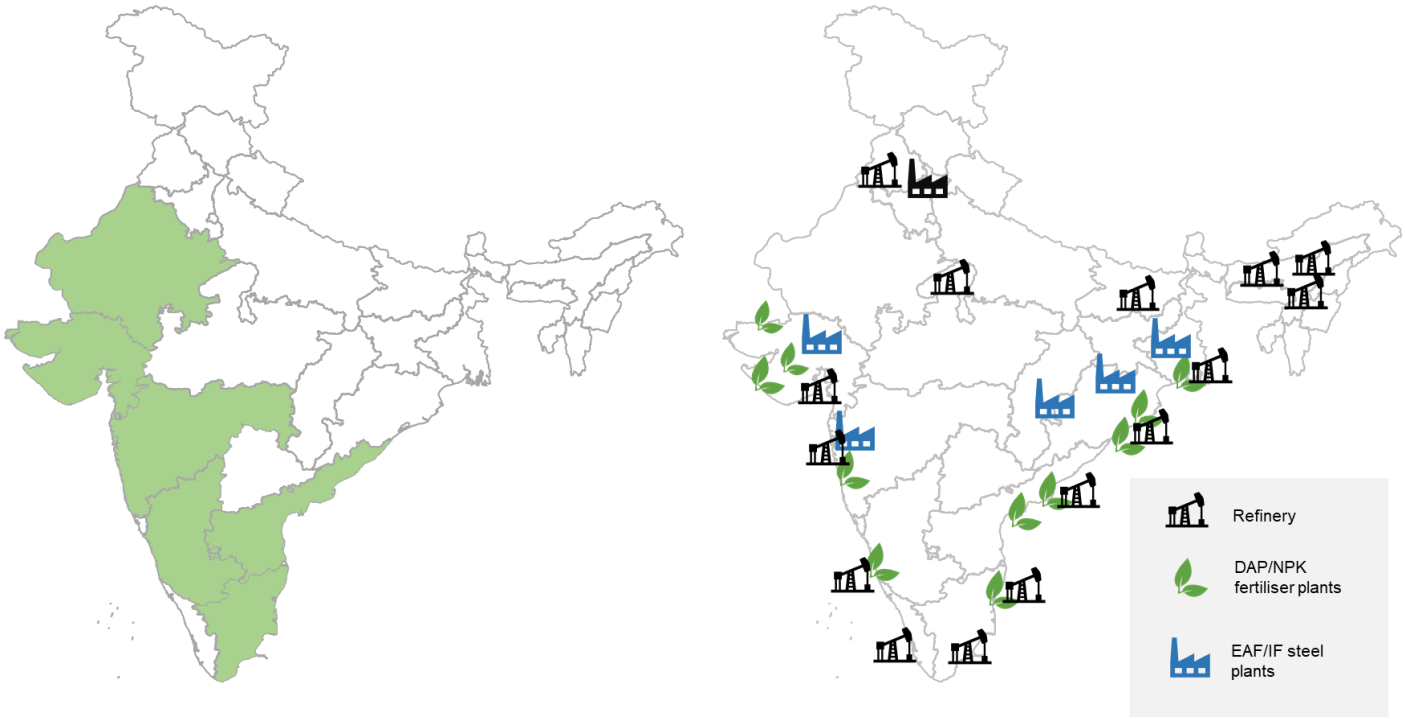
**High cost of production:** Producing green hydrogen is currently more expensive compared with fossil-based hydrogen. Going forward, the cost is expected to reduce on account of falling RE costs, as well as breakthroughs in electrolyser technologies, coupled with the realisation of economies of scale. However, significant risk remains to these assumptions, which may result in a lower-than-expected decline in costs. Electrolyser capex cost reductions need significant investment, research, and development, as well as active policy support. Moreover, RE tariffs, despite being competitive, are still higher than those of other global peers due to transmission charges. Additionally, as these charges vary for every state, the landed tariffs are not uniform across the country, which adds significant uncertainty for players wanting to set up green hydrogen plants.

**Muted demand uptake:** Hydrogen is currently being positioned as a decarbonisation solution for hard-to-abate sectors such as steel, refining, and chemicals. However, these industries currently use fossil-based solutions, which cost significantly less than green hydrogen-based ones. Hence, demand uptake remains a significant challenge. Active policy support is crucial for the industry to create markets, at least over the next decade.

**Technological obsolescence:** The green hydrogen sector is rapidly evolving, with frequent technological breakthroughs, especially in electrolysers. This poses a significant risk, as any new breakthrough technology to reduce production costs will affect investments already made in existing technologies.

**Higher transportation cost:** The majority of low-cost renewable energy resources are located away from potential demand centers. For instance, renewable-rich states such as Gujarat, Maharashtra, Karnataka, and Tamil Nadu are in the western region, while heavy industries such as those for steel are in the eastern region, requiring players to choose between transporting renewable energy or hydrogen. Transporting hydrogen is expensive and comes with safety concerns. Hence, in the near to medium term, we believe players will prefer to set up hydrogen plants closer to demand centres and source renewable energy from the eastern region, which will drive up landed tariffs for renewable energy.

**Figure 19: Renewable rich states vs location of major end-use industries**




*Source: CRISIL MI&A Research*

# Solar PV Modules

## Assessment of key policies and incentive mechanisms

The Government of India has supported clean energy initiatives through policies and incentives aimed at different verticals of the renewable power segment. Some noteworthy ones are detailed below:

**Production-linked incentives 2021**

The production-linked incentive (PLI) scheme is aimed at boosting domestic manufacturing and cutting down import bills, specifically those for solar power components. The scheme will provide companies with incentives for incremental sales from products manufactured in domestic units and encourages local companies to set up or expand existing manufacturing units, while also focusing on backward integration of the supply chain. It was initially rolled out for mobile and allied equipment, pharmaceutical ingredients, and medical devices, among others, committing nearly Rs 1.93 lakh crore over a period of five years, starting fiscal 2021.

In Union Budget 2021-22, the government introduced provisions for the renewable energy sector with an outlay of Rs 4,500 (Tranche I) for, inter alia, high-efficiency solar PV modules. The scheme also incentivised new gigawatt (GW) scale solar PV manufacturing facilities in India. In Budget 2022-23, with an aim to establish a larger manufacturing base for solar PV modules, the government announced an additional allocation of Rs 19,500 crore (Tranch II) for PLI for manufacturing high-efficiency modules, prioritizing fully integrated manufacturing units for products ranging from polysilicon to solar PV modules. This was also approved by the Union Cabinet in September 2022.

**Solar manufacturing zones**

Growth in the Indian power sector over the last decade has been fast-paced. However, India is largely reliant on imports to meet its growing domestic demand for renewable energy equipment, and this trend is likely to continue unless domestic capacity is ramped up with suitable policy support. The target of 50% renewable energy penetration in generation by 2030 offers tremendous opportunity to create skilled jobs, bring about technology transfer, and contribute to the Make in India campaign, in addition to reducing the country's trade deficit and reliance on imports. Thus, the MNRE and MoP have jointly proposed a scheme for the establishment of three manufacturing zones– two brownfield manufacturing zones already having developed land and a greenfield manufacturing zone in a coastal area– in the country (Scheme) with a total financial outlay of Rs 1,000 crore. The proposed funding of Rs 1,000 crore for the two brownfield and one greenfield manufacturing zones has been kept flexible for supporting common infrastructure and testing facilities with a ceiling of Rs 400 crore in any manufacturing zone. The duration of the Scheme is five years, from fiscal 2022 to fiscal 2026.

The EOI process authority, acting on behalf of the Government of India intends to select the successful proposer for setting up a brownfield manufacturing zone for power and renewable energy equipment. The purpose of this selection is to:

**a.** Establish a manufacturing facility with cutting-edge, clean, and energy-efficient technology for minimizing dependence on import of equipment, critical components, and critical spares, and so on, required for the power sector and in the manufacture of renewable energy equipment;

**b.** Promote Make in India and Atmanirbhar Bharat, and make India a global leader in the field of power and renewable equipment manufacturing;

**c.** Promote indigenisation through domestic manufacturing of items presently being imported;

d. Promote setting-up of an exclusive manufacturing zone in the country by providing hassle-free land allotment and clearances, and advanced CTF and CIF to bring down the manufacturing cost significantly, making the domestic industry competitive and self-reliant, helping it exploit benefits from the optimisation of resources and realising economies of scale.

## Approved models and manufacturers of solar photovoltaic modules

(Requirement for Compulsory Registration) Order, 2019 (ALMM Order)

To ensure good quality of solar cells and solar modules used in solar PV power plants, the MNRE issued the ALMM Order on January 2, 2019. It provides government-enlisted eligible models and manufacturers of solar PV power plants that comply with the applicable BIS standard, and included a list titled Approved list of models and manufacturers (ALMM). Only the models and manufacturers included in the list would be eligible for use in government/government-assisted projects under government schemes and programmes in the country, including projects set up for selling electricity to the government, under “Guidelines for tariff-based competitive bidding process for procurement of power from grid connected solar PV power projects”, dated August 3, 2017, and the amendments thereof (collectively, “Applicable projects”).

The ALMM consisted of List I, specifying models and manufacturers of solar PV modules, and List II specifying models and manufacturers of solar PV cells. Furthermore, with respect to applicable projects, solar PV module manufacturers from List I would have to mandatorily source PV solar cells only from manufacturers in List II. For becoming eligible to be included in List I, manufacturers are required to obtain a BIS certification in accordance with the compulsory registration order under this policy and have to apply to the MNRE for registration. If enlisted, the enlistment will be valid for a two-year period and can be renewed by submitting necessary documents and based on the satisfactory performance of their products. Prior to their inclusion in the ALMM, an MNRE team will inspect their manufacturing facility. Enlisted models and manufacturers will be subject to random quality tests, and failure or non-compliance will lead to their removal from the ALMM. The order will not apply to projects for which bids have been finalised before its issuance. Thereafter, the MNRE also issued guidelines for enlistment under the ALMM Order on March 28, 2019, which provide a procedural framework for the implementation of the order. On September 27, 2022, the MNRE issued an updated version of List I.

### *CPSU expansion*

Post the WTO ruling putting an end to domestic content requirement (DCR) after December 14, 2017, in competitively bid tenders, DCR was restricted, as per the ruling, to government energy procurement and use only. Thus, tenders related to energy procurement by CPSUs were exempt under the WTO ruling and could utilise the DCR clause to promote domestic PV module manufacturing demand. Implementation of the 1 GW allocated under the CPSU scheme was initially slow, with NTPC accounting for a large chunk of the capacity, at ~700 MW of the total ~800 MW commissioned under the scheme. However, as of March 2021, of the 882 MW sanctioned by the MNRE under the 1 GW (Tranche I) allocation, the entire capacity was commissioned. Under Tranche II, (the programme expanded in February 2019), agencies have issued a cumulative 4.5 GW under the CPSU scheme. The government, in February 2019, extended the scheme to 12 GW from the erstwhile 1 GW, to provide further impetus to the domestic solar module manufacturing industry. Through this, the government is encouraging cash-rich PSUs to set up renewable energy projects.

While SECI has issued two tenders under the CPSU scheme, of 2,000 MW and 1,500 MW, NTPC has floated a tender of 1 GW. SECI's 2 GW tender (subscribed for only 932 MW) has been auctioned, and 922.4 MW has been allocated with a commissioning schedule of 24 months. For SECI's 1.5 GW tender, 1,114 MW has been allocated, with a commissioning schedule of 24 months. Although this is expected to benefit the sector to some extent,

execution has remained slow amid Covid-led restrictions. Furthermore, the IREDA has allocated a 5 GW capacity under the CPSU scheme (Phase-II), along with its viability gap funding.

In particular, NTPC has already commissioned a total of over ~2,283 MW of capacities as of October 2022 and tendered ~3.2 GW, under various schemes as of July 2022. It has a target of installing ~60 GW of renewable energy capacities by 2032. Similarly, NHPC had allocated 2 GW of projects in 2020, while the Indian Railways has committed to set up 20 GW of solar power capacity by 2030. Other PSUs such as NLC, defence organisations, and government establishments are also expected to contribute to this addition.

### Rooftop solar (RTS) projects and DCR

For solar projects proposed to be developed under NSM, DCR was mandated. However, post the WTO ruling, DCR was restricted only to tenders where the government is the procurer. The central government, in December 2015, approved the Grid-connected rooftop and small solar power plants programme to install 4,200 MW of RTS plants in the country by fiscal 2020 – 2,100 MW through central financial assistance (CFA) and the remaining 2,100 MW without CFA.

The RTS projects sanctioned under this programme are under implementation by state nodal agencies, SECI, PSUs, and other government agencies. Subsequently, the central government, in February 2019, approved Phase II of the Grid-connected rooftop and small solar power plants programme for achieving a cumulative capacity of 40 GW RTS plants by December 2022. Phase II will be implemented by making discoms and their local offices nodal points. The major components of Phase II are:

Component A: CFA* to the residential sector – 4 GW

- CFA at the rate of 40% for capacity up to 3 kWp
- CFA at the rate of 20% for capacity beyond 3 kWp and up to 10 kWp
- CFA at the rate of 20% for GHS/RWA capacity up to 500 kWp (limited to 10 kWp per house and total up to 500 kWp)

Domestically manufactured modules and solar cells need to be deployed.

* CFA shall be on a percentage of the benchmark cost of MNRE for the state/ UT, or the lowest of the costs discovered in tenders for that state/ UT that year, whichever is lower

Implementing agency: discoms

Component B: Incentives to discoms

Schemes such as the CPSU Scheme Phase-II, PM-Kusum, and Grid-connected rooftop solar programme Phase-II are to be driven via DCR, which will promote domestic manufacturing.

### Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan Scheme 2019 (“PM-KUSUM”)

The government has added a DCR clause in this scheme as well, as it is a government-led, subsidised initiative. This is expected to increase demand for domestic modules and cells. Capacities have been allocated to different states in line with their required demand, targets listed under the KUSUM programme, and guidelines. In November 2020, MNRE scaled up and amended the PM KUSUM scheme. The scope of the scheme has now been increased as farmer-owned pasture lands and marshy lands have been included. Further, the size of the solar plant has also

been reduced so that small farmers can participate, and the completion period has been increased from nine to twelve months. Moreover, any penalty for shortfall in generation has been removed, to enable ease of implementation for farmers. Component-wise revised solar capacity and financial support measures are summarised below.

**Table 8: Component-wise revised solar capacity and financial support**

| Component | Revised target | Solar capacity (GW) | CFA (Rs) | Service charges (Rs) | Total (Rs) |
|---|---|---|---|---|---|
| A | 10,000 MW | 10.0 | 33.0 | 0.3 | 33.3 |
| B | 2 million pumps | 9.6 | 156.0 | 3.1 | 159.1 |
| C | 1.5 million pumps | 11.2 | 145.1 | 2.9 | 147.9 |
| Total | | 30.8 | 334.1 | 6.3 | 340.4 |

*Source: MNRE, CRISIL MI&A Research*

**Safeguard duty**

In July 2018, the Government of India imposed a two-year safeguard duty on solar cells and modules, in an attempt to protect domestic manufacturing. After repeated representations to government authorities by the domestic industry for import duties, a safeguard duty of 25% with a declining trajectory was imposed on imported solar cells and modules, including from China and Malaysia, two key exporters to India. Despite this, there were roadblocks to demand shifting entirely, or to a large extent, to the domestic industry:

1. Dependence of module makers on import of raw material (cells/wafers),
2. A narrow window of 2 years for domestic players to achieve scale and backward integration, and
3. Rise in imports from other nations such as Vietnam, Thailand, and Singapore

However, the subsequent application of BCD on cells and modules from April 1, 2022, has given a much-needed edge to domestic modules in terms of pricing competitiveness with their Chinese counterparts. Imported modules from China, post the application of BCD, were costing ~$0.44-46/Wp as on September 2022, wherein tax components comprise ~$0.17/Wp, with domestically assembled modules with imported cells also priced similarly, of which taxes comprise only ~$0.09/Wp. While BCD is expected to have the desired effect of bringing in price parity for Indian modules with their imported counterparts, India remains dependent on China for cells and other upstream components. CRISIL MI&A Research believes BCD with PLI would drive incremental domestic demand. However, the following remain monitorable in this respect:

1. Technology needs to evolve sharply for preference to shift towards domestically manufactured modules, which requires continuous R&D investment and better efficiency levels
2. The domestic industry needs fully integrated plants to reduce dependence on China for import of upstream components such as cells and wafers

**Export incentives**

Exports increased ~46% on-year in fiscal 2022, and are expected to rise over the next three fiscals to 2-5 GW cumulatively, owing to extended tariffs on China in the US market. Export demand will also be supported by other key renewable energy markets, such as the Middle East, European Union, and Latin America. Additionally, the government's PLI scheme Phase-II of Rs 19,500 crore is expected to support domestic supply and encourage exports in future, especially post fiscal 2025.

**Special Economic Zones Act, 2005, rules and amendments thereof (SEZ Act)**

The SEZ Act provides for the establishment, development, and management of SEZs for the promotion of exports and other related matters. The SEZ Act provides incentives in duties, tariffs, and applicability of commercial laws, mainly to encourage investment and create employment. In an SEZ, economic laws are more liberal compared with their typical application in the country, to purport development and promote rapid economic growth by providing tax and business incentives. Such incentives are governed by the provisions of the SEZ Act. Manufacturing facilities for solar components located within an SEZ are governed by the provisions of the SEZ Act and receive incentives and subsidies.

**Modified special incentive package scheme ("MSIPS")**

The MSIPS was notified by the Government of India on July 27, 2012. It provides a capital subsidy of 20% on investments in SEZs and 25% on non-SEZ investments. Incentives are given for 44 categories/verticals spanning stages across the value chain, i.e., raw materials, assembly, testing, packaging and accessories, chips, and components, for 5 years from the date of approval of the application. MSIPS was revised via a notification dated August 3, 2015, to cover 15 new product categories and provided for simplified procedures concerning the date of submission of application, allowing disbursement of incentives every quarter, as against annually under the earlier scheme, the dispensation of separate technical evaluation, and allowing MSIPS in any part of the country as against only in notified areas. The scheme was further revised vide the notification dated January 30, 2017.

## Broad overview of market and competition assessment

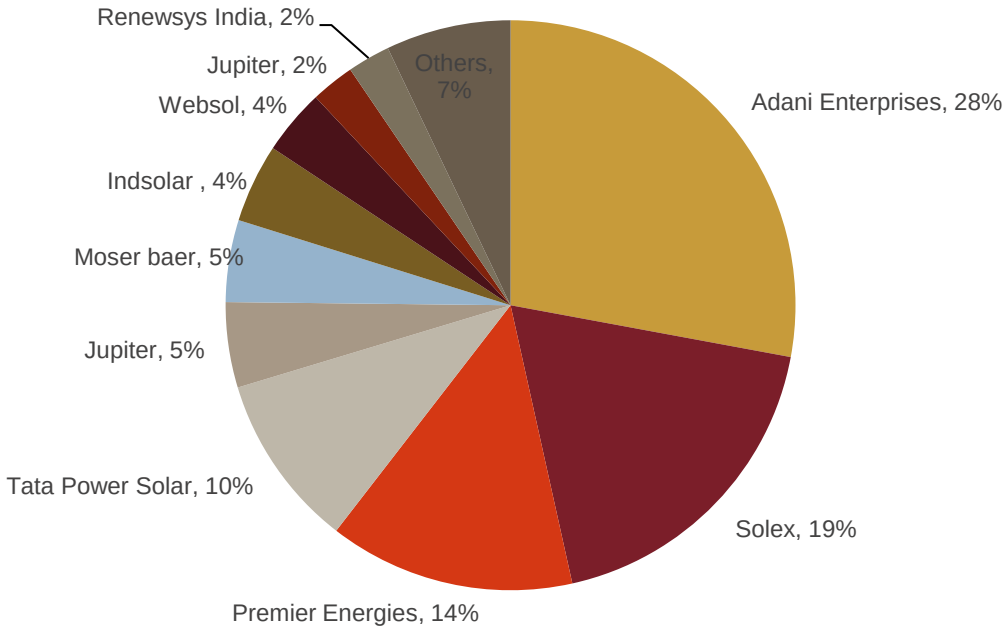
**Key exporters in the Indian market**

With the world gaining momentum on renewable energy usage, the installed renewable base stood at 295-298 GW as of 2021 and is expected to push through the 300 GW mark in 2022, as per IEA. The global installed solar capacity witnessed an addition of ~454 GW between calendar years 2017 and 2021, led by government support to renewables in the form of clean energy penetration mandates, taxation and other incentives, and subsidised tariffs set for renewables, along with government-led renewable project allocations to drive additions in the segment. During the period, India added ~31 GW of solar capacity, and its renewable energy installed capacity reached 165 GW as of September 2022, with solar capacity comprising ~70% of the total installed base. This is propelled by the country enjoying about 5,000 trillion kWh per year of solar energy incident over its land area, with most parts receiving 4-7 kWh per sq. m per day.

In terms of solar component manufacturing, India was estimated to have a total installed base manufacturing capacity of about 5 GW for solar PV cells as of March 2022. The operational cell capacity (here operational capacity refers to the capacity that we estimate can be used to service demand) remained 93-95% only, on account of manufacturing lines either employing obsolete technology and/or not being operational due to financial stress.

Of all the players, Indosolar Ltd, Jupiter Solar, and Websol Energy Systems Ltd. exclusively manufacture solar cells, while the others produce modules as well. Technology dependence on foreign manufacturers and higher capital intensity have limited the number of players in this space.

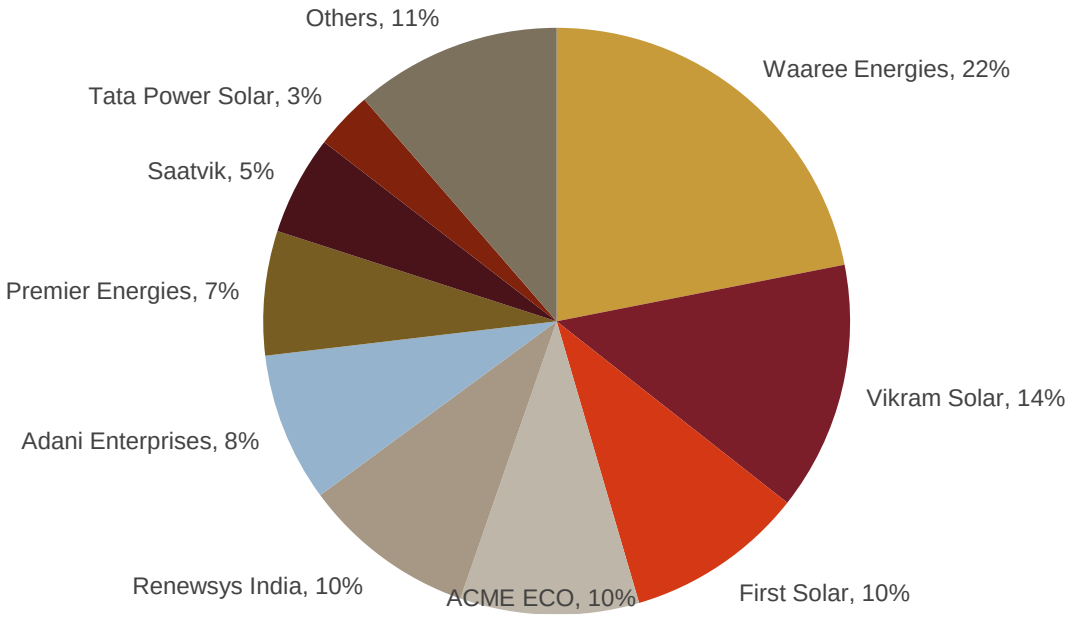
**Figure 20: Market share of Indian PV cell manufacturers**




Note: The above share pertains to fiscal 2022 and is based on installed capacity of key players.

*Source: MNRE, CRISIL MI&A Research*

**Figure 21: Market share of Indian PV module manufactures**




Note: The above share pertains to fiscal 2022 and is based on installed capacity of key players.

*Source: MNRE, CRISIL MI&A Research*

Similar to PV cells, the top three module manufacturers account for close to 50% of the market share. India had an annual solar module production capacity of ~19 GW per annum as of March 2022. However, currently, of the ~19 GW module manufacturing capacity, almost 20-25% is defunct due to obsolete technology or financially stressed players, while the balance is operating at sub-optimal levels. This is a result of tepid demand, weak cost competitiveness, and working capital issues caused by a weak financial position. Technology is also a key variable, with the global module manufacturing industry currently providing mono-PERC and bifacial capability modules, with emerging technologies of TOPCON and HJT being explored globally.

Adani Enterprises launched the first 1.2 GW cell-to-module integrated manufacturing unit in India in 2017. This has expanded to 3.5 GW integrated cell and module manufacturing, the largest integrated capacity as of September 2022. The entity manufactures mono-PERC and n-type bifacial cells. (Source – Company filings, CRISIL MI&A Research)

**Table 9: Overview of major domestic players in the market**

| Parameter | Vikram Solar | Waaree Energies | Adani Enterprises | Premier Energies | RenewSys India | Tata Power Solar | Emmvee Photovoltaic | Alpex Solar | Goldi Solar |
|---|---|---|---|---|---|---|---|---|---|
| Number of manufacturing factories | One each in West Bengal and Tamil Nadu | Three in Gujarat | Two in Gujarat | Two in Telangana | One each in Karnataka, Telangana, and Maharashtra | Two in Karnataka | Two in Karnataka | One each UP and HP | One in Gujarat |
| Experience in PV module manufacturing | 16 years | 15 years | 5 years | 27 years | 7 years | 31 years | 15 years | 15 years | 11 years |
| Enlisted capacity as per ALMM list (September 2022) | 2022 MW | 4,750 MW# | 1,622 MW | 1,193 MW | 1,237 MW | 810 MW | 1,025 | 240 MW | 500 MW |
| Market share as a percentage of total enlisted capacity (as per ALMM) | 10% | 24% | 8% | 6% | 6% | 4% | 5% | 1% | 2% |
| Products and services | Integrated Solar energy solutions provider with a presence in Solar PV modules, EPC services, and O&M services | Solar PV modules, inverters, batteries, EPC services, rooftop solutions, O&M services, solar home appliances, and solar water pumps | Solar PV cells and modules, EPC services, O&M services | Solar PV cells and modules, EPC services, O&M services, water pumps, power | Solar PV modules and cells, encapsulants, backsheets | Solar PV cells and modules, EPC services, O&M services, and water pumps | Solar PV cells and modules, EPC services, rooftop solutions, O&M services, and solar water heater solutions | Solar PV modules, EPC services, solar water pumps | Solar modules, EPC services, water pumps |

| Parameter | Vikram Solar | Waaree Energies | Adani Enterprises | Premier Energies | RenewSys India | Tata Power Solar | Emmvee Photovoltaic | Alpex Solar | Goldi Solar |
|---|---|---|---|---|---|---|---|---|---|
| Technology | Mono-PERC mono-facial and bifacial, half-cut and full cell modules, poly-Si modules | Mono-crystalline and poly-crystalline PV modules, mono-PERC, bifacial, flexible modules, BIPV | Multi-crystalline, mono-PERC, and bifacial modules | Poly-crystalline and mono-crystalline Si cells, mono-PERC, poly-crystalline PV modules | Mono/multi-PERC, bifacial, half-cut and full cell modules | Mono-PERC cells, mono-PERC half-cut modules | Mono-PERC, poly-crystalline modules, bifacial modules, half-cut cell modules | Mono-crystalline, poly-crystalline PV modules, bifacial modules | Mono-crystalline, poly-crystalline PV modules |

Note: # Includes: Waaree Renewables

*Source: Company websites, MNRE ALMM September 2022, CRISIL MI&A Research*

### *Competitive intensity*

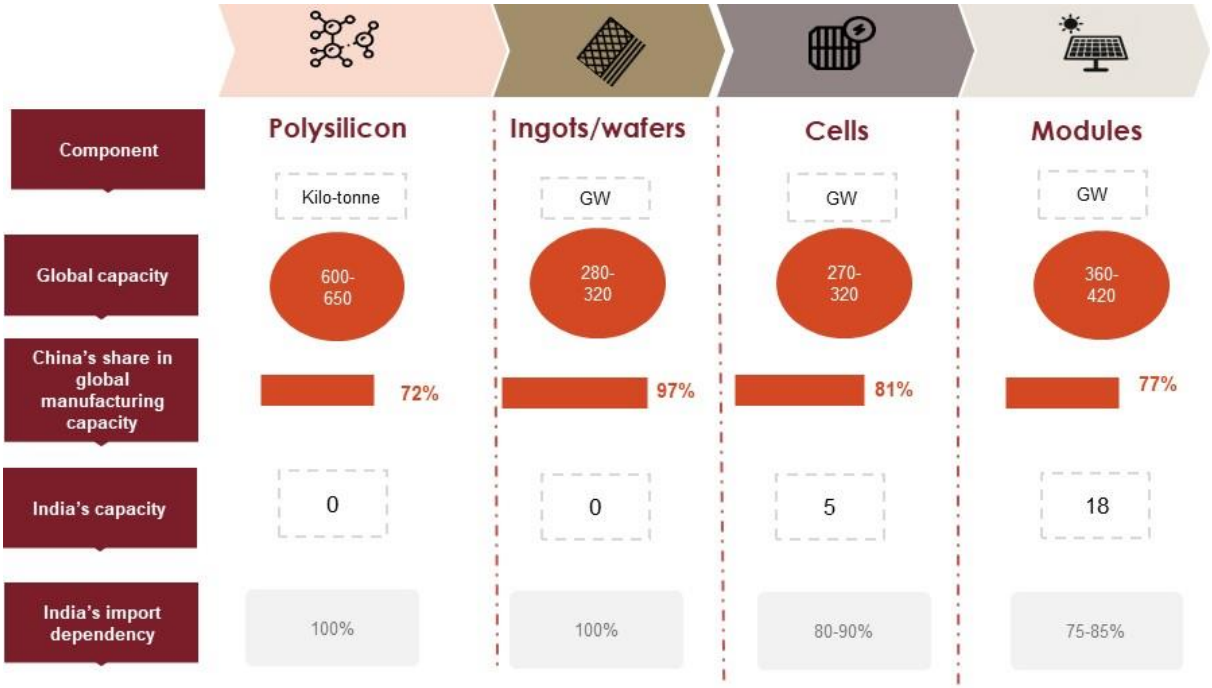
The high-wattage GW capacity in India was low at 8.4 GW as of September 2022 due to limited domestic supply. The cost to domestically assemble high wattage modules in line with latest technology amounted to $0.43-0.45/watt peak due to the introduction of soft barriers such as basic customs duty. The total landed cost for imported modules and domestic modules is relatively similar. However, this scenario depends on supply availability. Supply availability of upstream components for import based modules affect the base pricing, which can fall in the future as supply improves. From a domestic supply perspective, presently, supply of high-capacity wattage modules is only available with a few players. Due to limited availability, module prices are expected to remain high.

# Domestic and export market potential

## Overview of solar PV value chain in India

The installed base for solar power rose sharply to ~54 GW at end- March 2022 (versus a negligible 0.02 GW on March 31, 2011). However, domestic module manufacturers could not capitalise on high demand, as they lacked cost-competitiveness, compared with their global counterparts. The absence of backward integration and a smaller operating scale have rendered Indian manufacturers uncompetitive. While India has begun to make its mark across various levels of the domestic value chain, it is largely import-dependent. Similarly, global dependence on China also remains significant in PV component manufacturing. While a small percentage of these components can be sourced outside China, the global solar PV supply chain is predominantly dependent on China for modules and upstream components like polysilicon, ingots, wafers, and cells.

**Figure 22: Lack of backward integration results in import dependence**




Note 1: The above global manufacturing capacity corresponds to CY 2021 and are estimates.
2.India's module capacity is as per ALMM September 2022. Remaining value chain data for India is as of March 2022
*Source: U.S Department of Energy, CRISIL MI&A Research*

The major reason is that input material required in the above supply chain, including metallurgical grade silicon (MGS), used to make polysilicon, is sourced from China, which accounts for ~70% of the global manufacturing capacity for MGS. The photovoltaics industry is the main consumer of polysilicon, comprising approximately 80% demand.

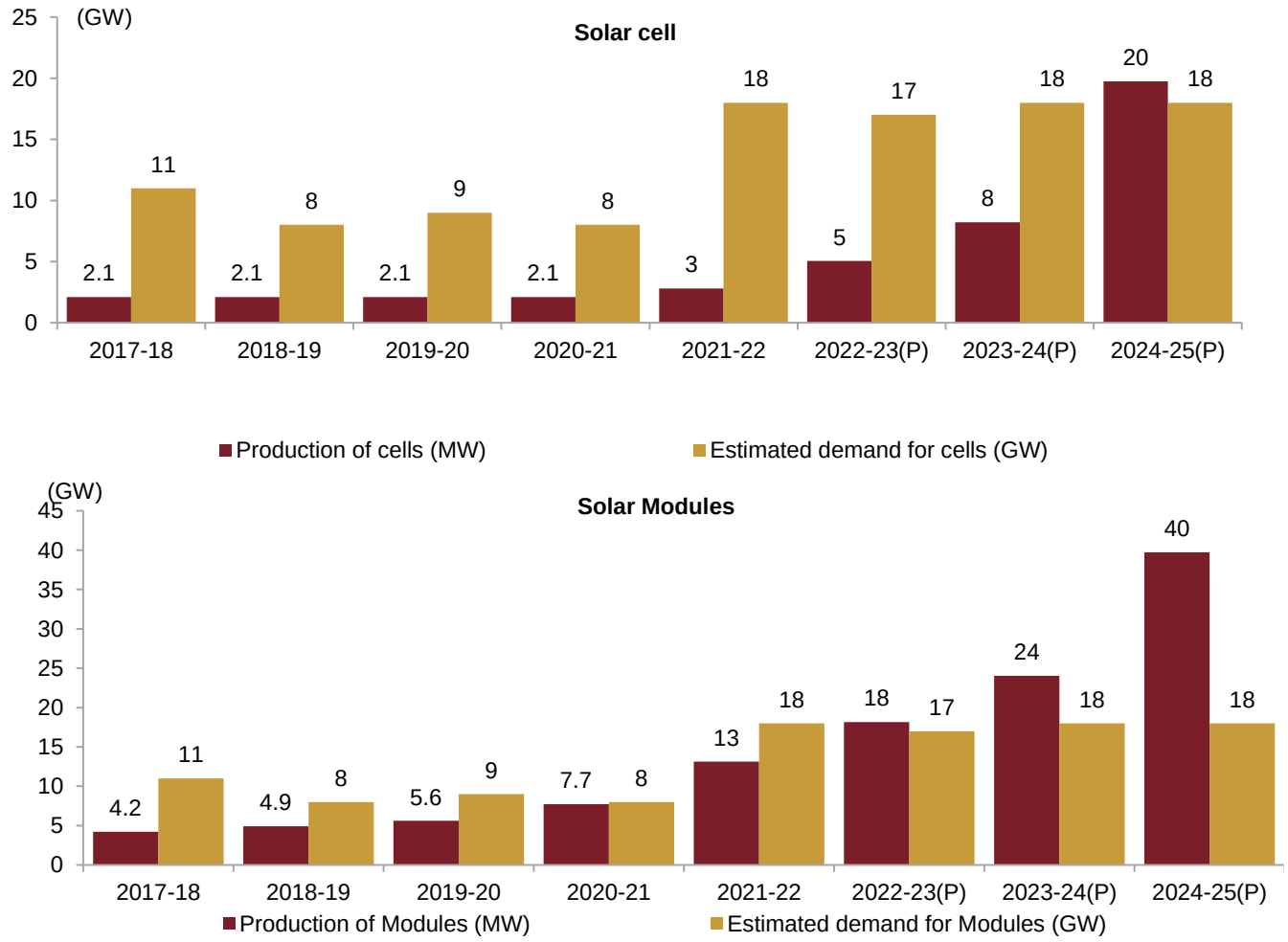
In line with this, China accounts for the largest share across the PV manufacturing value chain from polysilicon to module manufacturing, with a ~85% share, on average across, followed by Germany and the US for polysilicon, and other countries in Southeast Asia, such as Taiwan, Vietnam, and Malaysia, for other upstream components. To reduce import dependence, the domestic cell and module manufacturing industry requested the government to take a protectionist stance, in addition to providing promotional measures, to boost domestic production.

## Broad assessment on outlook of capacity additions and export potential

With the government incentivising the PLI scheme, China+1 policy, and BCD impositions resulting in competitive landed costs, Indian players can capitalise on the market gap as domestic demand for solar panels and cells is expected to steadily rise, with significant adoption targets related to clean energy and approaching completion timelines for projects requiring ALMM based modules. This has led to a healthy project pipeline, with a spill over from projects stalled during the pandemic.

As of fiscal 2022, module production capacity remained lower than demand and is expected to remain so up to fiscal 2024, after which, an influx of supply of modules and cells on account of expansion plans and announcements is expected to improve production capacity, resulting in production capacity surpassing demand. While module and cell production capacity additions between fiscals 2023 and 2025 are expected to grow, the level of full integration (polysilicon to module) is only expected to enhance from fiscal 2025 and beyond on account of PLI Phase-II. The incremental production capacity available is also expected to cater to other demand avenues such as exports, green hydrogen, EV ecosystem etc.

**Figure 23: Solar cell and solar modules**




*Source: CRISIL MI&A Research*

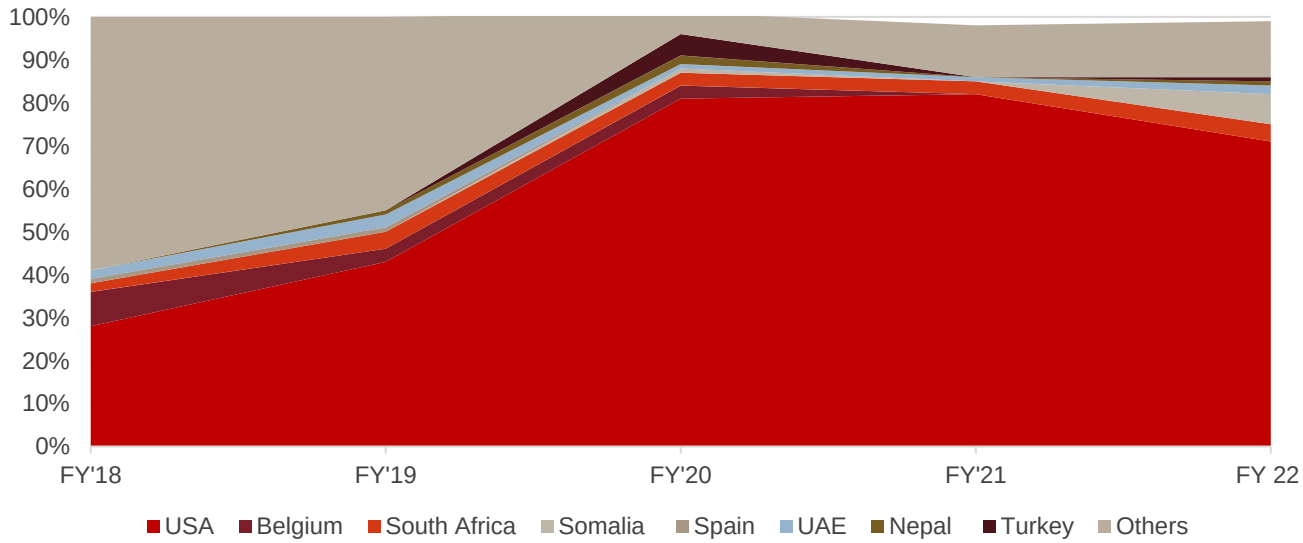
## Export potential of 2-5 GW between fiscals 2023 and 2025 for domestic manufacturers

In fiscal 2022, exports increased 46% to Rs 8.3 billion after declining 32% on-year to Rs.5.7 billion. While in fiscal 2021, export demand was driven by Indian manufacturers garnering more demand in the US market (after the US imposed a tariff on Chinese photovoltaic products in FY20), in fiscal 2022, the US continued to have the highest share in exports at 71%, followed by African countries at ~14%. European countries, however, witnessed a loss in share over the years. Asian countries gained a ~9% share.

Furthermore, in light of rapidly declining module prices, several Chinese firms had withdrawn from the EU Minimum Import Price (MIP) arrangement, preferring instead, to pay the high duties. But the MIP arrangement was withdrawn September 3, 2018, onwards by the EU in the interest of the new renewable energy targets set by the European Commission. This brings top Chinese players back into the competition, which would compromise the market share gained by Indian module makers over the past few years in the region.

For India, the export potential could be higher due to the US's recent ban on solar panel materials originating from the Xinjiang province and higher global renewable installations, led by stronger policies and targets under COP 26 and 27, which remain key monitorables. Besides this, diversifying sourcing policies to consider destinations apart from China would be key positive drivers for Indian-make modules. This will be supported by the domestic expansion of capacity and newer technology lines being set up to cater to incremental demand. Also, on February 4, 2022, the Biden administration extended the Section 201 tariffs imposed on the import of solar modules from China for four years. This is a positive growth driver for domestic module exports. Over the next four to five years, the EU and US have the potential of adding 20-25 GW each of solar energy each year, as per the IEA. Both regions would be key drivers for export demand from India. Exports will be further supported by continued demand from Africa, the EU, and the Middle East.

**Fig 24: Country wise exports of solar PV components**




*. Note: The numbers for exports in the above graphs consist of values from two HS Codes (starting FY'22), this is due to re-classification of cells imported without being assembled in modules or panels and import of preassembled modules or panels. The reclassification came into effect April 2021*

*Source: CRISIL MI&A Research*

## Risks to PV manufacturing

Module manufacturers are vulnerable to exchange rate volatility risk and market competition risk, among others.

Mentioned below are risks the industry could face:

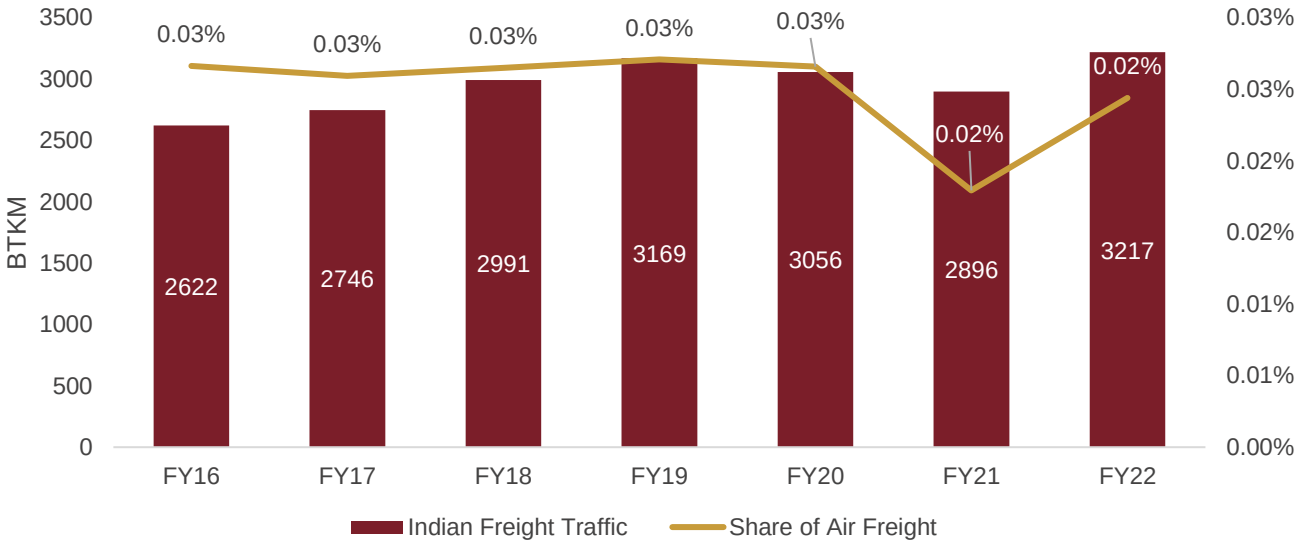
- **Change in import export regulations** - Raw material cost forms 65-70% of the total cost in module assembly in India; of this, photovoltaic cells form a major part. Around 35-40% of the total cost in manufacturing a module goes towards solar wafers or cells. These are required for cell/module manufacturing/assembly and are imported in India owing to insufficient domestic production. A change in import duties or import tariffs would impact input costs for manufacturing of domestic modules, on account of their limited competitiveness
- **Fluctuation in foreign exchange rate** - The industry depends heavily on imports, and any adverse movement in exchange rates would impact profitability for manufacturers. Foreign exchange gains/losses also impact players' margins. Further, a weak rupee can push up raw material costs. Effective hedging strategies would minimise the impact of any such volatility for players in the sector
- **Rise in competition from domestic markets and imports** - Foreign players (mainly Asian – China, Malaysia, Taiwan, Korea) are more competitive than domestic manufacturers due to their significantly larger scale of module manufacturing, leading to massive economies of scale. Additionally, government support, coupled with backward integration undertaken by foreign players across the solar module manufacturing supply chain, right from the polysilicon stage, has made these players morecompetitive
- **Technology risk** - Globally, solar photovoltaic cell and module manufacturers constantly spend on R&D to either adopt new technology trends in module manufacturing or develop their own technological disruptions to gain a competitive edge over competitors. This helps improve cell/module efficiency and module design, or make the manufacturing process more cost-effective, helping improve either the marketability of the firm’s products or its profitability
- **Price volatility and market risk** - There is much volatility in input prices and module selling prices in the sector. Module costs had declined 17% and 8% in fiscals 2019 and 2020, respectively, mainly due to falling input cost and over-capacity in the global solar market. However, in fiscal 2022, module prices rose an account of a price surge for upstream components amid supply chain disruptions in China. As of September 2022, prices had begun to soften due to fall in upstream component prices
- **Business concentration risk** - Dependence on few counterparties, or across only particular states/regions may pose a risk to manufacturers in the event customer attrition or dampened demand from the segment. This is especially true for exports, which are concentrated to particular markets in the EU, the UK, and African nations, and DCR contracts, which henceforth, will only be limited to PSUs, as per the WTO ruling.

# Airports

## Overview

India was the fifth largest aviation marked based on airline passengers as of 2019. The country is poised to emerge as the third largest by 2025. It is already the third largest domestic passenger market and is expected to be among the fastest growing domestic air passenger markets over the next decade(*source: IATA*). The factors that boost the domestic aviation sector are: 1) the country's population that is the second largest and increasing per capita income; 2) low air trips per capita than other developing nations; 3) improving aviation ecosystem; 4) a land mass that is the world's seventh largest; and 5) the country's ideal geographical location between the western and the eastern hemisphere. India has seen massive growth in the airport sector with investments from both the government and private sector. As per an International Civil Aviation Organisation (ICAO) study, the output multiplier and employment multiplier for the aviation ecosystem are 3.25 and 6.10, respectively.

**Figure 25: Air cargo handled (domestic and international): Share of aviation in Indian freight traffic**




*Source: CRISIL MI&A Research*

Currently, India has 21 international and 35 domestic cargo terminals. To improve air cargo penetration, the government has taken several steps. They include:

- To facilitate easy freight movement, the National Civil Aviation Policy, 2016 (NCAP) proposed a minimum mandatory level of cargo facility at the upcoming airports
- The government has implemented a single-window project by bringing all clearances by regulatory agencies onto a common platform, aimed at shortening the dwell time of air cargo
- The free period for air cargo has been reduced from 72 hours to 48 hours. Moreover, 24X7 customs clearance of import/export cargo has been initiated at 17 air cargo complexes

**Freight traffic at Indian airports**

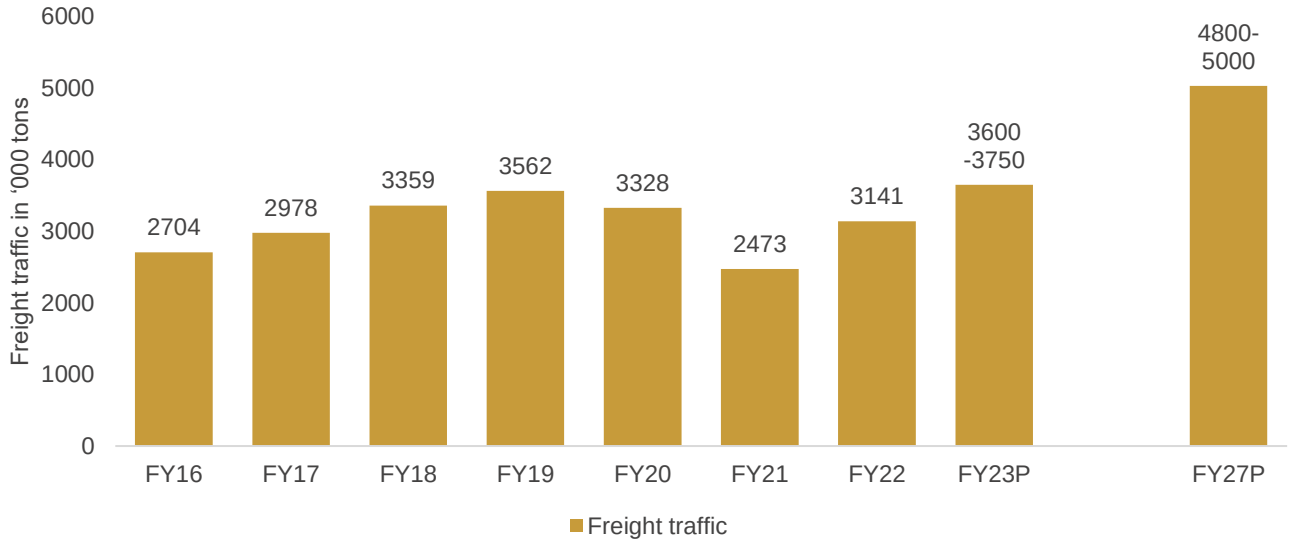
Freight traffic at Indian airports logged a 4% CAGR between fiscals 2016 and 2020 and passenger traffic 9% as airlines concentrated more on the passenger business than on cargo. Air freight is dominated by perishables, pharmaceutical goods, gold and precious metals, electrical equipment, readymade garments, aircraft components

and chemicals. Air cargo has been growing as a focus area for carriers given the rise in domestic ecommerce volume and policy initiatives aimed at boosting Indian exports. However, it continued to be a secondary focus area for most carriers given the double-digit growth passenger traffic is recording. Until fiscal 2020, only Blue Dart Express operated dedicated freighters. In fiscal 2020, SpiceXpress entered the market. Air freight traffic in the pandemic-hit fiscal 2021 recorded a 26% on-year decline, much better than a 66% decline passenger traffic saw. This was because air freight saw renewed demand across sectors as lockdowns disrupted road and rail transport and clogged supply chains; ocean freight rates spiked; and sipping saw shortage of containers even as goods transfer was urgent and essential.

Post the pandemic the air cargo market has seen a major shift due to the following reasons: i) rising trade with other nations as both imports and exports are on an upswing the Indian and world economies recovered; ii) rise in e-commerce attributable to a permanent shift brought about by the pandemic as more people get comfortable with online ordering; iii) the Indian government halting fifth freedom cargo flights; iv) neighbouring countries, such as Vietnam and Bangladesh, seeing high volume of exports to Europe and other nations and India becoming the preferred air cargo hub for them as the country's airline network and air cargo market is better developed than those countries; v) rising congestion at ports and other supply-chain bottlenecks, coupled with skyrocketing shipping prices, pushing demand towards air freight services; and vi) depressed widebody capacity due to lower deployment of widebody on international routes, pushing up demand for cargo-only flights and freighters. Further, during the pandemic, the air cargo industry emerged as a lifeline delivering medical supplies and vaccines and keeping supply chains open. During the pandemic, the share of cargo revenue for airlines shot up considerably vis-a-vis pre-Covid levels, albeit due to a drop in passenger numbers impacting passenger revenue. The steady yields that cargo business provided to carriers has prompted Indian carriers such as Indigo and SpiceJet announce specific plans for induction of freighters in their fleet, which suggests the industry may be looking at a faster pace than in the past.

While the factors one to four mentioned above are structural shifts that will impact the sector in the long term, the latter two points are shorter-term measures that will provide a boost in the short to medium term. Freight traffic in fiscal 2022 recorded a 27% rise to 3.1 million tonnes, still below pre-Covid highs of 3.6 million tonnes achieved in fiscal 2019. Freight traffic in fiscal 2023 is projected to record a 15-20% on-year rise to 3.60-3.75 million tonnes similar to pre-Covid highs of fiscal 2019. Freight traffic is seen returning to pre-Covid levels this fiscal with a revival in the domestic economy.

**Figure 26: Freight traffic at Indian airports**

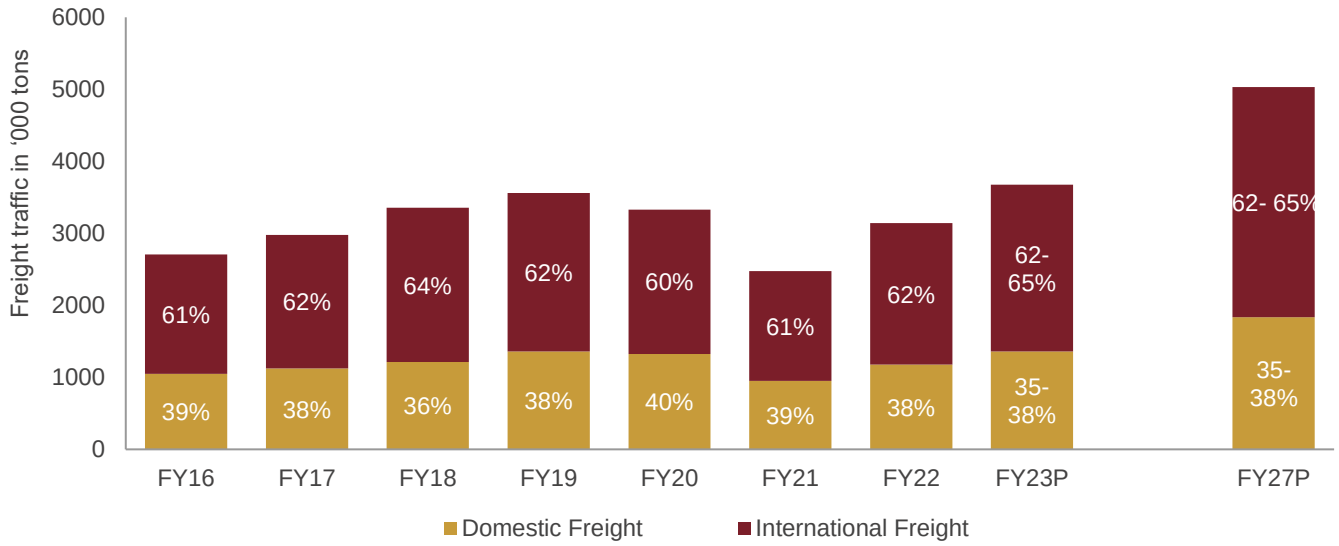



*Source: AAI, CRISIL MI&A Research*

Over fiscals 2023-2027, freight traffic is projected to record a 7-8% CAGR, higher than the 5% recorded over fiscals 2016-2020, attributable to the rising prominence of air transport, rising e-commerce penetration necessitating quick cargo movement, expected rise in trade with India after signing of FTAs with various countries and airlines focussing on the cargo market. The operationalisation of the dedicated freight corridor, improved highway network, operationalisation of additional national waterways and expected reduction of ocean supply chain clogs would prevent further growth for air freight in the long term.

Domestic freight traffic has outgrown international freight traffic between fiscals 2016 and 2020 with domestic traffic recording a CAGR of 6% and international traffic a modest 5%. The share of international traffic in overall freight traffic at Indian airports reduced from 61% in fiscal 2016 to 60% in fiscal 2020 attributable to rising demand in domestic traffic led by the e-commerce sector and expansion by dedicated freighter operators, such as Blue Dart Express and SpiceXpress. Domestic freight traffic recorded a 28% decline in fiscal 2021, hitting the fiscal 2015 levels. International traffic declined 24% returning to the fiscal 2015 levels, too. In fiscal 2022, with further opening of the economy and tailwinds for the freight segment, domestic freight traffic rose 24% to 1.2 million MT, similar to fiscal 2018 levels while international passenger traffic rose 29% to 2.0 million MT just below the fiscal 2018 levels. This fiscal, both domestic and international freight traffic is projected returning to pre-Covid highs seen in fiscal 2019. By fiscal 2027, the share of international freight traffic in overall freight traffic is seen at 62-65%.

**Figure 27: Share of International freight**




*Source: AAI, CRISIL MI&A Research*

## Passenger traffic

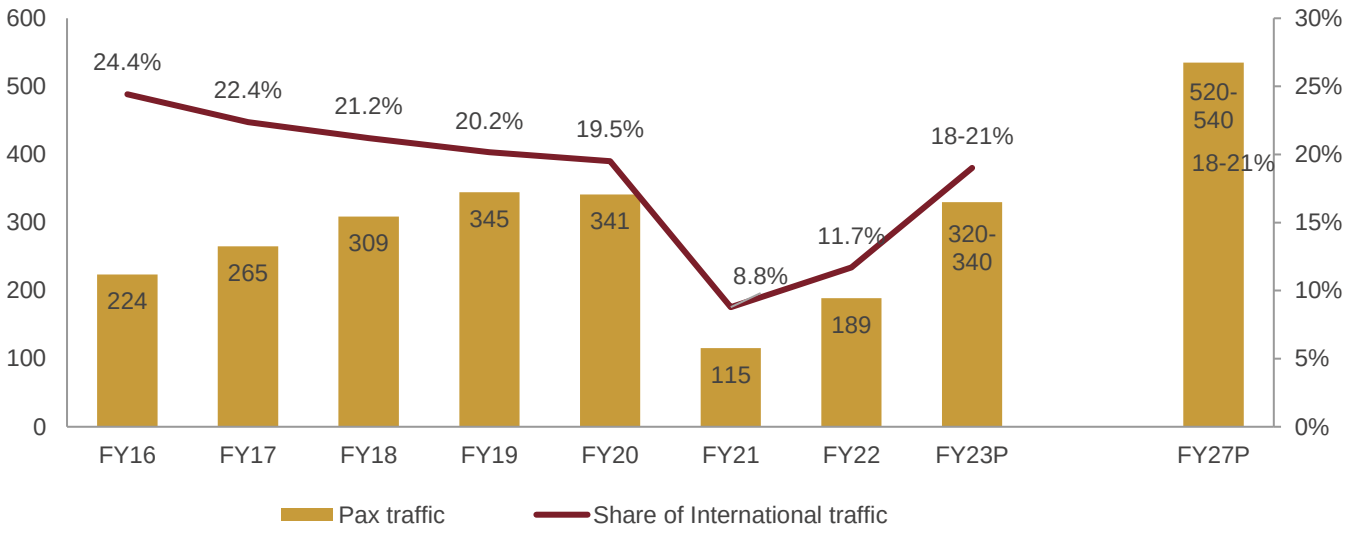
Passenger traffic at Indian airports recorded a 9% CAGR over fiscals 2016-20. In the pandemic-impacted fiscal 2021, passenger traffic at airports declined 66% to 115 million passengers, similar to fiscal 2008 levels, attributable to (i) suspension of domestic air services from March 25, 2020 to May 24, 2020, and international services from March 23, 2020, onwards; (ii) apprehension among passengers about flying upon resumption of air services in May 2020 (leisure and business travel was avoided, and only essential and some Visiting friends and relatives (VFR) traffic was seen); (iii) suspension of scheduled international services, with international flights restricted to Vande Bharat and air-bubble flights; (iv) caps on domestic flight capacity imposed by the Ministry of Civil Aviation; and (v) higher caseloads in some states, mandating passengers to carry negative RT-PCR test reports and thereby negatively impacting traffic.

In fiscal 2022, passenger traffic rose 64% on-year on a low base to 189 million passengers, similar to fiscal 2015 levels, aided by rising vaccinations boosting travel sentiment, end of capacity caps mid-October 2021 onwards, the wider population having learnt to live with the virus and pent-up demand from leisure travel. The numbers would have been higher but for the severe second wave of the pandemic in the first quarter of fiscal 2022, which saw a sharp drop in passenger numbers, and the third wave in the fourth quarter of the fiscal, which handicapped passenger recovery that had reached 80% of pre-Covid levels in December 2021.

Passenger traffic is expected to rise 70-80% on-year to 320-340 million in fiscal 2023, almost returning to the levels recorded in fiscals 2019 and 2020. The rise would be led by domestic passengers, with domestic passenger traffic seen returning to pre-Covid levels owing to pent-up demand across leisure and VFR, return of business travel and Meetings, Incentives, Conferences and Exhibitions (MICE), and vaccination-induced confidence among domestic passengers. International passenger traffic lags as scheduled services were only allowed to commence on March 27, 2022, and because of delays in processing tourist visas across countries due to application backlogs during the pandemic. These projections, however, are based on assumption of no or mild further waves of the pandemic in India, with no local lockdowns or suspension of air services between countries and expectation of scheduled international services to continue. Over fiscals 2023-27, passenger numbers are expected to log a 12-14% CAGR,

led by an expanding market for air travel with rising incomes and increased propensity to spend; rising connectivity across the nation and internationally; and narrowing of price differential between air and rail tickets.

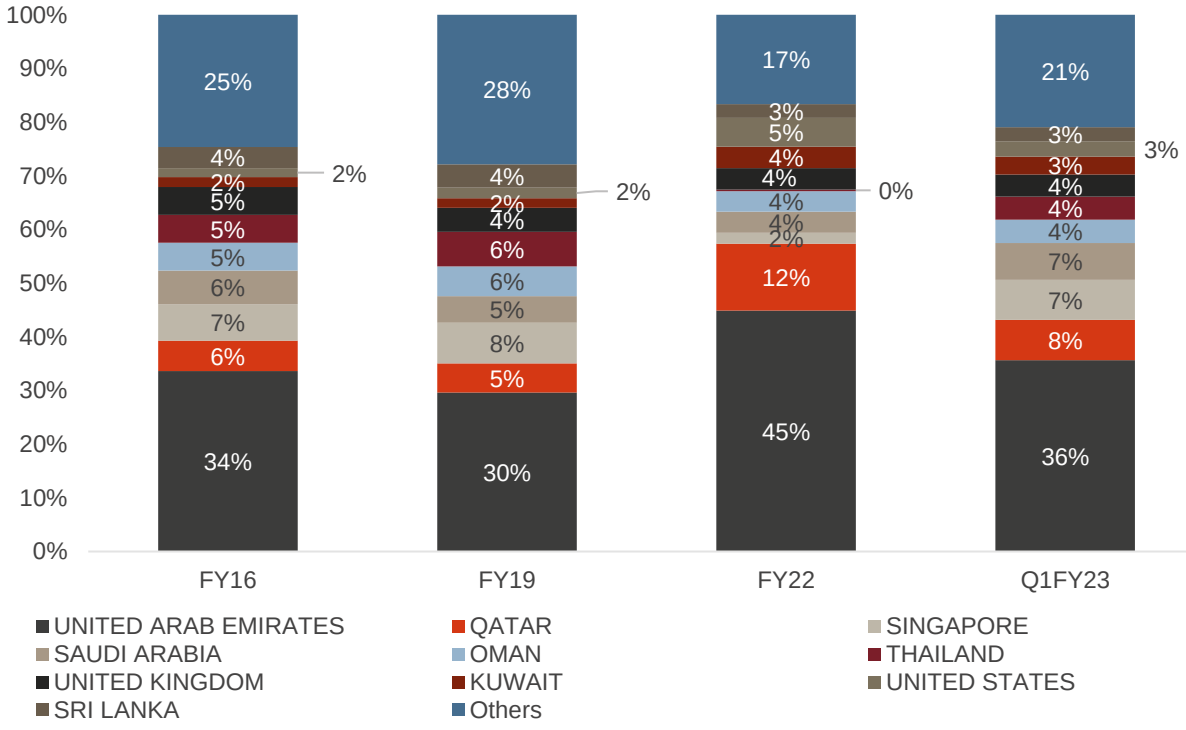
**Figure 28: Total passenger movement (domestic and international)**




*Source: CRISIL MI&A Research*

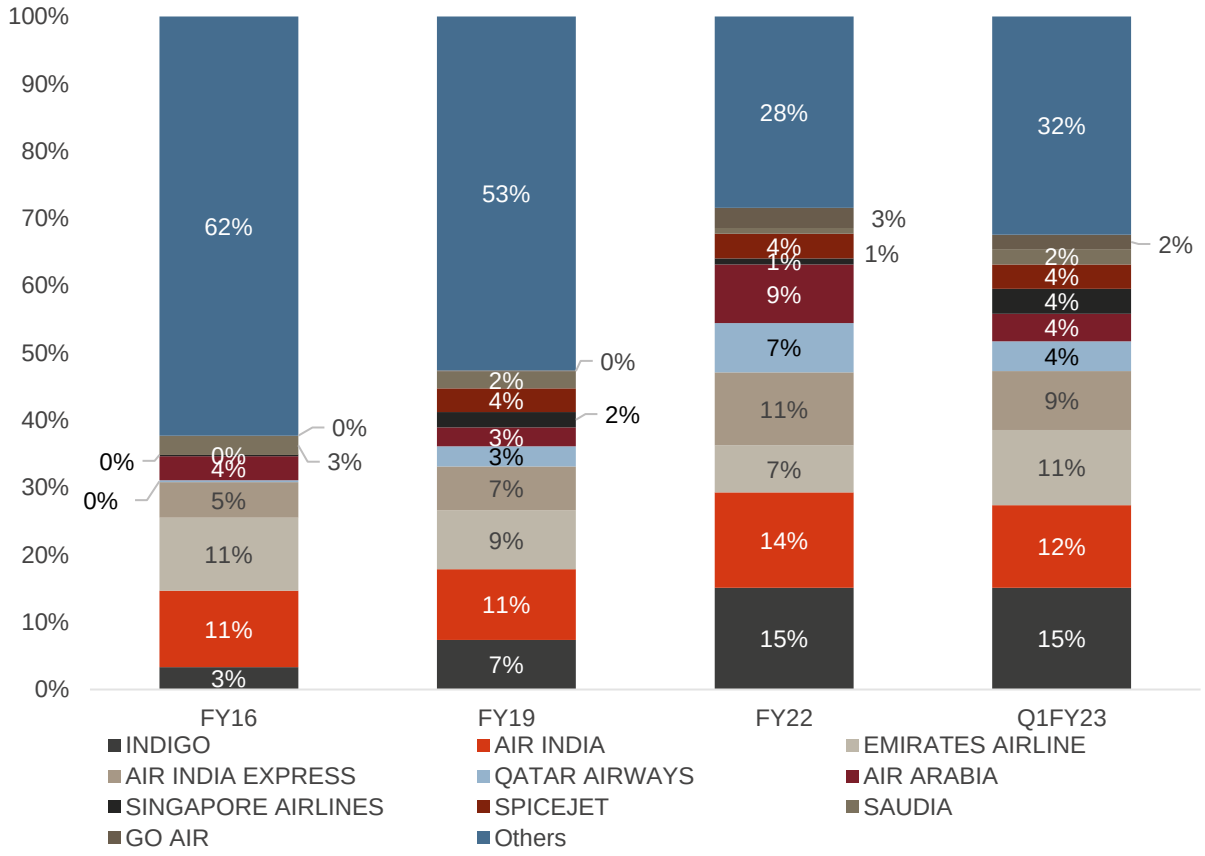
## Changing trends in international passenger traffic

**Figure 29: UAE maintains significant market share in international passenger traffic**




*Source: DGCA, CRISIL MI&A Research*

**Figure 30: Indigo's market share rises 5x in 6 years**




*Source: DGCA, CRISIL MI&A Research*

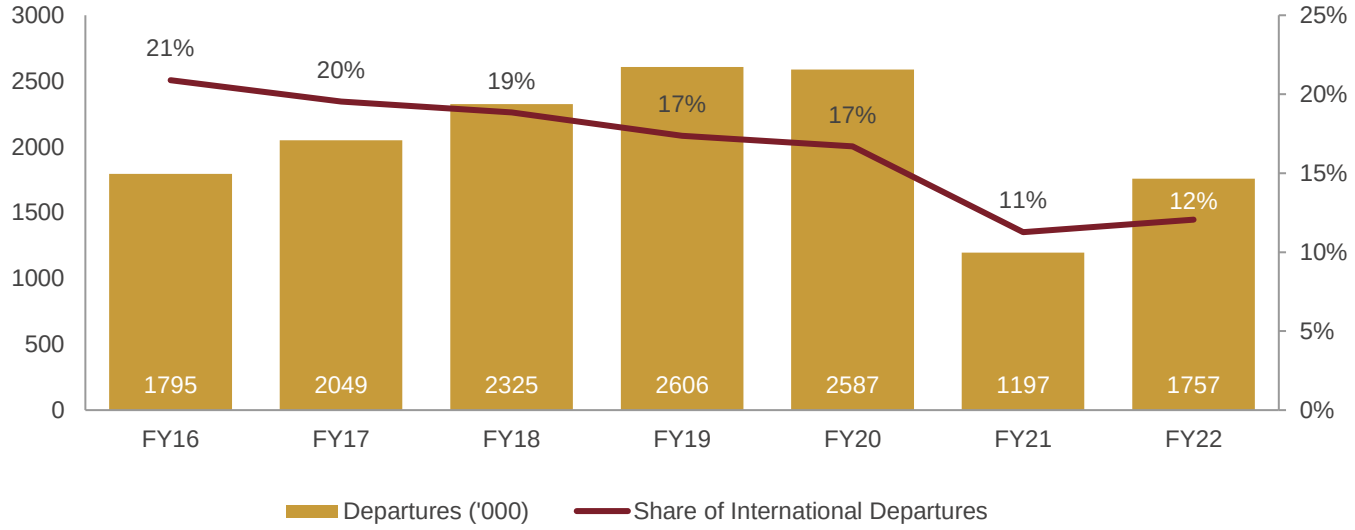
## Air traffic movement

In fiscal 2022, flight count reached 1.75 million — 67% of pre-Covid levels (fiscal 2019) and 47% higher than in the pandemic-impacted fiscal 2021. International departures accounted for 12% of total aircraft movement in fiscal 2022, attributable to suspension of scheduled international services till March 27, 2022.

Air traffic movement is expected to recover in fiscal 2023 in line with passenger traffic recovery, and the entry of new players will result in fleet addition, thereby increasing the flight count. Akasa has already placed an order for 72 aircraft. Tata's takeover of Air India coupled with the merger announcement of Air India with Vistara and AirAsia India with Air India Express and the re-launch of Jet 2.0 would also add to the fleet of Indian carriers in the near future.

As per Airbus, India would need about 2,210 aircraft in the next 20 years to serve its growing aviation market. This would mean 6.6% annual growth in fleet, higher than the global average of 3.9%.

**Figure 31: Air traffic movement**



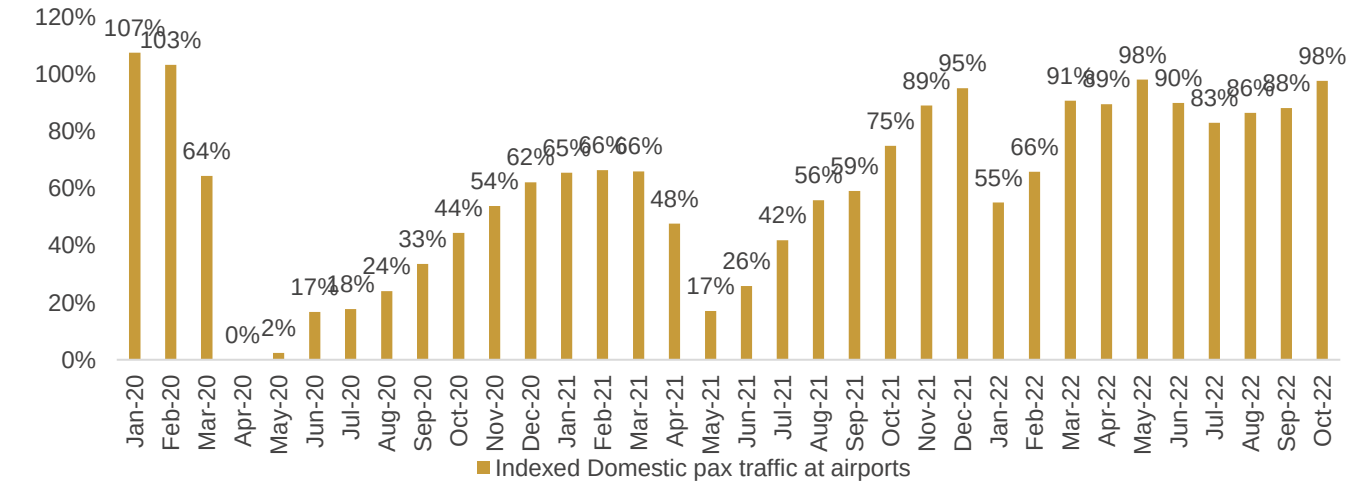

*Source: CRISIL MI&A Research*

## Impact of pandemic and return to normalcy

The Indian air travel market was recovering from the grounding of Jet Airways by the third quarter of fiscal 2020, when the Covid-19 pandemic struck. Some international services had to be suspended from mid-February 2020 onwards. All the international flights were suspended from March 23, 2020, onwards as countries closed borders. Domestic services were suspended from March 25, 2020, onwards. Traffic growth of low double digits was expected to continue over the short term but for the pandemic. Domestic flights were allowed to resume from May 25, 2020, onwards, but with number of flights limited to one-third of the pre-Covid flight capacity. The limits were raised progressively as passenger traffic reached 80% of pre-Covid levels. The cap was reduced to 50% on June 1, 2021, amid the severe delta wave. The passenger carrying limit was finally abolished on October 18, 2021.

Domestic passenger traffic rose to 98% of pre-Covid levels in May. However, because of high airfares and the onset of seasonally weak second quarter of the fiscal, passenger traffic dropped to 88% of pre-Covid levels in September and reached 98% in October 2022.

**Figure 32: Monthly domestic passenger traffic recovered to 98% of pre-pandemic level in October 2022**

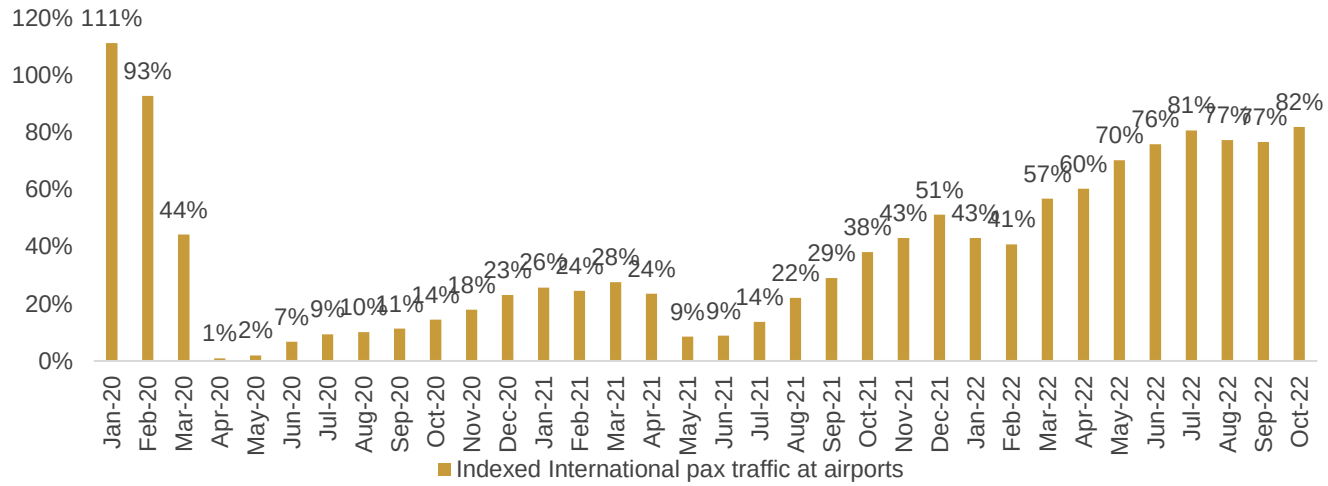


Note: Traffic indexed to CY19 base

*Source: AAI, CRISIL MI&A Research*

On the international front, unscheduled services under the Vande Bharat Mission were allowed to operate from May 7, 2020, onwards for repatriation of passengers. These services were expanded to bilateral bubble arrangements later. Around 37 bilateral bubbles were operationalised in the interim. Scheduled services were allowed to resume only from March 27, 2022, onwards. International passenger traffic recovered to 81% of pre-Covid levels in July 2022, in just four months of resuming scheduled international services. It reached 82% of pre-Covid levels in October 2022.

**Figure 33: International passenger traffic recovered to 82% of pre-pandemic level in October 2022**

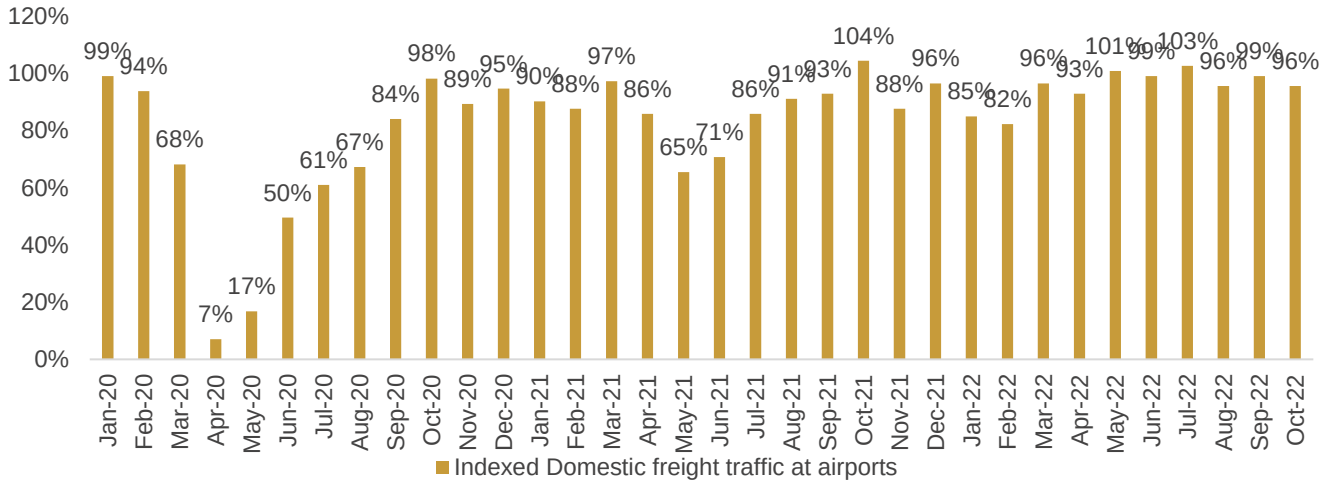



Note: Traffic indexed to CY19 base

*Source: AAI, CRISIL MI&A Research*

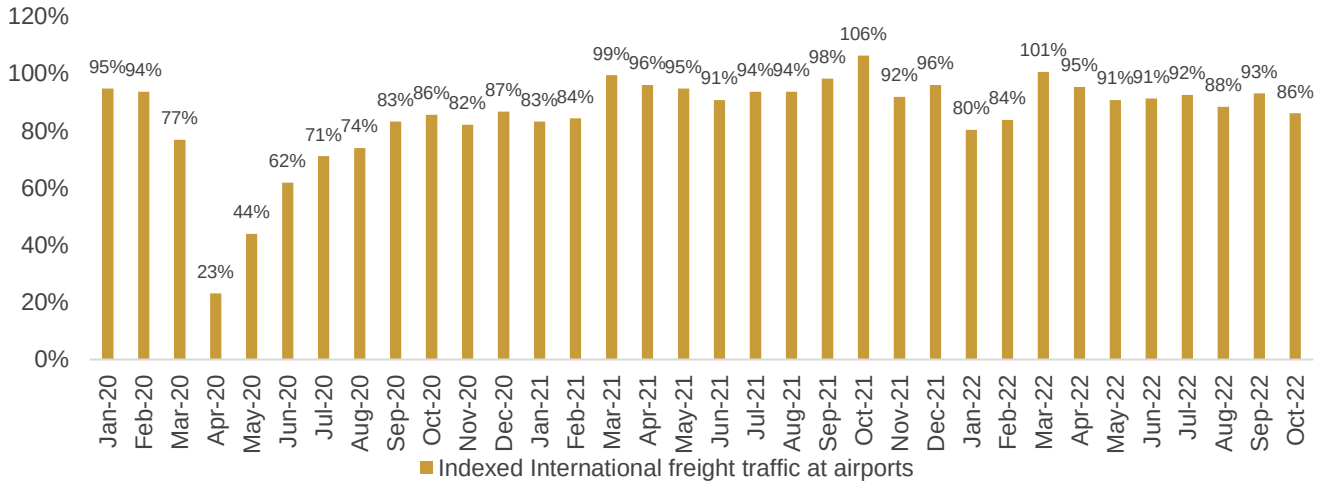
Domestic and international freight traffic reached 96% and 88% of pre-pandemic levels, respectively, in August 2022, attributable to (i) recovery of economic activities leading to rising demand for freight; (ii) transportation of vaccines via air; (iii) need for faster transportation of goods due to supply-chain bottlenecks; (iv) rising shipping constraints and high prices reducing the gap between air freight and ocean freight; (v) no material impact of Covid-19 caseloads on freight traffic (has higher dependence on economic conditions); and (vi) demand for trans-shipment to the EU and the US from neighbouring export nations such as Bangladesh and Vietnam.

**Figure 34: Monthly domestic freight traffic recovered to 96% of pre-pandemic level in October 2022**




*Source: AAI, CRISIL MI&A Research*

**Figure 35: Monthly international freight traffic recovered to 86% of pre-pandemic level in October 2022**



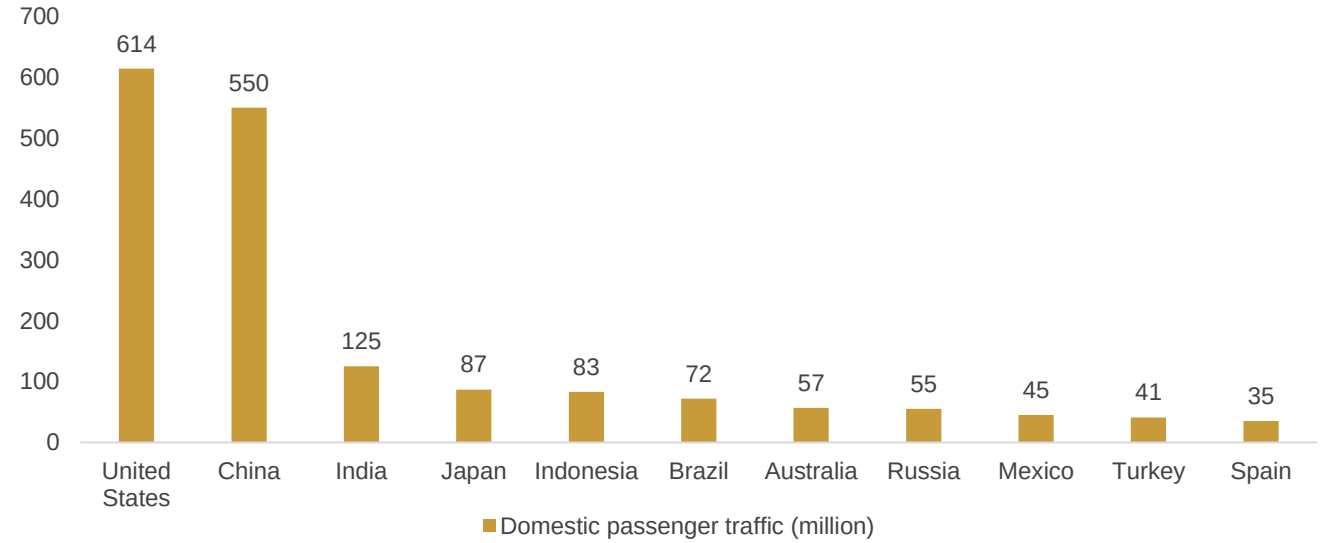

*Source: AAI, CRISIL MI&A Research*

## Indian aviation sector

### Passenger traffic at Indian airports

Passenger traffic at Indian airports logged a 12% CAGR between fiscals 2015-20, attributable to i) the country's economic growth leading to rising disposable incomes; ii) more options for low-cost air travel; iii) narrowing price differential between air tickets and AC 2 tier fares; iv) lower air trips per capita compared with other developing nations; and v) increased air connectivity to Tier 2 and 3 cities. In 2019, India became the third-largest domestic civil aviation market in the world based on passengers flown, and it has immense potential to grow further.

**Figure 36: India became the third-largest domestic civil aviation market in CY19**




Note: Data as of CY19

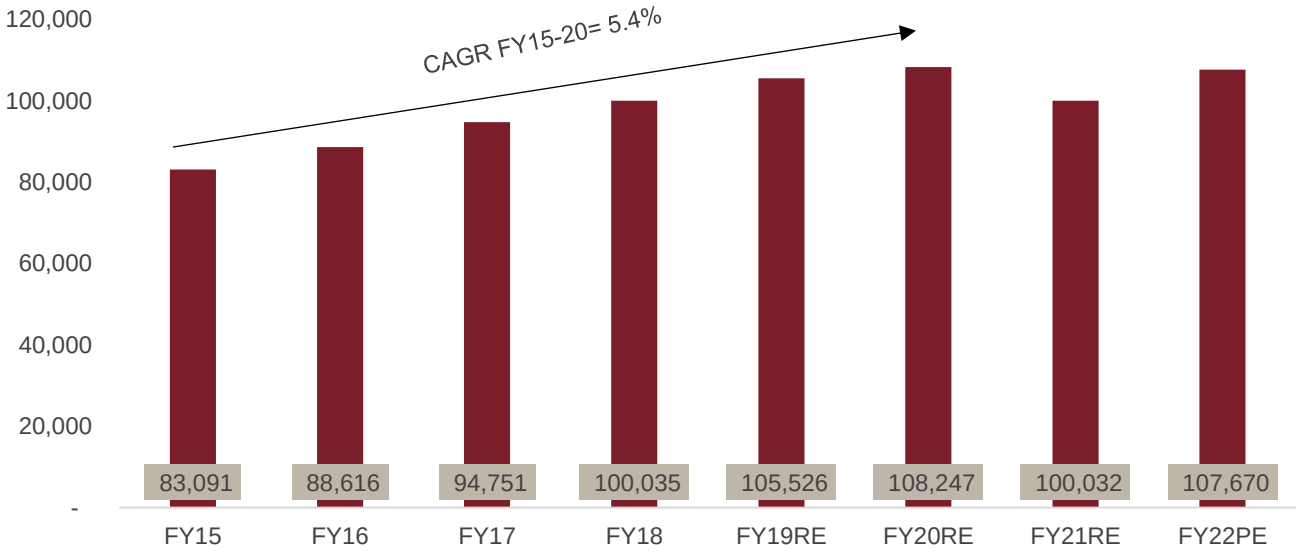
*Source: IATA, CRISIL MI&A Research*

Factors driving air passenger growth in India:

**1. Economic growth, increasing urbanisation and rising disposable income**

India's per-capita GDP recorded a 5.4% CAGR over fiscals 2015-20 on a real basis, rising from Rs 83,000 to Rs 108,000. In fiscal 2021, it declined 7.6% on-year to Rs 100,000 — fiscal 2018 levels — because of the Covid-19 pandemic-induced lockdown, which reduced incomes and resulted in a widespread loss of jobs. In fiscal 2022, it grew 7.6% on the low base, to Rs 108,000, marginally lower than pre-Covid levels of fiscal 2020.

**Figure 37: Per-capita GDP growth**



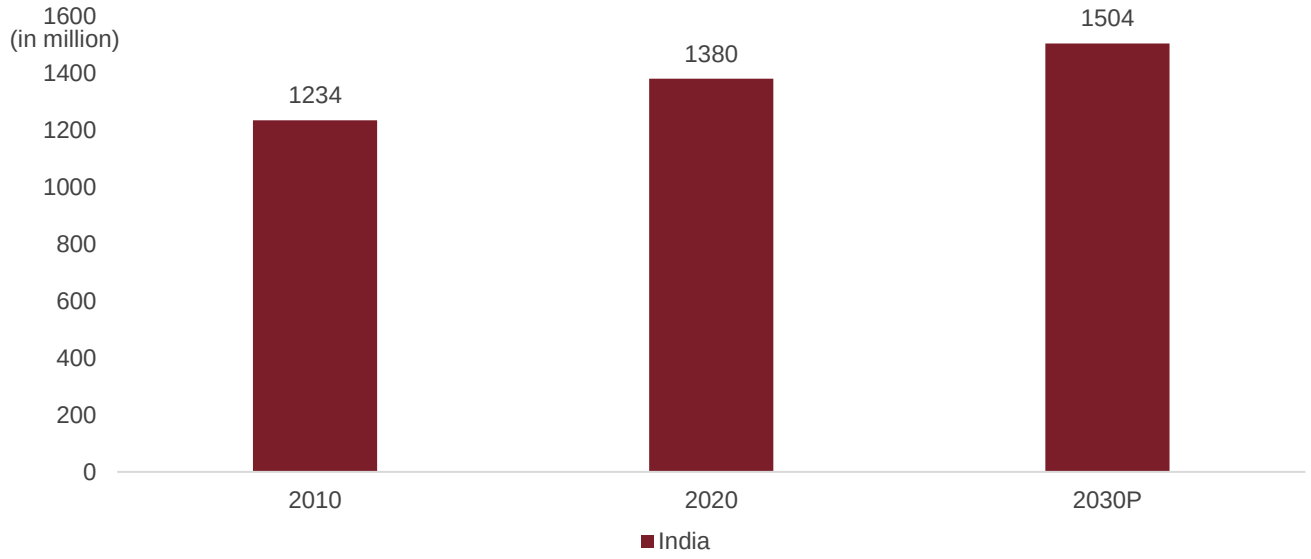

Note: Based on constant prices, 2011-12 base

*Source: National Accounts Statistics, CRISIL MI&A Research*

## Rapid urbanisation led by income expansion

India's population is expected to have recorded a 1.1% CAGR over 2010-20, rising from 1.2 billion to 1.38 billion. Over 2020-30, it is projected to expand at a 0.9% CAGR to about 1.5 billion.

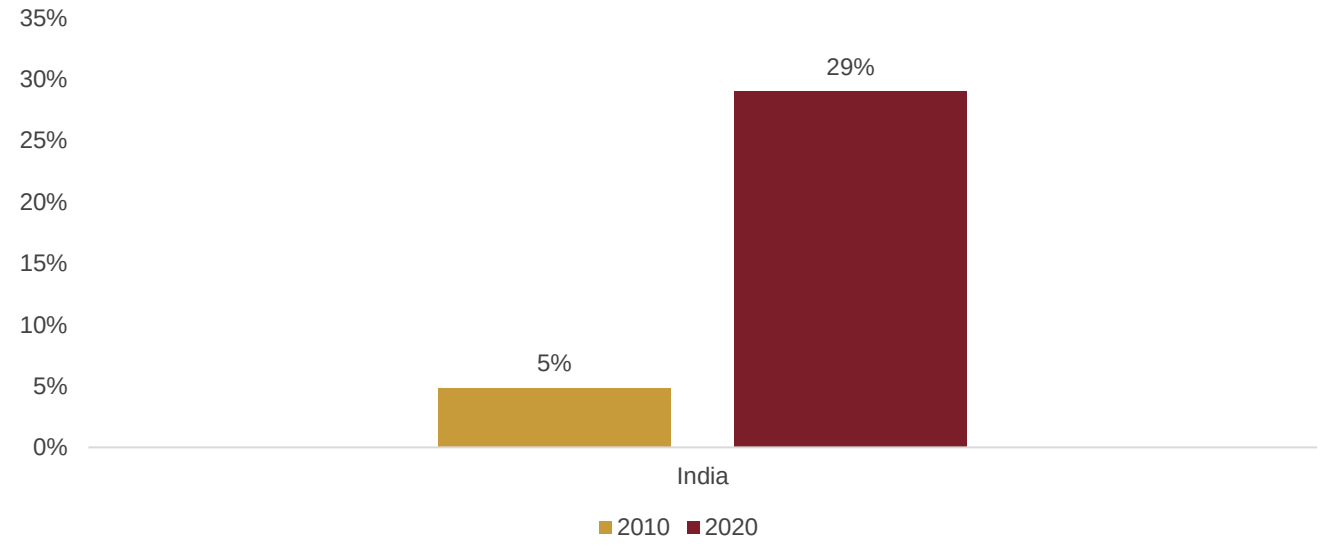
**Figure 38: Population growth in India**




*Source: World Bank, CRISIL MI&A Research*

Urbanisation is increasing worldwide as rural population moves towards urban areas in search of better livelihood. The share of people classified as middle class (defined as people spending between $10 and $110 per day in PPP terms on 2011 levels) was only 5% in India in 2010.

**Figure 39: Indian middle-class population estimated to have grown 6x in the past decade**

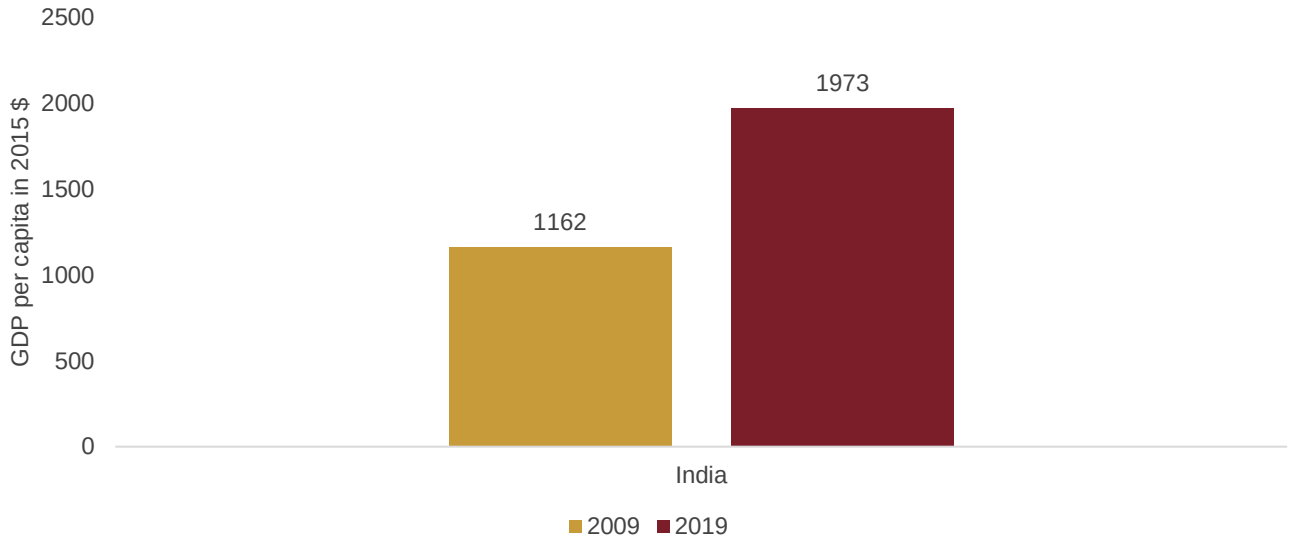



Note: Middle class is defined as people spending between $10 and $110 per day based on 2011 PPP levels

*Source: Population Projection report, 2020 by National Commission on Population, World Data Lab, United Nations, CRISIL MI&A Research*

The corresponding figures for 2020 is 29% driven by significant upliftment of the population from lower class attributable to the improvement in the Indian GDP. India's GDP per capita recorded a CAGR of 5.4% between 2009 and 2019 in fixed terms.

**Figure 40: GDP per capita for India**

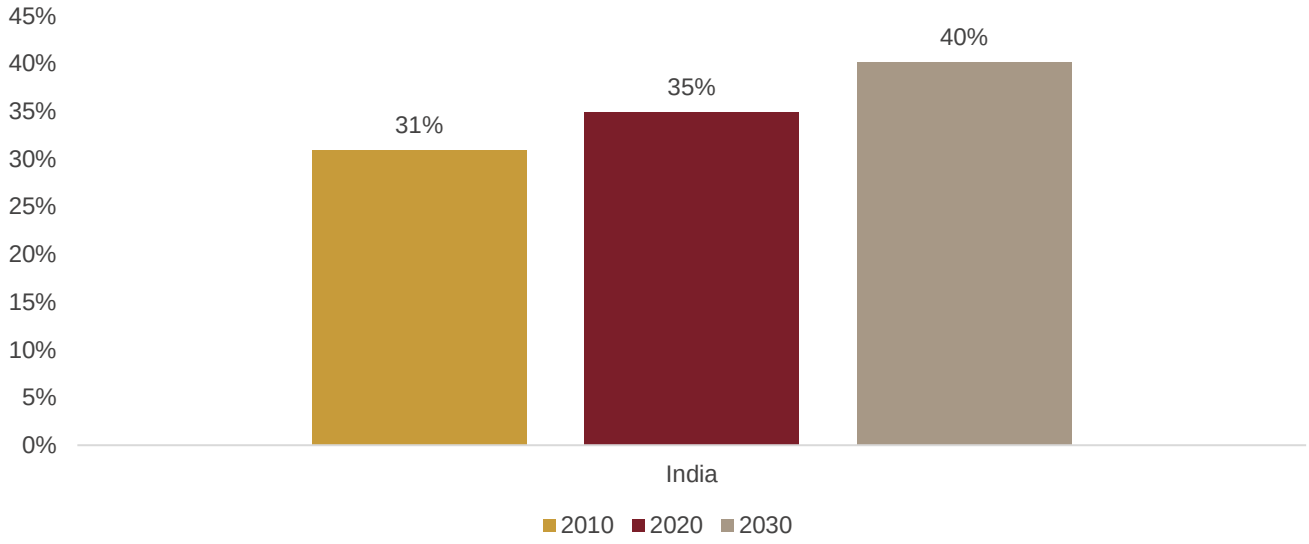



Note: GDP per capita in 2015 USD

*Source: World Bank, CRISIL MI&A Research*

Upliftment of the population and growing middle class have boosted urbanisation in India. The share of urban population in India was about 31% in 2010, which rose to 35% in 2020 and is projected to rise to 40% by 2030.

**Figure 41: Rapid urbanisation in India**

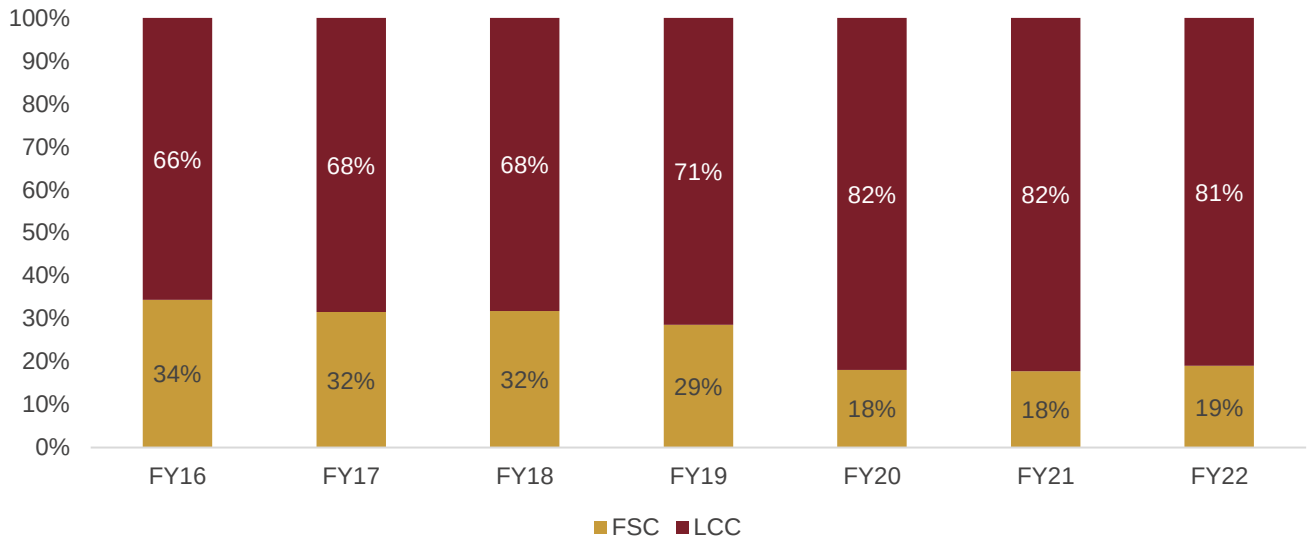



*Source: World Bank, CRISIL MI&A Research*

**2. LCCs boost affordability**

Low-cost carriers (LCCs) have grown to occupy a lion's share in the domestic civil aviation market, led by the rise of players such as IndiGo, SpiceJet and Go First, and the grounding of Jet Airways, leaving only Air India and Vistara as full-service carriers (FSCs) in the market. FSCs, too, have launched hybrid services. LCCs' share of revenue passenger kilometres (RPKs) rose to 81% in fiscal 2022 from 66% in fiscal 2016.

**Figure 42: Domestic aviation market dominated by LCCs**

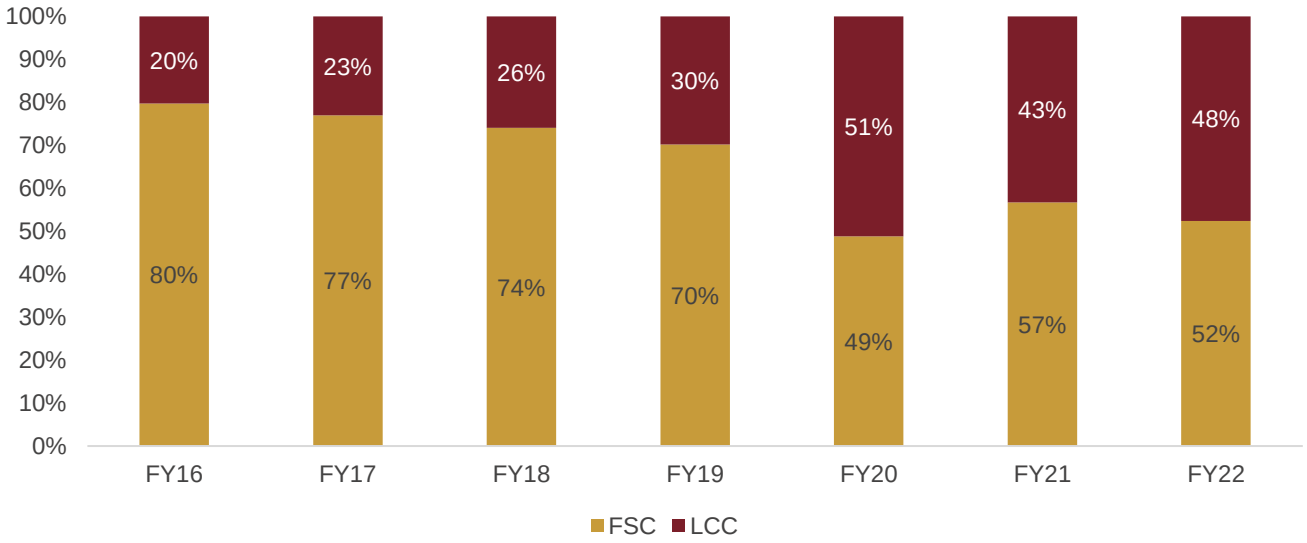



Note: Based on RPK

*Source: DGCA, CRISIL MI&A Research*

The international segment was dominated by FSCs as Air India and Jet Airways were the only carriers deploying widebody aircraft capable of performing non-stop medium- to long-haul flights. Indian LCCs started exploring and doubling down on short- and medium-haul international operations aided by induction of newer-generation aircraft capable of performing medium-haul non-stop operations. Moreover, customer willingness to fly LCCs on international routes also increased, driven by better frequencies and lower ticket prices. Overall, the share of LCCs in international routes rose to 48% in fiscal 2022 from 20% in fiscal 2016. The grounding of Jet Airways in fiscal 2020 hastened the transition as the traffic on short-haul routes was captured by LCCs.

**Figure 43: LCCs gaining share in international operations**




Note: Based on RPK

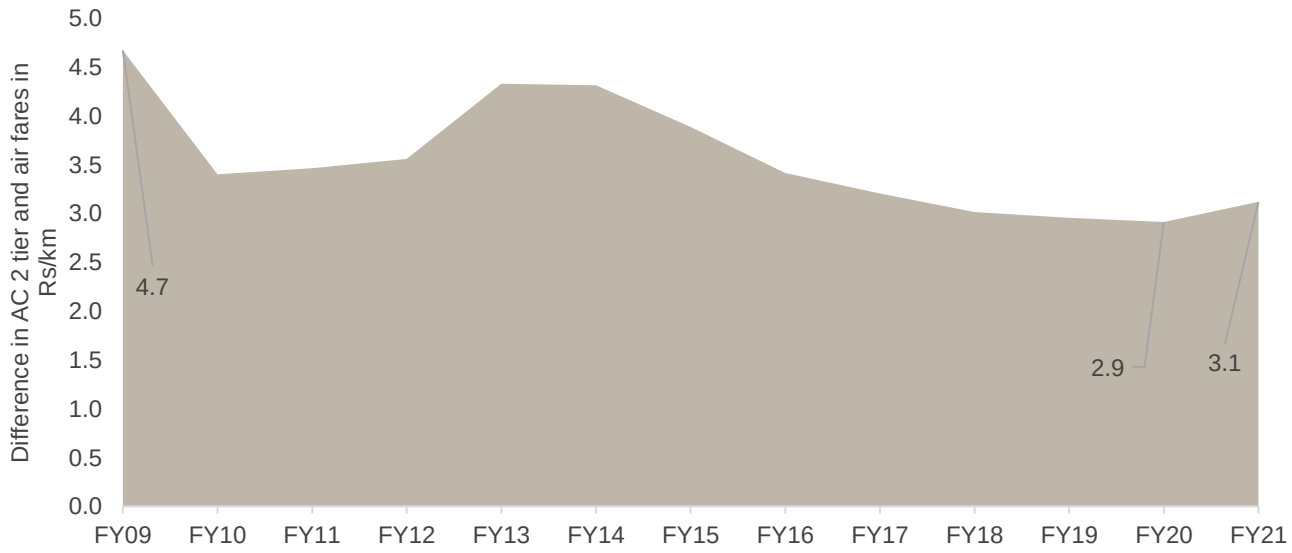
*Source: DGCA, CRISIL MI&A Research*

The increasing popularity of LCCs and intense competition have led to a drop in airfares on both domestic and international routes, leading to higher number of price-elastic Indian passengers taking to the air.

### 3. Narrowing price differential between air tickets and AC 2 tier fares

Rising competitive intensity between Indian airlines, increasing share of LCCs and technological advancements have led to airfares falling over the years. On the flip side, reduced subsidisation of passenger fares by India Railways and the introduction of dynamic fares on some routes have led to a rise in railway fares per km. The difference between per-km cost of AC 2 tier vs airlines reduced to about Rs 2.9 in fiscal 2020 from ~Rs 5 in fiscal 2009. This, coupled with the time advantage of air travel, is boosting domestic air passenger numbers.

**Figure 44: Fare differential narrowing between AC 2 tier and flight tickets**

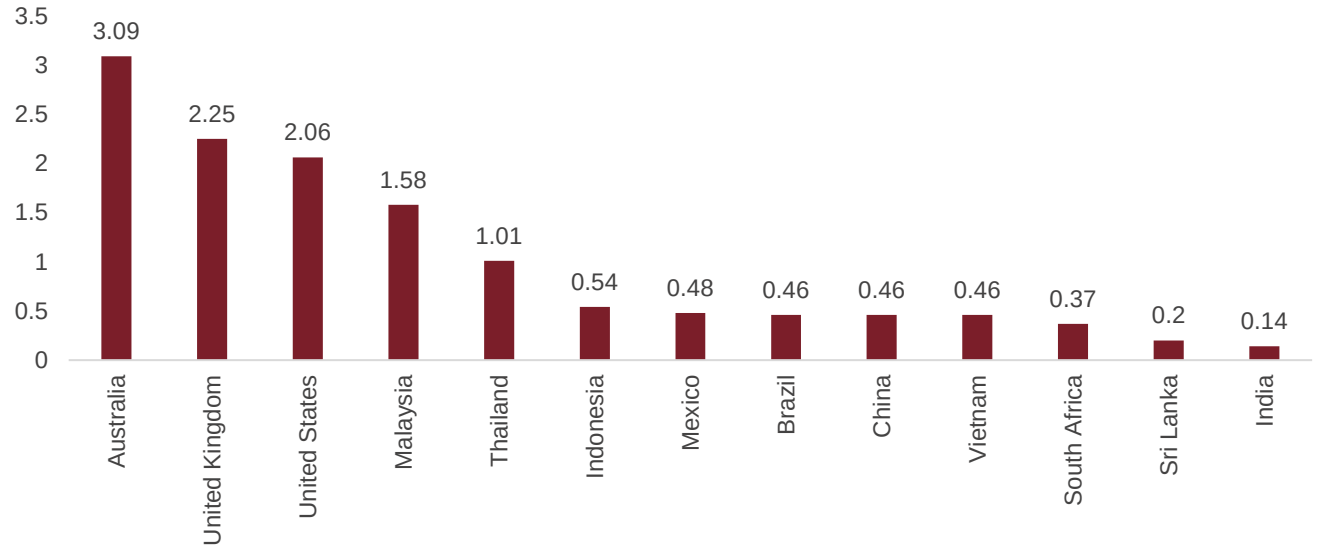



*Source: Indian Railways, company reports, CRISIL MI&A Research*

### 4. Lower air trips per capita

As of calendar year 2019, India ranked 147 among 203 countries based on the number of air trips per capita at 0.14, below other developing nations such as Indonesia, Sri Lanka, Mexico, Vietnam and South Africa.

**Figure 45: India among the lowest-ranked developing countries in air trips per capita**

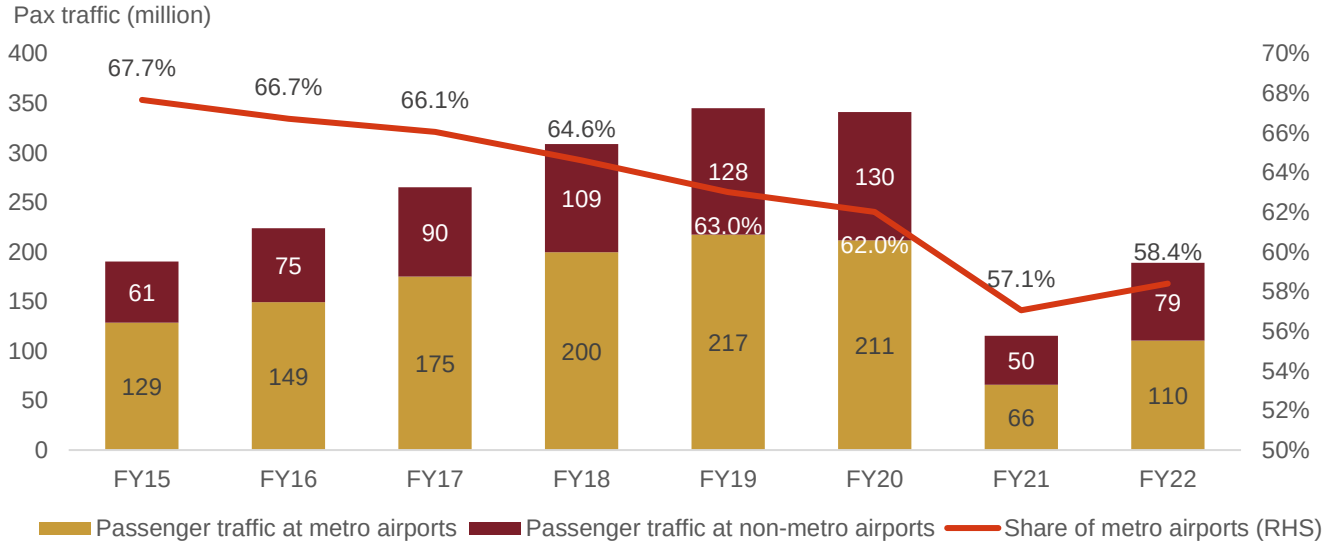



*Source: Airbus commercial market forecast 2019, CRISIL MI&A Research*

### 5. Connectivity beyond metro cities

Metro airports accounted for 68% of air passenger traffic in fiscal 2015. However, owing to the rise in demand for air travel from non-metro destinations, improvement in airport infrastructure in non-metro cities, availability of high-yielding traffic and rising congestion at metro airports, airlines have increasingly started looking at serving non-metro destinations. The UDAN scheme has also helped popularise air travel in these cities. Passenger traffic at metro airports logged a 10.4% CAGR over fiscals 2015-20, from 129 million to 211 million, while non-metro passenger traffic clocked a 16% to reach 130 million in fiscal 2020, from a lower base of 61 million.

**Figure 46: Share of metro traffic down 927 bps in fiscal 2022 from fiscal 2015 levels**



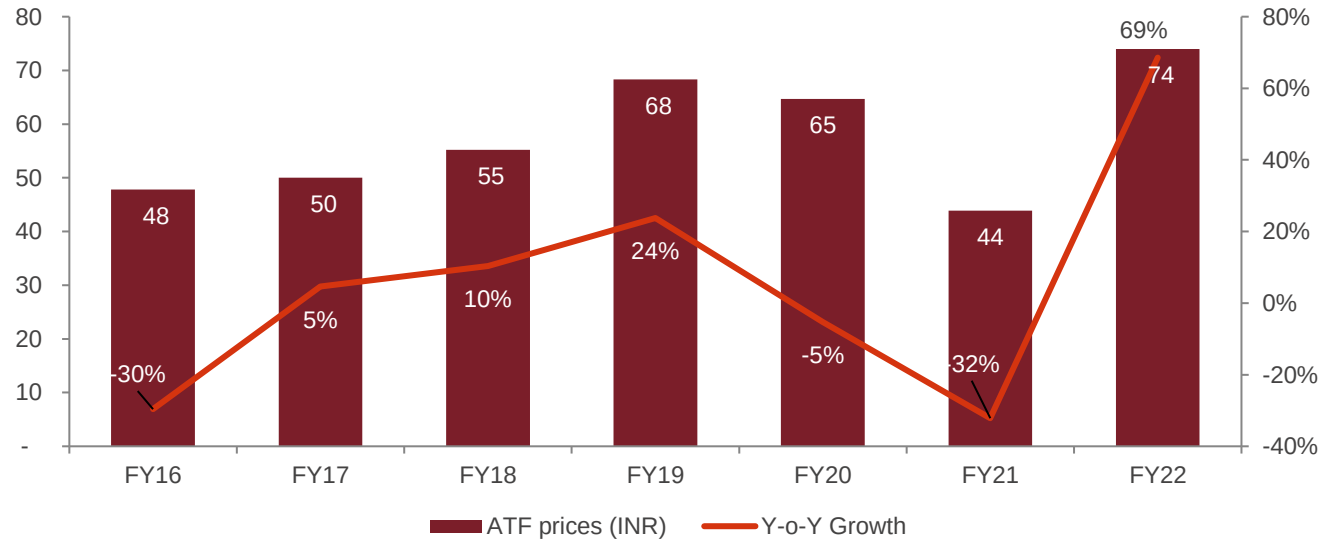
*Source: AAI, CRISIL MI&A Research*

## Challenges faced by the aviation sector and airport operators

### Airlines

Aviation turbine fuel(ATF) accounts for 25-40% of an airlines cost base. ATF price jumped 69% on-year in fiscal 2022, resulting in high airfares. Airline profitability is inversely proportional to ATF rates.

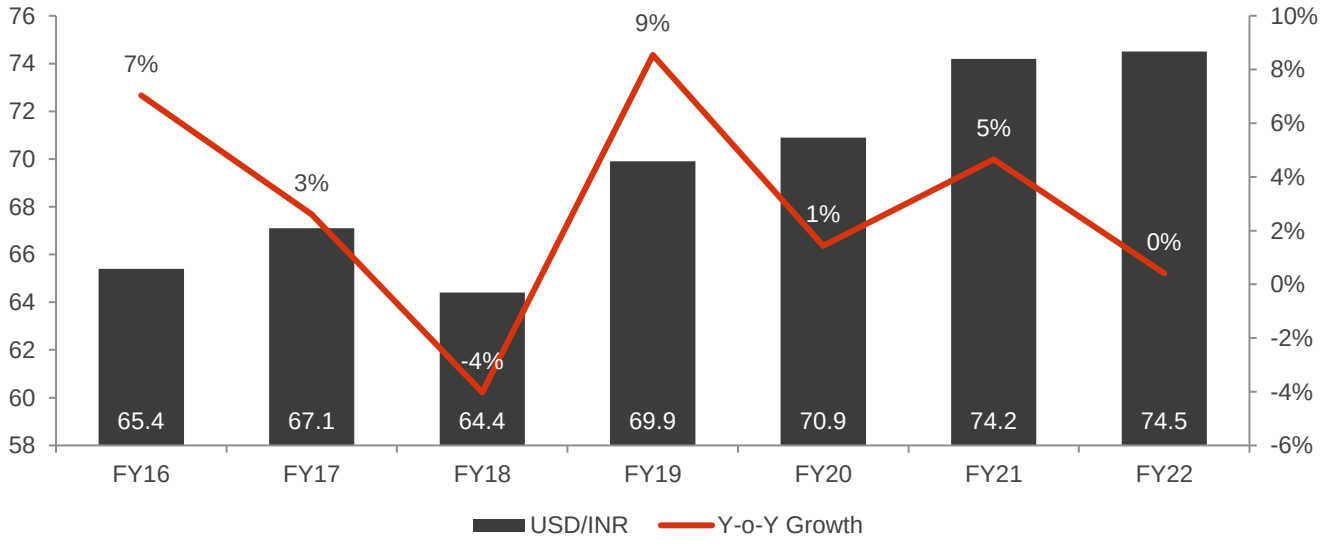
**Figure 47: Annual change in ATF prices per litre**




*Source: CRISIL MI&A Research*

About 40-50% of an airline's expenses are dollar-denominated. Adverse movement of the dollar impacts airline profitability.

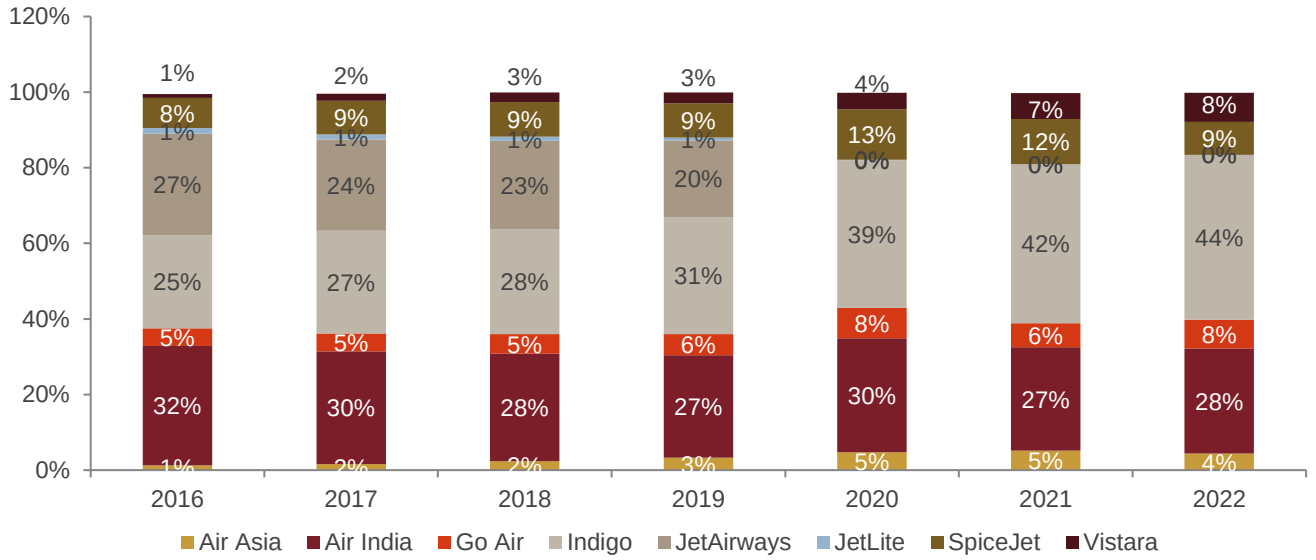
**Figure 48: Annual change in forex rates**



*Source: CRISIL MI&A Research*

Airlines have limited pricing power due to intense domestic competition from new entrants and high elastic demand.

**Figure 49: Intense competition in the Indian market**




Note: Comparison based on RPK

*Source: DGCA, CRISIL MI&A Research*

In recent years, technical issues resulting in grounding of aircraft (for example, 737 Max, A320 neo engines and 787 engine issue) have impacted network planning and route deployment, leading to a shortfall in planned capacity. Airlines explore short-term leasing of aircraft from the secondary market often at higher rates to meet the shortfall, impacting profitability.

**Airports**

Government policies, competition and cash-flow mismatch are the key risk factors impacting profitability of the airport sector.

Airport operators face delays in tariff determination and passing of control orders by AERA, which leads to over/under-recovery of revenues and cash-flow mismatches.

Competition in the sector is growing with upcoming secondary airports, while establishment of new airports is also reducing the catchment area of an airport. The upcoming Jewar Airport would provide stiff competition to Delhi Airport with traffic likely to be weaned away by Jewar. Operationalisation of Kannur Airport adds added competition in the southern airports in Tamil Nadu and Kerala, while smaller AAI airports opening up under UDAN would wean away traffic from the larger established PPP airports.

The development of super expressways would also see some passenger and freight traffic shifting away from airlines.

There have been cost escalations at BOT airports compared with initial costs when they started their construction. However, AERA considers the project cost escalation in the tariff model determination provided it is not related to the delays on account of the concessionaire. Moreover, most of the difference in operating expenses is trued up based on such rise. On account of true-ups, there is no impact on returns, but cash flows get impacted.

**Change in government policy**

Change in the government's stance on the model of operation for airports will impact profitability of airports as it will change the regulated and unregulated part of revenue.

Earlier, airports in India operated on a single- or hybrid-till model. During allocation of four PPP airports, Delhi and Mumbai airports were offered under a 30% hybrid-till model; Bengaluru under a 40% hybrid-till model; and Hyderabad under a single-till model.

As per the National Civil Aviation Policy, 2016, the government has standardised the 30% hybrid-till model across all major airports in India.

**Delays in land monetisation**

Typically, non-aeronautical revenue accounts for 30-40% of the total revenue depending on various factors. During allocation of airports under the PPP model, the government earmarked certain areas of land for commercialisation by airports. The earnings were unregulated. However, there has been a significant delay in monetising land, impacting the overall return generated by airports. For instance, in the case of DIAL, about 55% of the land has been monetised to date. For GHIAL, about 6% of the land has been monetised to date, while in the case of MIAL, only 3% has been monetised so far. No land has been monetised to date in the case of BIAL.

**Short-term cash-flow mismatch due to delays in true-ups**

AERA has defined control period as a period of five years to determine tariffs based on actual financials vis-à-vis projected financials. Most of the regulated revenue for airports is subject to a true-up based on the shortfall or excess collections compared with forecast revenue for that period. This true-up is considered to determine the tariff for future control period.

Risks such as fall in passenger traffic below forecasts, discontinuance of airline operations, change in hub airports and cost overruns (which are beyond the control of management) are considered in the true-up. However, the true-up is done on a five-year basis during the determination of tariffs. This can lead to a mismatch in cash flows for airports during intermittent periods based on the level of over/under-recovery in revenue during the previous control period, expansions planned and passenger traffic.

**History of privatisation**

The first Indian airport to be privatised in India was Cochin airport in 1999, followed by Hyderabad in 2002 and Bengaluru in 2004.

In 2003, the AAI Board approved the modernisation proposal for the two largest airports in the country — Delhi and Mumbai. The government announced the modernisation plan in 2004 and offered 74% of the ownership stake in Mumbai and Delhi Airports to private players, keeping 26% for itself. Foreign direct investment (FDI) was allowed up to 49% of the 74% private ownership. Post the privatisation of Delhi, Mumbai, Bangalore, Hyderabad and Cochin airports, Kannur airport was developed on a PPP basis.

The AAI outlined six airports for privatisation, which were ultimately won by Adani Enterprises in 2019.

**Table 10: List of bidders for past airport monetisation**

| Mumbai | Delhi | Ahmedabad | Mangalore | Guwahati | Thiruvananthapuram | Jewar | Bhogapuram |
|---|---|---|---|---|---|---|---|
| **GVK Group / Adani Enterprises*** | **GMR Consortium** | **Adani Enterprises** | **Adani Enterprises** | **Adani Enterprises** | **Adani Enterprises** | **Zurich Airports** | **GMR Group** |
| GMR Consortium | Reliance Consortium | GMR Group | GMR Group | GMR Group | GMR Group | Delhi International Airport Ltd** | DOIT Smart Infra |
| Essel-TAV Consortium | Essel-TAV Consortium | AMP Capital | Cochin International Airport Ltd | AMP Capital | KSIDC | Adani Enterprises | GVK Group |
| DS Construction Consortium | DS Construction Consortium | Autostrade | - | PNC Infrastructure | - | Anchorage Infrastructure | |
| Macquarie Consortium | Macquarie Consortium. | Fairfax India Holding | - | Autostrade | - | | |
| Reliance Consortium | - | PNC Infrastructure | - | Fairfax India Holding | - | | |
| - | - | NIIF and Zurich AG Consortium | - | - | - | | |

*Adani Enterprises took over management of Mumbai airport from GVK Group in July 2021

**GMR Group-led consortium comprising Delhi International Airport Ltd (DIAL)

*Source: CRISIL MI&A Research*

In August 2021, the government identified 25 AAI airports for asset monetisation under the National Monetisation Pipeline. The airports for privatisation were identified based on two criteria: i) annual passenger traffic above 0.4 million in 2019 and 2020 and ii) airports with a sizeable ongoing/proposed capex plan as per the National Infrastructure Pipeline (NIP).

## Qualitative performance of private airports

Airports under the National Monetisation Pipeline (Phase 3) were growing faster but were loss-making before Covid-19 struck. In the first half of fiscal 2023, domestic passenger traffic at Phase 1 airports reached 91% of the pre-Covid level, and international passenger traffic recovered to 78% of pre-Covid levels.

Freight traffic was dominated by PPP airports (Phase 1 and 2); however, Phase 3 airports witnessed declining domestic freight traffic.

**Table 11: Qualitative performance of private airports**

| | Phase 1 | Phase 2 | Phase 3 |
|---|---|---|---|
| | DEL, BOM, BLR, HYD, COK, CNN | AMD, JAI, LKO, GAU, IXE, TRV | 25 airports |
| | CAGR/ Share in overall market/ 1HFY23 as % of 1HFY20 | CAGR/ Share in overall market/ 1HFY23 as % of 1HFY20 | CAGR/ Share in overall market/ 1HFY23 as % of 1HFY20 |
| Domestic pax traffic | 9.5% / 49% / 91% | 18% / 9% / 83% | 18% / 20% / 86% |
| International pax traffic | 4% / 68% / 78% | 7% / 10% / 73% | 6% / 18% / 76% |
| Domestic freight traffic | 6% / 62% / 95% | 13% / 8% / 94% | 5% / 14% / 107% |
| International freight traffic | 5% / 79% / 94% | 10% / 4% / 78% | 5% / 15% / 89% |
| Net profit over FY18-FY20 (Rs crore) | 4,061* | 652 | (899) |

*Numbers do not include financials for KIAL as they are not available for the 3-year period

Note: In case of passenger and freight traffic, Green – Faster than all Indian airports; Amber – In line with all Indian airports; Red – Slower than all Indian airports

*Source: Company reports, AAI, CRISIL MI&A Research*

## New models of private sector participation

### New airport tariff model

AERA is responsible for creating a level-playing field and fostering healthy competition among all major airports; encouraging investment for building new airport infrastructure; regulating tariffs of aeronautical services; protecting the interest of fliers; operating efficient, economically viable airports; fixing tariffs for aeronautical services; funding airport expansion projects; and ensuring timely completion of connectivity projects. Also, airport operators need to be proactive in explaining their point of view to the authorities in fixing tariffs for all regulated charges and charges such as user development fees.

AERA follows a 'fixed return on equity'-based model to determine tariffs. Under the current tariff model, the regulator has significantly reduced the risk for airport operators by accommodating under- and over-recoveries in revenues compared with pre-determined levels. These lower/higher revenues are adjusted (called as true-ups) accordingly during the determination of tariff in subsequent control periods. AERA considers the following areas for true-ups:

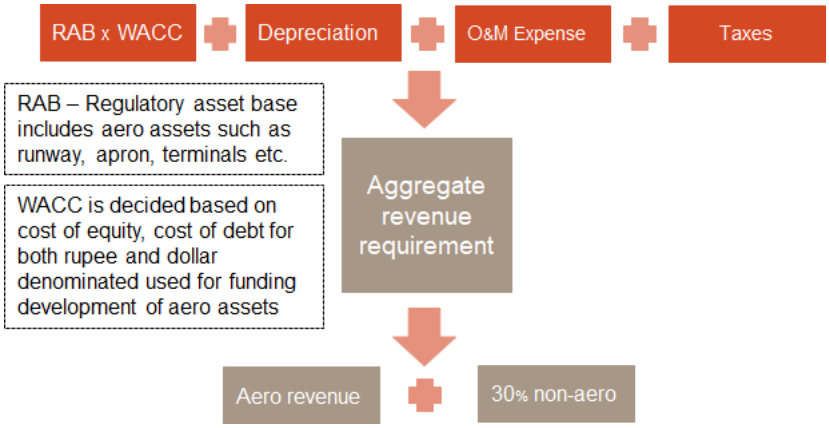
i. Operating and maintenance expenses
ii. Cost of debt, subject to a certain ceiling in interest rate
iii. Corporate taxes on aeronautical services
iv. Change in allocation mix of aeronautical and non-aeronautical assets for additions
v. Delay in tariff implementation
vi. Change in mix of debt and equity

As per the National Civil Aviation Policy, 2016, all major airports operate under a 30% hybrid-till tariff model, where aggregate revenue requirement (ARR) from aeronautical activity is cross-subsidised with 30% revenue from non-aeronautical activities.

Aeronautical tariffs are set by AERA after considering the following:

i. Weighted average cost of capital (WACC)
ii. Project cost and means of finance
iii. Regulatory asset base (RAB) on which returns will be calculated
iv. Passenger traffic forecast for the next control period
v. Aeronautical revenue over/under-recovery for the previous control period

**Figure 50: Aggregate revenue requirement for an airport**



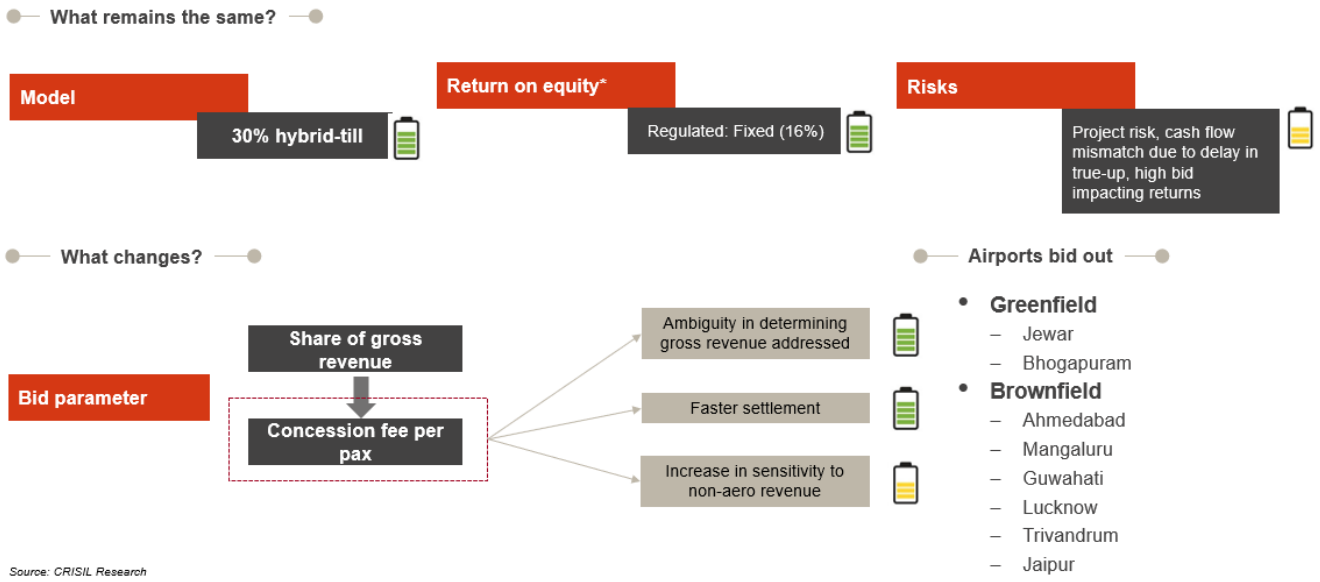

*Note: WACC is decided on cost of debt and cost of equity basis normalised debt-equity ratio*

*Source: CRISIL MI&A Research*

## AERA orders 30% hybrid till model for tariff setting

In the 30% hybrid till model, ARR from aeronautical revenue is cross-subsidised, with 30% of revenue from non-aeronautical activity.

**Figure 51: Change in new bidding model**




*Source: CRISIL MI&A Research*

**Table 12: Key revenue streams for airports**

| Aeronautical revenue | Non-aeronautical revenue |
|---|---|
| Landing charges | Retail – including duty free, lounges |
| Parking charges | Car park |
| Housing charges | Space rentals |
| User development fees | Food and beverages |
| Fuel farm | Advertising |
| X-ray baggage charges | Cargo |
| | Ground handling |
| | Others |

*Source: CRISIL MI&A Research*

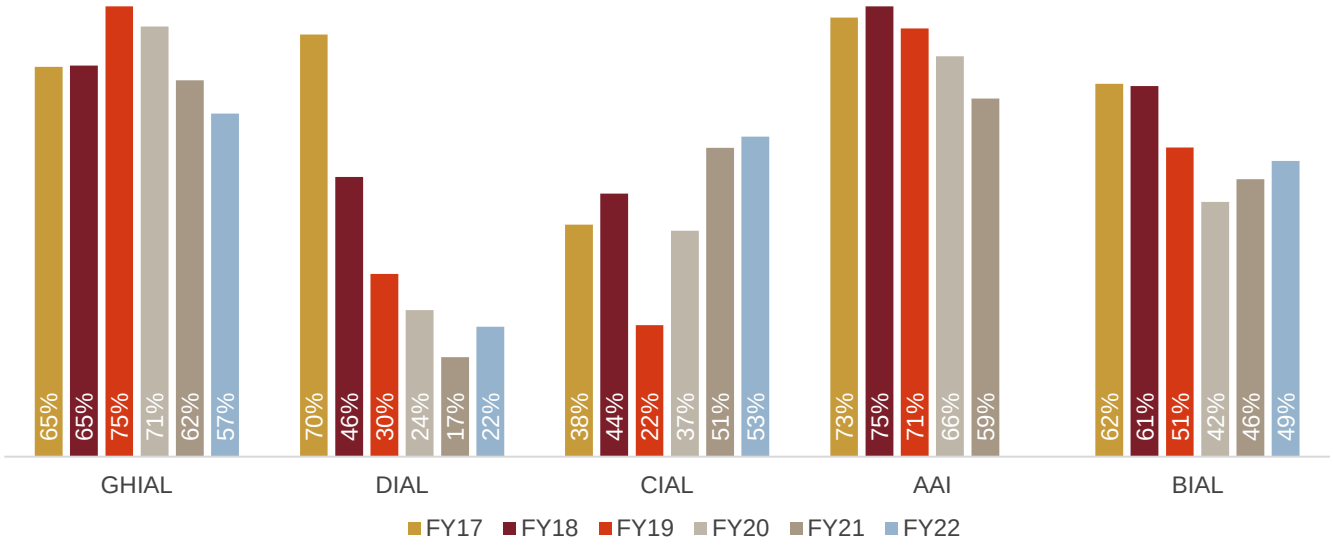
## Aeronautical revenue

Aeronautical revenue is generated from an array of charges and fees that are levied on aircraft operators and passengers for airport facilities and services. Aeronautical charges are determined by the AERA for major airports, airports with annual passenger traffic of more than 3.5 million passengers or any other airport notified as major airport by the central government and also a group of airports notified by the central government.

- For aircraft operators – These charges are usually based on an aircraft weight formula and include landing, parking and housing charges
- For passengers – Collected by carriers for the airport, these include aviation security fee, user development fee and are accrued on a per passenger basis

The share of aeronautical revenue has averaged around 52% for the PPP airports over fiscals 2017 to 2022 with non-aeronautical revenue accounting for the rest. The high variation in aeronautical revenue can be explained by the user development fee (UDF). The imposition of a UDF leads to higher share of aeronautical revenue.

**Fig 52: Aeronautical revenue share across Indian airports**




Note: 1. Cargo and GH have been considered under non-aeronautical revenue across all airports

2. Only aeronautical and non-aeronautical revenue have been considered for AAI; ANS and revenue share from PPP airports have not been considered

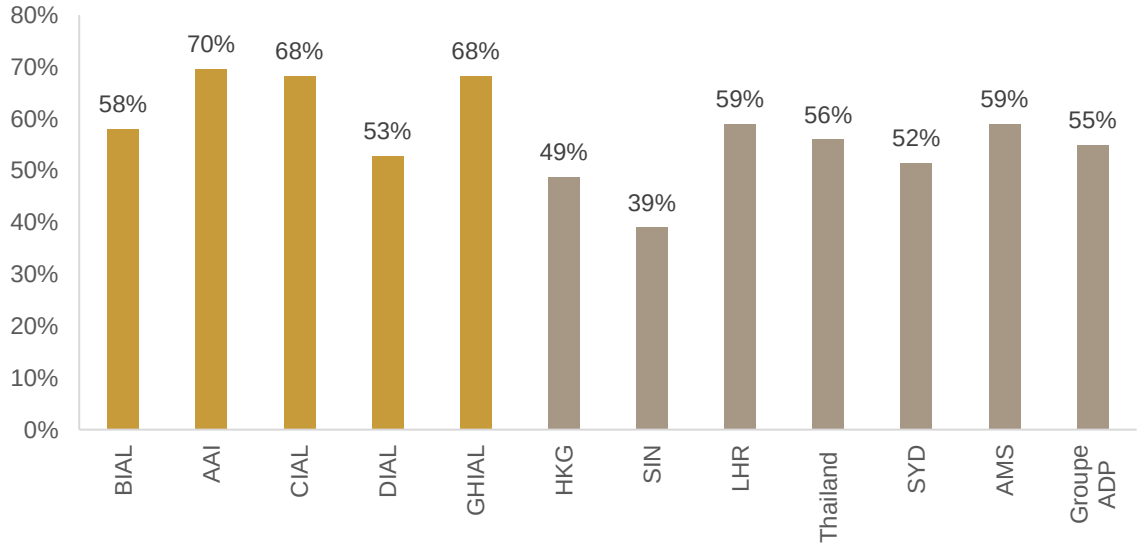
3. FY22 data is not available for AAI airports.

*Source: Company reports, CRISIL MI&A Research*

### Global comparison of aeronautical revenue

The share of aeronautical revenue of Indian airports is similar to those of global airports.

**Fig 53: Global benchmarking of share of aeronautical revenue across airports**




Note: 3-year average over FY17 to FY19 has been considered for data on Indian airports, HKG and SIN;
3-year average over 2017-2019 has been considered for LHR, SYD, AMS, Groupe ADP

3-year average FY17-19 (October-September fiscal pattern) considered for Thailand airports
AAI revenue excludes revenue from air navigation services and revenue share receipts from the PPP airports
*Source: Company reports, CRISIL MI&A Research*

## Non-aeronautical revenue

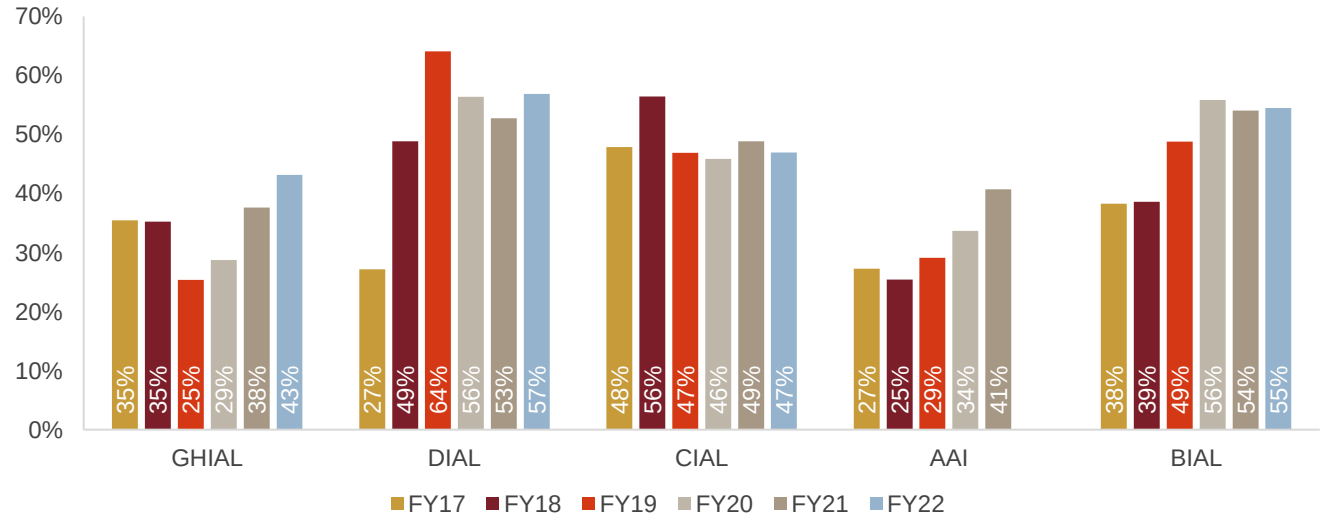
Non-aeronautical revenue collections play a significant role in the profitability of Indian airports as only 30% of non-aeronautical revenue is used to subsidise aeronautical revenue to arrive at the aggregate revenue requirement and airport operators have pricing freedom in non-aeronautical revenue heads.

**Non-aeronautical revenue can be broadly divided into the following heads**

1. Duty-free
2. Retail
3. Food and Beverages (F&B)
4. Advertisement
5. Space Rentals
6. Cargo
7. Ground Handling
8. Others

Others includes car park, taxi, ground transportation, lounges, foreign exchange counters, banks, etc.

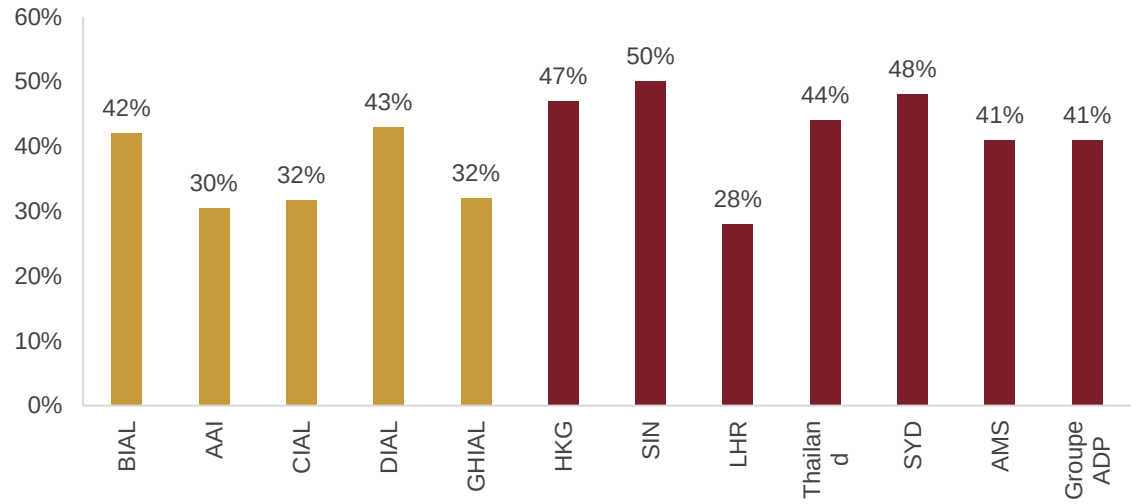
**Fig 54: Non-aeronautical revenue contribution across Indian airports**




Note: 1. Cargo and GH have been considered under non-aeronautical revenue across all airports
2. Only aeronautical and non-aeronautical revenue have been considered for AAI; ANS and revenue share from PPP airports have not been considered
3. FY22 data not available for AAI airports
*Source: Company reports, CRISIL MI&A Research*

The contribution of non-aeronautical revenue heads for Indian airports is similar to global airports.

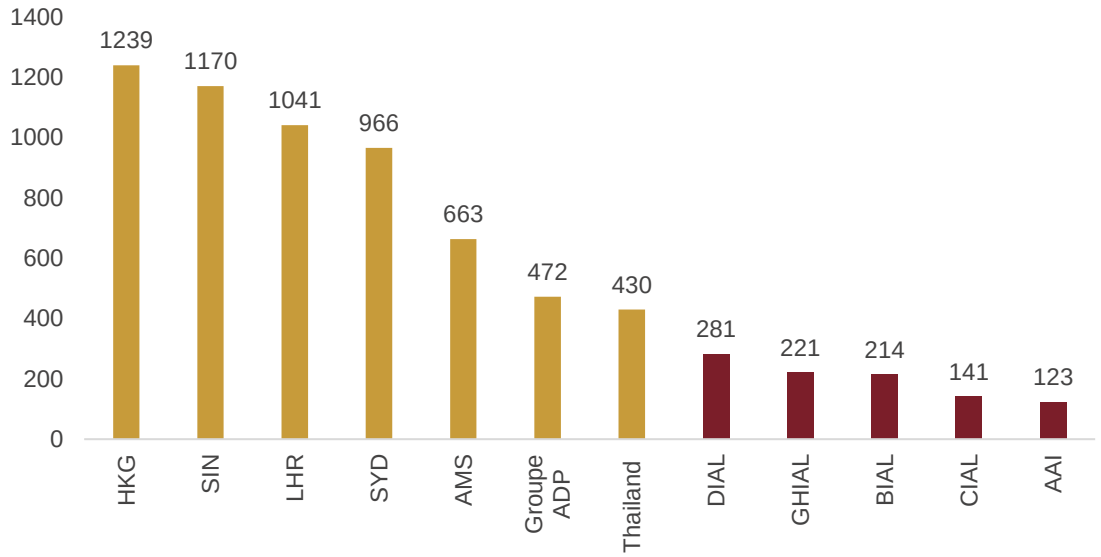
**Fig 55: Non-aeronautical revenue share comparison across Indian and global airports**




Note: 3-year average over FY17-FY19 considered for data on Indian airports, HKG and SIN;
3-year average over 2017-2019 considered for LHR, SYD, AMS, Groupe ADP
3-year average of October-September FY17-FY19 has been considered for Thailand airports
AAI revenue excludes revenue from air navigation services and revenue share receipts from the PPP airports
*Source: Company reports, CRISIL MI&A Research*

While the share of non-aeronautical revenue may be in line for Indian airports when compared with global airports, the difference in spending power per passenger is visible when comparing non-aeronautical spends per passenger.

**Fig 56: Non-aeronautical revenue per passenger**




Note:1) Non-aeronautical spends over FY17-19 considered for Indian airports, HKG and SIN 2) 3-year average over CY2017-2019 considered for LHR, SYD, AMS, Groupe ADP 3) Three-year average of October-September FY17-19 considered for Thailand airports 4) Exchange rates as of April 20, 2022 considered 5) CIAL data does not include duty-free revenues
*Source: CRISIL MI&A Research*

### *Steps taken by government to push privatisation*

Under the National Monetisation Pipeline, 25 airports have been identified for monetisation. Some of the identified airports are loss-making, and hence bundling of these airports with profit-making airports may be considered as per the National Monetisation Pipeline document.

**Table 13: Airports identified for monetisation accounted for 20% of passenger traffic in fiscal 2020**

| Fiscal 2022 | Fiscal 2023 | Fiscal 2024 | Fiscal 2025 |
|---|---|---|---|
| Bhubaneswar (3.6) | Calicut (3) | Chennai (22.2) | Imphal (1.3) |
| Varanasi (3) | Coimbatore (2.8) | Vijayawada (1.1) | Agartala (1.5) |
| Amritsar (2.5) | Nagpur (3.1) | Tirupati (0.8) | Udaipur (1.2) |
| Trichy (1.6) | Patna (4.5) | Vadodara (1.1) | Dehradun (1.3) |
| Indore (2.9) | Madurai (1.4) | Bhopal (1.3) | Rajamundhry (0.4) |
| Raipur (2) | Surat (1.5) | Hubli (0.48) | |
| | Ranchi (2.5) | | |
| | Jodhpur (0.6) | | |

Note: Numbers in parenthesis denote passenger traffic in million at the airport in fiscal 2020; passenger traffic in India was 341 million in fiscal 2020.

*Source: National Monetisation Pipeline document, AAI, CRISIL MI&A Research*

Airport monetisation/ privatisation previously saw healthy participation from bidders, including global airport operators, Indian infrastructure conglomerates, Indian airport operators, investment management firms and quasi-sovereign wealth funds.

**Limited revenue risk driving participation towards PPP airports**

The airport sector is one of the few infrastructure sectors in India where the PPP model has achieved maturity, receiving acceptance from all stakeholders, including the regulator, ministry, operators and lenders.

The salient features of the PPP model contributing to rising participation of private entities in the airport sector are:

i. Regulated fixed return-based structure for aeronautical revenue, with upside potential from non-aeronautical revenue

ii. Assured return on regulatory assets through cost plus model

iii. Inclusion of capex for aeronautical revenue determination

iv. Clarity on applicability of 30% hybrid till model at airports with pax greater than 3.5 million

v. Rising penetration of air travel in India

vi. Increasing propensity to spend of the Indian consumer

vii. Stable regulatory mechanism with AERA regulating tariffs and fees, and TDSAT identified as a dedicated appellate tribunal responsible for addressing disputes with AERA and other related issues

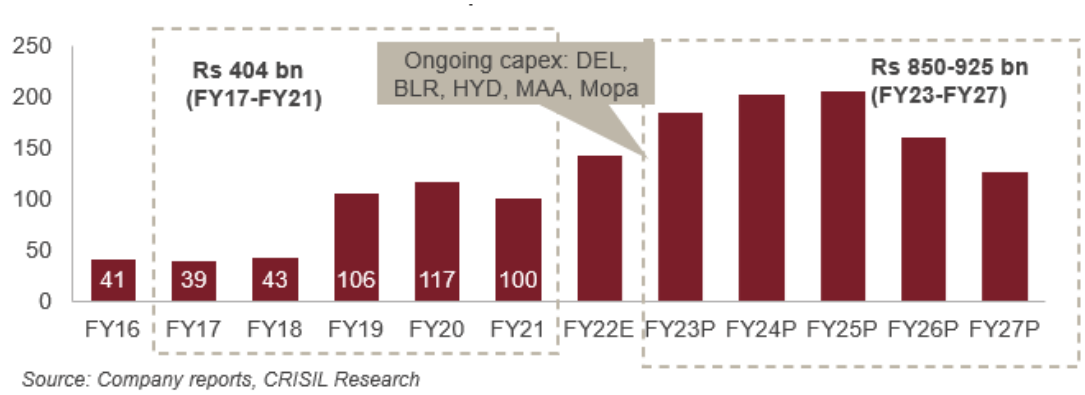
viii. Clarity on end-use of real estate

   **e.** Clarity on National Civil Aviation Policy's (2016) liberalised end-use of airport Real estate land endorsed by the Supreme Court

   **f.** Real estate deposits (RSD) of commercial property development can be used to finance project capex

## Review of investments by various players in airport infrastructure

**Figure 57: Total investment of Rs 850-925 billion expected over fiscals 2023-27**




*Source: Company reports, CRISIL Research*

CRISIL Research expects investments of Rs 825-925 billion in airport infrastructure over fiscals 2023-27, compared with investments of Rs 404 billion over fiscals 2017-21. The bulk of these investments is in greenfield capacity at Navi Mumbai, Jewar, Bogapuram, Mopa and brownfield capacity expansion projects for airports in Delhi, Bengaluru, Chennai and Hyderabad.

Expected recovery of pax traffic in fiscal 2023 to pre-Covid levels and surpass those numbers in fiscal 2024 coupled with mature PPP model which ensures healthy return on equity to support capex plans of players.

# Competition profile

## GMR Hyderabad International Airport (GHIAL)

GHIAL is a joint-venture company promoted by the GMR Group, in partnership with the AAI, the Andhra Pradesh state government and Malaysia Airports Holdings Berhad (MAHB). The company was incorporated to set up, operate and maintain the Rajiv Gandhi International Airport at Shamsabad, Hyderabad, in March 2008. The project is as per the PPP model. As per the concession agreement between the Union Ministry of Civil Aviation and GHIAL, 4% of gross revenue is to be shared with the state government as concession fees.

In 2008, the GMR-led consortium was given the mandate to design, finance (with government aid), build, operate and maintain the HIAL greenfield airport for 30 years, with an option to extend it by another 30 years. The airport and other related facilities are spread across 5,495 acres. The first phase of airport development became operational in March 2008, with a capacity to handle 12 million passengers and 150,000 tonne of cargo.

## Bengaluru International Airport (BIAL)

BIAL is a joint venture company between Siemens and Fairfax Holdings, which together hold a 74% stake — the Indian government holds the remaining 26% stake. It was named Kempegowda International Airport on July 17, 2013. It is the primary hub for AirAsia (India).

The GVK-led consortium was mandated to design, develop, finance, construct, operate and manage BIAL for 30 years, with an option to extend it by another 30 years. In June 2018, Fairfax completed the purchase of GVK's stake in the airport. The airport and related facilities span more than 4,000 acres, of which 720 acres have been reserved for commercial real estate development. As of fiscal 2020, BIAL operated at 116% capacity utilisation.

### Delhi International Airport (DIAL)

DIAL is a consortium of the GMR Group, the AAI, Fraport and MAHB. In 2006, DIAL was given the mandate to operate, modernise, manage and develop Indira Gandhi International (IGI) Airport over a period of 30 years, with an option to extend it by another 30 years. The airport is a primary hub for Air India and Indigo. DIAL shares 45.99% of its revenue with the AAI.

Besides upgrading the existing terminals, DIAL commissioned a runway at the airport on September 25, 2008. It inaugurated the domestic departure terminal 1D (T1D) on February 26, 2009, which helped increase the capacity of domestic departures to 10 million passengers per annum.

### Cochin International Airport (CIAL)

CIAL, also known as Nedumbassery Airport, began operations in 1999. The airport was built under the PPP model with equity participation from the Kerala government, industrialists, non-resident Indians, financial institutions, airport service providers and the public.

As of March 2022, CIAL has three main terminals, two domestic and one international. It also has a cargo terminal spread over an area of 200 acres. The domestic terminal complex has exclusive arrival and departure areas spread over a floor area of 10,000 sq. m, with a peak-hour passenger handling capacity of 400 incoming and 400 outgoing. In September 2012, the director Board of CIAL approved the design of the new international terminal. It can handle 12 million passengers annually and 4,000 passengers during peak hours.

### AAI

The AAI, an organisation under the Ministry of Civil Aviation, was formed on April 1, 1995. The International Airports Authority of India and the National Airports Authority were merged with a view to accelerate the development, expansion, modernisation and management of civil aviation infrastructure, both on the ground and air space, in the country. Its key functions include:

- Design, develop, operate and maintain the airports
- Construct, modify and manage passenger and cargo terminals
- Control and manage Indian airspace extending beyond the territorial limits of the country, as accepted by the ICAO
- Expand and strengthen operation areas, viz. the runways, aprons, taxiways, etc.
- Provide visual, communication and navigation aids
- Conduct annual performance audit of all airports, providing reports on economic viability of airport operations

### Jewar Airport

In November 2019, Zurich Airport won the bid to develop and operate the new greenfield airport in Jewar, Greater Noida region, at a bid of Rs 401 per passenger. Phase I of the project is planned to have a capacity of 12 MPPA with a total project cost of Rs 46 billion.

### Bhogapuram Airport

In March 2019, the GMR Group won the bid for operating Bhogapuram Airport for a period of 40 years under the PPP model at a concession fee of Rs 303 per passenger. Phase I of the airport is being planned to be built with an investment of Rs 23 billion.

This airport was earlier awarded to the AAI with a revenue share of 30.2% in August 2017. However, the award was later withdrawn in January 2018 as the government planned a revised master plan for the project.

### Goa Airport (MOPA)

In August 2016, the GMR Group won the Goa International Airport project at Mopa by offering a 36.99% revenue share. The airport operator has also been provided with 232 acres of land for commercial purposes.

In January 2020, the Supreme Court reinstated the environmental clearance which it had suspended in March 2019 due to lapses in environmental impact assessment (EIA). The airport was inaugurated by the Hon. Prime Minister of India, Mr Narendra Modi on 11th December, 2022 and is poised to commence operations on 5th Jan, 2023.

## Current trends in competition — airport infrastructure

**Multiple airport systems**

Professor Richard de Neufville of MIT, a world leader in airport systems, defines a multi-airport system (MAS) as “a set of two or more significant airports that serve commercial traffic within a metropolitan region.” Multiple airport systems are critical when the sole airport serving a catchment area has reached its capacity and is unable to expand. In the absence of a second airport, the city would see diversion of air traffic to neighbouring airports and would lose the opportunity to provide better connectivity to its passengers.

Different airports in a city are meant to cater to different kinds of passengers. Globally, LCCs were able to bloom because of their ability to fly to secondary airports — these were typically no-frills airports and had lower airport charges than primary airports, which served as a transit hub and a full-service carrier base. Airlines were able to pass on lower charges to passengers. However, in India, no multi-airport systems exist as of now. As aviation traffic grows over the next decade, many cities in India may see a move towards multiple airports. Such plans have already been announced in at least three cities, viz. NCR, Mumbai and Goa, where we expect to have two airports operational by fiscal 2026. Goa may be an outlier given that one of the airports is a defence airport. However, apart from Delhi and Mumbai, it is likely that other metro cities such as Bangalore and Chennai may see demand for more than one airport, similar to global examples such as London, Istanbul and New York.

London, for example, is served by five airports: Heathrow, London City, Gatwick, Stanstead and Luton. Heathrow is the base of British Airways and is home to foreign carriers and facilitates both originating and transit traffic. London City, despite being the smallest airport, has the highest percentage of business travellers, who value its in-city location, compact size, speedy processing and maximum productivity. Gatwick is the home to ultra-low-cost carriers such as Easyjet, and has the lowest percentage of business passengers. Stanstead is home to ultra-low-cost Ryanair, while Luton caters to those living in the north-west suburbs around London. The same person may choose to use London City for a European business trip, Heathrow for a trans-continental business trip, and Gatwick or Stanstead for a family vacation. Similarly, airlines tend to offer flights from Gatwick to primarily leisure destinations, and from Heathrow to business destinations. Even in the economically bracketed BRIC (Brazil, Russia, India and China), similar patterns are observed. Shanghai’s distant airport, Pudong, caters to international flights, and in-city airport, Hongqiao, flies domestic and regional routes. In the Brazilian capital, Sao Paulo, in-city Congonhas caters to domestic flights, while out-of-city Guarulhos handles all the international traffic and some domestic connections. Similarly, New York-Newark, San Francisco, Los Angeles, Chicago, Dallas Fort Worth, Bangkok, Tokyo, Osaka and others operate multi-airport systems — fostering competition, and enabling choice and affordability for their citizens.

# Brief on institutional framework (AERA regulations) for aviation sector by the central government

## Airports Economic Regulatory Authority(AERA) — regulator for tariff fixation

AERA is a statutory body constituted under the Airports Economic Regulatory Authority of India Act, 2008, notified vide a gazette notification dated December 5, 2008. AERA was established by the government in 2009 and is headquartered in New Delhi.

**Key functions**

- To determine tariff for aeronautical services
- To determine development fees to be charged at major airports
- To determine passengers service fees to be levied
- To monitor set performance standards in airports relating to quality, continuity and reliability of service, as may be specified by the government or any authority authorised by it in this behalf
- To perform such other functions relating to tariff structures for airport operators, as may be entrusted to it by the government or as may be necessary to carry out the provisions of this Act

**Powers of AERA**

- Penalise airports for failure to comply with its orders and directions of the AERA Act
- Penalise for offences by government departments
- Appeals on the AERA's rulings can be filed only in the Supreme Court
- AERA has been constituted to fix, review and approve the tariff structure for aeronautical services, and monitor pre-set performance standards at Indian airports, but with no regulation over army and paramilitary airports
- The prime objective of AERA is to create a level-playing field and foster healthy competition among all major airports, encourage investment for building greenfield airports, protect reasonable interest of fliers, and operate efficient, economic and viable airports.

# Key initiatives taken by the government

## Regional connectivity scheme — UDAN

Regional connectivity scheme (RCS), effective second quarter of fiscal 2017, would be designed such that fares for a one-hour flight will be capped at Rs 2,500 — applicable only in states which reduce value-added tax (VAT) on ATF at RCS airports to 1% or less. The government is aiming to implement this by reviving unserved or underserved airports.

This scheme would be implemented via viability gap funding (VGF) for airlines. While the Ministry of Civil Aviation will provide viability gap funding on air tickets from 80% of the regional connectivity fund (RCF), the rest will come from the state. The RCF will be funded by a levy charged on domestic flights operating other than Category II/IIA (as defined by civil aviation) and RCS routes. The government is also offering a host of incentives (to operators), such as lower excise duty at 2% on ATF drawn from RCS airports (compared with 14% currently) and nil airport charges.

On October 21, 2016, the Ministry of Civil Aviation launched the Final Regional Connectivity Scheme(RCS) called UDAN. The scheme aims to promote regional connectivity by reviving unserved/ underserved airports requested by the airlines.

RCS would be applicable for a period of 10 years from the date of its announcement. As per the scheme, an RCF would be created, which will be funded through a levy or fee per departure on all domestic departures other than Category II/IIA under route dispersal guidelines (RDG), RCS routes, and flights with maximum seating capacity less than 80 seats. It will also be funded by the premium realised from the allotment of additional capacity entitlements on foreign routes, as mentioned in the National Civil Aviation Policy (NCAP 2016).

The AAI has been designated as the implementing agency for the scheme, and it would be responsible for the payment of VGF to airlines, and collections of levies and reimbursements from state governments from time to time. Also, only 20% of VGF will be funded by respective state governments (10% in case of north-east states and Union Territories), and the rest will be funded by RCF.

The scheme has proposed an airfare cap per RCS seat for a particular flight distance. This is indexed to inflation on a quarterly basis. Airlines flying on the RCS routes should allocate at least 50% of capacity as RCS seats, which are subject to a minimum of nine and a maximum of 40 seats per flight. In certain situations, if the airline chooses to sell its tickets of non-RCS seats below the airfare cap, VGF will be deemed to have been applied over all such seats, for which the airfares are below the cap. The positive proposition is that the airfare on an RCS seat will not be subject to any levies or charges imposed by airport operators, including passenger service fee (PSF), development fee (DF) and user-development fee (UDF). To avoid large exposure of a single entity, no airline can have more than 50% of RCF allocated for a region and 25% of total RCF allocated for all regions, whichever is less.

**Incentives to control costs and lure airlines**

The incentives offered for RCS flights include, but are not limited to, reduction in excise duty on ATF from 14% to 2% for a period of 3 years, and reduction of VAT on ATF to less than 1% for a period of 10 years — state governments are allowed to offer additional incentives such as underwriting of seats outside the purview of the scheme. Also, the airports shall not levy landing, parking and terminal navigation charges on RCS flights; however, route navigation and facilitation charges would be applicable with a 57.5% discount.

## Emergency Credit Line Guarantee Scheme (ECLGS)

ECLGS was announced as part of the Atmanirbhar Bharat package in 2020 with the objective to support businesses, including MSMEs, to meet their operational liabilities and resume businesses in view of the distress caused by the pandemic. On May 30, 2021, ELCGS was extended to include the civil aviation sector, the first direct step taken by the government to support the sector, one of the worst impacted from the pandemic. To aid the airline sector, the government had announced capacity caps and fare ceiling and floors to prevent stronger players from taking advantage of the pandemic, while also maintaining pricing discipline for flyers. There were no direct steps announced for the airport sector.

ECLGS provided a government guarantee that allows stressed businesses to take additional loans to tide over working capital issues. Under ECLGS, companies whose days past due were up to 60 days as of February 29, 2020 were eligible for it. Under ECLGS 3.0, the amount of Guaranteed Emergency Credit Line (GECL) airlines are eligible for loan up to 100% of their combined fund and non-fund based credit outstanding with maximum limit is capped at Rs 1,500 crore.

## Open air service agreement (ASA) policy

Air Service Agreements (ASA) covers aspects relating to number of flights, capacity, landing point and codeshare agreements. India has signed Air service Agreement with 116 countries. Any designated foreign airline can operate to and from the designated point of call in India as agreed in the bilateral air service agreement between the two countries. Similarly, designated Indian carriers can operate to and from any international airport under the scope of bilateral ASA.

Under NCAP 2016, Policy for utilisation of bilateral rights are as follows:

Open Sky ASA: The government can enter into open sky agreement on reciprocal basis with SAARC countries and other countries beyond 5,000 km radius from New Delhi. Unlimited flights will be allowed to and from major international airports including Kannur International Airport. However, the point of call will be as per the existing ASA until renegotiated.

Capacity utilisation: For countries partially or fully within the 5,000 radius, where Indian designated carries have not fully utilised 80% of their entitled capacity however foreign carriers have exhausted the entitled capacity and seek an increase, the method for allocating additional capacity will be recommended by a committee headed by the cabinet secretary.

Whenever Indian designated carrier exhaust 80% of the entitled capacity and seeks an increase, the capacity entitlements (bilaterals) will be renegotiated in the usual manner.

Cargo airline: As per Substantial Ownership and Effective Control (SOEC)' clause in the ASA, Indian cargo airlines with 74% FDI cannot normally be considered as designated carrier. However, ASA can be amended based on "principal place of business" and "effective regulatory control" of the host country. The criteria for "effective regulatory control' will be defined by MoCA while issuing the implementation orders.

## Government announcements for MRO hub creation in India

The government announced new Maintenance, Repair and Overhaul (MRO) policy with the aim to make India a global MRO hub servicing 90% of the Indian carriers MRO requirements by 2040. MRO services are categorized into four major segments – Line maintenance, Component maintenance, Engine maintenance and Airframe heavy maintenance and modification of which Engine maintenance and APU holds 60% of the total MRO outlay.

New MRO policy to attract investments:

- Land leasing at the airports will be done through open tender process
- Land allotment for MRO facilities will be for 30 years instead of 3-5 years earlier
- Lease rents will be determined by a bidding process rather than the current practice of the Airports Authority of India (AAI) setting rates. The rental escalation is fixed at 15% every three year.
- Airport royalty charges completely waived-off for MRO service companies
- GST rate for domestic MRO services has been cut from 18% to 5%

## Relaxation in FDI thresholds for brownfield and greenfield airports in India

Foreign Direct investment (FDI) into airport projects, both greenfield and brownfield projects, is currently allowed up to 100% under the automatic route. Earlier, for brownfield projects foreign direct investment was limited to 74% under the automatic route.

## National Logistics policy 2022

The National Logistics Policy was launched with the objective of reducing India's logistics cost to 8% of GDP by facilitating inter-ministerial co-ordination, enabling swift resolution of the issues faced by industry participants and consolidating all digital services related to transportation sector in a single platform called ULIP. The policy is expected to streamline the process of approvals, enable access to real-time data and ensure efficient movement of cargo. The central government's efforts have been well complemented by the state governments who have themselves announced incentives to attract investments and improve the logistics system in their respective states.

## Digital initiative by airports

Considering the growth projections for Indian aviation, the Ministry of Civil Aviation has taken up a key initiative, the Digi Yatra (DY) programme, to reimagine air travel in the country, which looks beyond the conventional "build a bigger airport to manage more passengers" approach. It aims to provide a seamless, hassle-free and paperless journey experience, using cutting-edge identity management and facial recognition technology. The Digi Yatra foundation has been set up to drive the DY programme and comprises five shareholders: the AAI, BIAL, CIAL, DIAL and GHIAL. Passengers will be automatically processed based on a facial recognition system at check points, such as entry point check, entry to security check, and aircraft boarding, Additionally, this will facilitate self-bag drop and check-in, using facial recognition to identify pax and data recall. The DY programme will facilitate paperless travel and avoid identity check at multiple points, thus boosting operational efficiency and potentially increasing the handling capacities of airports.

Digital transformation at airports is about not just embracing technology but also determining and delivering updated processes and services to deliver a better experience for all stakeholders, viz. airport operators, airlines, passengers, customers, security, customs, concessionaires, and ground handlers. Digital transformation at airports aims to leverage newer technologies to improve safety and security and streamline business processes.

## Adani portfolio

Adani Enterprises won the mandate to modernise and operate six airports — Ahmedabad, Lucknow, Mangaluru, Jaipur, Guwahati and Thiruvananthapuram — through the AAI's globally competitive tendering process. Adani Enterprises also acquired MIAL in 2021, and thereby won the contract for Navi Mumbai International Airport. As of September 30, 2022, its portfolio comprises seven operational airports and one greenfield airport. The company has emerged as the largest private operator of airports based on the number of airports. Airports under Adani Enterprises serviced 33 million passengers, 252,063 air traffic movements and 0.48 million tonnes of cargo across airports in the first half of fiscal 2023.

**Table 14: Comparison by market share with other private airport operators**

The Adani Enterprises owned airports rank second across operational parameters among PPP/ JVC airports.

| H1FY23 | Adani Enterprises | GMR Group | BIAL |
|---|---|---|---|
| Passenger | 22% | 27% | 9% |
| ATM | 21% | 24% | 8% |
| Cargo | 30% | 33% | 13% |

*Source: AAI, CRISIL MI&A Research*

**Table 15: Positioning of Adani Airports holding limited airports on passenger traffic across years**

| Pax traffic (domestic + International) | 2018-19 | 2019-20 | 2020-21 | 2021-22 | 2022-23 |
|---|---|---|---|---|---|
| **Mumbai** | | | | | |
| **in million** | 48.8 | 45.9 | 11.1 | 21.7 | 19.4 |
| **Rank** | 2 | 2 | 2 | 2 | 2 |
| **Ahmedabad** | | | | | |
| **in million** | 11.2 | 11.4 | 3.6 | 5.7 | 4.2 |
| **Rank** | 7 | 7 | 7 | 7 | 7 |
| **Lucknow** | | | | | |
| **in million** | 5.5 | 5.4 | 2.4 | 3.3 | 2.3 |
| **Rank** | 12 | 12 | 12 | 12 | 12 |
| **Mangalore** | | | | | |
| **in million** | 2.2 | 1.9 | 0.6 | 1.0 | 0.9 |
| **Rank** | 29 | 29 | 29 | 29 | 29 |
| **Jaipur** | | | | | |
| **in million** | 5.5 | 5.0 | 1.9 | 2.9 | 2.1 |
| **Rank** | 13 | 13 | 13 | 13 | 13 |
| **Guwahati** | | | | | |
| **in million** | 5.7 | 5.5 | 2.2 | 3.2 | 2.3 |
| **Rank** | 11 | 11 | 11 | 11 | 11 |
| **Trivandrum** | | | | | |
| **in million** | 4.4 | 3.9 | 0.9 | 1.7 | 1.7 |
| **Rank** | 15 | 15 | 15 | 15 | 15 |

*Note: Rank is based on pan-India airports*

*Source: AAI, CRISIL MI&A Research*

**Table 16: Positioning of Adani Airports holding limited airports on freight traffic across years**

| Freight traffic (domestic + International) | 2018-19 | 2019-20 | 2020-21 | 2021-22 | 2022-23 |
|---|---|---|---|---|---|
| **Mumbai** | | | | | |
| **in Tons** | 963460 | 863782 | 592966 | 770953 | 393587 |
| **Rank** | 2 | 2 | 2 | 2 | 2 |
| **Ahmedabad** | | | | | |
| **in Tons** | 101731 | 103741 | 60749 | 90634 | 46311 |
| **Rank** | 7 | 7 | 7 | 7 | 7 |
| **Lucknow** | | | | | |
| **in Tons** | 6111 | 14882 | 9968 | 14942 | 7738 |
| **Rank** | 14 | 14 | 14 | 14 | 14 |
| **Mangalore** | | | | | |
| **in Tons** | 3287 | 4605 | 2186 | 3521 | 2282 |
| **Rank** | 31 | 31 | 31 | 31 | 31 |
| **Jaipur** | | | | | |
| **in Tons** | 18513 | 17499 | 12204 | 14180 | 8857 |
| **Rank** | 13 | 13 | 13 | 13 | 13 |
| **Guwahati** | | | | | |
| **in Tons** | 23840 | 21270 | 15951 | 21858 | 11918 |
| **Rank** | 12 | 12 | 12 | 12 | 12 |
| **Trivandrum** | | | | | |
| **in Tons** | 25167 | 25511 | 14799 | 16356 | 8389 |
| **Rank** | 11 | 11 | 11 | 11 | 11 |

*Note: Rank is based on pan-India airports*

*Source: AAI, CRISIL MI&A Research*

**Table 17: Positioning of Adani Airports holding limited airports on air traffic movement across years**

| Air traffic movements(Domestic + International) | 2018-19 | 2019-20 | 2020-21 | 2021-22 | 2022-23 |
|---|---|---|---|---|---|
| **Mumbai** | | | | | |
| **in Numbers** | 321263 | 304675 | 115864 | 186186 | 136225 |
| **Rank** | 2 | 2 | 2 | 2 | 2 |
| **Ahmedabad** | | | | | |
| **in Numbers** | 78412 | 84577 | 40209 | 51157 | 35709 |
| **Rank** | 7 | 7 | 7 | 7 | 7 |
| **Lucknow** | | | | | |
| **in Numbers** | 41752 | 38494 | 22954 | 30005 | 19765 |
| **Rank** | 13 | 13 | 13 | 13 | 13 |
| **Mangalore** | | | | | |
| **in Numbers** | 19365 | 15685 | 6664 | 9980 | 7336 |
| **Rank** | 32 | 32 | 32 | 32 | 32 |
| **Jaipur** | | | | | |
| **in Numbers** | 46185 | 39484 | 18933 | 27157 | 18949 |
| **Rank** | 12 | 12 | 12 | 12 | 12 |
| **Guwahati** | | | | | |
| **in Numbers** | 50488 | 45539 | 23442 | 33557 | 22174 |
| **Rank** | 11 | 11 | 11 | 11 | 11 |
| **Trivandrum** | | | | | |
| **in Numbers** | 33093 | 28842 | 9313 | 15356 | 11905 |
| **Rank** | 15 | 15 | 15 | 15 | 15 |

*Note: Rank is based on pan-India airports*

*Source: AAI, CRISIL MI&A Research*

**Table 18: ASQ ratings before acquisition and post acquisition of airports:**

| Airport name | Pre-acquisition (March 2020) | Post-acquisition (September 2022) |
|---|---|---|
| Ahmedabad | 4.87 | 4.98 |
| Mangalore | 4.75 | 4.85 |
| Lucknow | 4.92 | 4.96 |
| Jaipur | 4.47 | 4.95 |
| Guwahati | 4.9 | 4.9 |
| TRV | 4.95 | 4.7 |
| MIAL | 4.98 | 5 |

*Source: ACI World*

# Data Centres

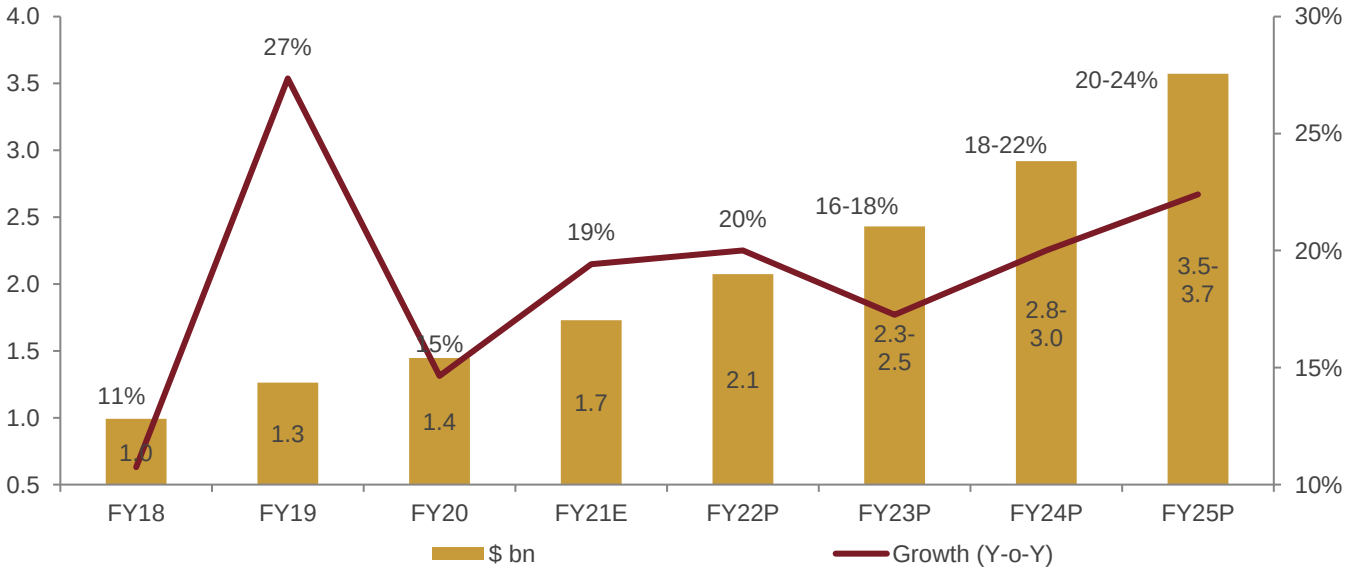
## Changing digital landscape makes India a data centre hub

Digital solutions being implemented across a range of social and economic sectors and activities will help make India a $1 trillion digital economy by 2025[1]. Indian SaaS ecosystem was valued at $3.5 billion in fiscal 2020[2]. New business models are emerging within the SaaS landscape, leading to further diversification and potential growth opportunities. It is expected that by 2025, the pureplay SaaS industry has the potential to grow 6x to $13-15 billion. With more firms moving towards a SaaS platform and hybrid cloud environment, the need for robust and scalable data centres became a necessity to accommodate future demand.

The Indian data centre industry is at an inflection point where accelerated digitalisation and rapid cloud adoption are driving growth of the industry. As part of the digitalisation strategies, industries are shifting their IT infrastructure to the cloud to enhance user experience and reduce costs. The industry stood at ~$2.1 billion in fiscal 2022, after growing at a CAGR of 19-21% between fiscals 2018 and 2022. Growth was supported by the Digital India initiatives and growth of sectors like e-comm, BFSI, technology and media. The industry is expected to clock ~20% CAGR between fiscals 2022 and 2025, led by robust investments by Indian as well as global players.

*Source: [1] Ministry of Electronics and Information Technology, [2] NASSCOM,*

**Figure 58: Cloud, social media and technology companies drive the industry**



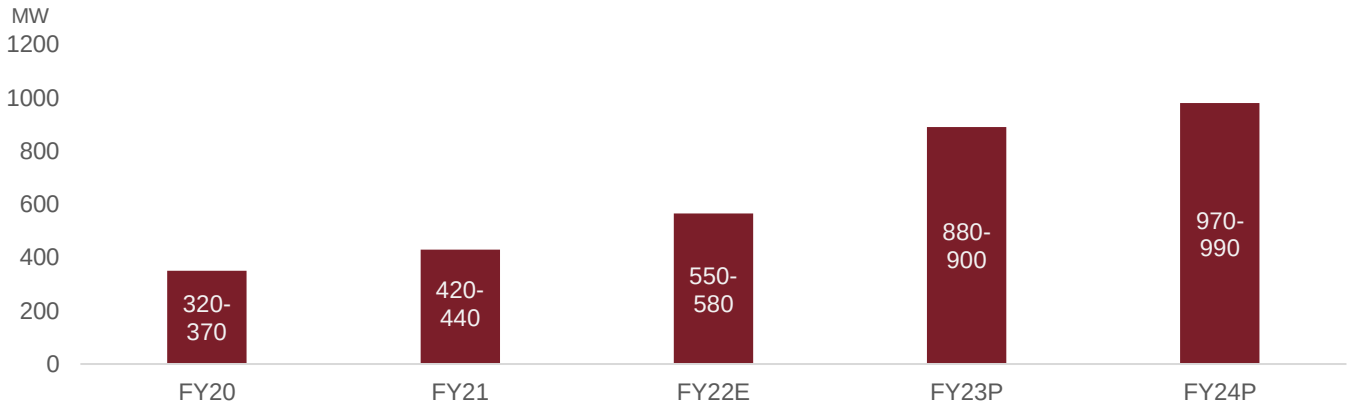

*Source: CRISIL MI&A Research*

## Power capacity addition to support digital revolution for the future

India hosts ~164 data centres spread across nine cities. Total installed capacity as of fiscal 2022 was 550–580 MW and 320-370 MW in fiscal 2020. With the pandemic-induced challenges, digital transformation became a necessity, and the demand for hybrid cloud and colocation models surged. Data usage also increased, creating more demand for data storage and transformation of the data centre industry to a large and strategically important segment.

India's data centre industry is expected to add 320-340 MW capacity in the current fiscal. This capacity addition will be on account of the growing internet penetration, increase in data consumption, and rising adoption of cloud and big data analytics. Government initiatives like Digital India and emphasis on data protection and localisation will also play a significant role in the capacity addition. India holds high potential to become the data centre hub in the Asia-Pacific region on account of the low power tariff, presence of undersea cable landing stations, and high bandwidth speed.

**Figure 59: Capacity to grow 970-990 MW by FY25 led by investments from players across the globe**




*Source: CRISIL MI&A Research*

## Cable landing stations & government incentives gave Maharashtra edge over other states

In India, data centres are buoyant in key cities like Mumbai, Chennai, Bengaluru, Hyderabad, Pune and Delhi. Mumbai accounts for ~50% of the installed capacity. The presence of undersea cable landing stations, proximity to corporate houses, and well-distributed fibre connectivity, which act as the backbone network that provides interconnectivity between them all, increase the prominence of the city. The city is witnessing strong demand from the BFSI segments as they move to hyper scales and the regulations about the data storage of BFSIs.

Chennai, which hosts 65-75 MW of the data centre capacity, is an emerging data centre hub in the country. The state data centre policy, which offers financial incentives in taxes and power, along with the presence of undersea cables and availability of surplus power, makes the city attractive. The demand is largely from IT firms and e-commerce segments.

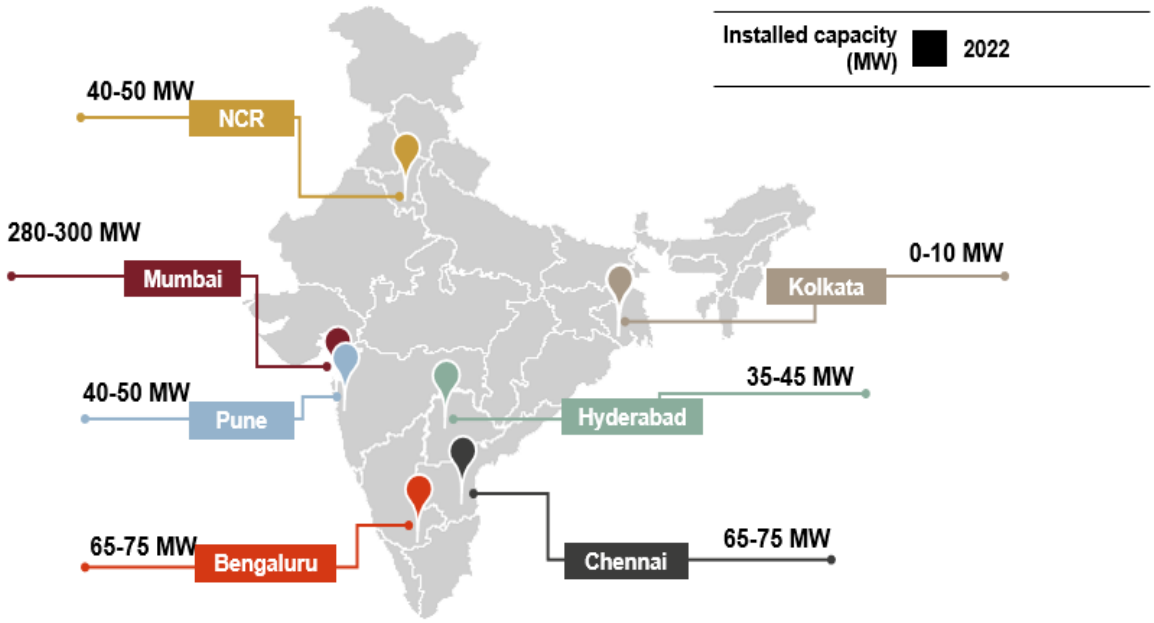
Bengaluru, known as the Silicon Valley of India, is the hotbed for start-ups and technological developments. The city has 65-75 MW of data centre capacity. The state data centre policy, which targets to make Karnataka the 'destination of choice' for data centres that offers capital and land subsidies, tax exemptions, and tariff concessions, is creating a favourable business environment in the city. Further, Bengaluru is in a geographic region that's less susceptible to natural calamities and the low risk of seismic activity will spike the demand.

With 40-50 MW of capacity, investments in Delhi NCR are largely driven by government policies. The city witnessed large-scale investments in the recent past with the anticipated demand from government digital initiatives.

Pune, an upcoming IT hub preferred by MNCs, gained prominence as a data centre hub as the disaster recovery location for banking and financial services due to its proximity to Mumbai. The installed capacity is 40-50 MW.

Hyderabad, which is the headquarters of global cloud providers, hosts 35-45 MW of capacity. Tax incentives introduced by the government to attract hyperscale data centres are boosting investments in the city.

**Figure 60: Proximity to client locations and cable landing stations continues to drive demand**




*Source: Industry, CRISIL MI&A Research*

## Co-location – A widely used business model

There are three widely accepted business models in the data centre industry:

**I) Captive**

This is the most accepted model as these data warehouses host the most important and proprietary assets of businesses in highly controlled physical infrastructure. Captive data centres are in-house data centres that are built to suit the business requirements.

**II) Colocation**

Commonly known as multitenant data centres, these are facilities where organisations and businesses rent out space (racks) to store their IT infrastructure. The colocation provider gives power, cooling, connectivity requirements, and physical security for the servers. Here, the end user pays for the required capacity, making it more efficient than operating a captive with unutilised capacity.

**III) Hosting**

The hosting or cloud computing model is where businesses transfer their workload to a cloud environment. In this model, businesses subscribe to services offered by the cloud provider.

**Table 19: Comparison of business models**

| | Captive | Colocation | Hosting |
|---|---|---|---|
| Business model | Built-to-suit | Subscription | Pay-per-use |
| Pros | 1. Complete control over choice of hardware software, and security<br>2. No vendor lock-ins | Capex saving due to direct leasing of rack space | 1. No capex spends on IT hardware or software<br>2. Hyper-scalability of infra, based on demand |
| Cons | Large capex along with maintenance and security cost | Capex on servers.<br>Hiring and training of staff required to manage systems | Inability to deploy customised solutions |

*Source: Industry, CRISIL MI&A Research*

## Government policies and digitalisation are leading growth drivers

### Data protection bill

- Over the past decade, there has been an explosive rise in the creation and consumption of digital data. Total digital data in India grew to 2.3 million petabytes in 2020 from an estimated ~40,000 petabytes in 2010.The Data Protection Bill suggests protecting the citizen's data by storing it locally. It also helps the government form better policies for the citizens. With this policy, the need for local data centres was realised and central as well as state governments came up with data centre policies.

  The central government's data centre policy was focused on the following aspects:

  i. Infrastructure status for data centres, which improved the ease of doing business

  ii. Declared data centres under 'essential services' under the Essential Services Maintenance Act, 1968, which ensures ensure reliable power, internet connectivity and business continuity

  iii. Setting up of data centre economic zones for creating an ecosystem for hyper scalers, cloud providers, IT firms, and other allied businesses to operate and benefit

- As the data localisation rules come in the current capacity will be highly constrained so the development of more hyper-scale data centres is necessary to cater to this incremental data storage and data processing demand.

### Rising internet subscriber base

India has the second largest internet user base globally. The subscriber base grew to 740 million in fiscal 2022 from 473 million in fiscal 2018 [1]. This accelerated growth was because of the pandemic-induced challenges as more people moved online, and more businesses digitalised. The average monthly consumption per user of data was 0.6 GB in fiscal 2016, and it reached 17 GB in fiscal 2022[1]. With the launch of 5G services, the quantum of data created, consumed, and processed will grow multifold. As the bandwidth increases, users will get access to more quality content like full HD videos. Edge data centres will act as the intermediary between the large amounts of such data-to-data processing.

### Rising cloud adoption

Government initiatives to accelerate delivery of e-services and partnerships with cloud service providers will boost cloud adoption by enterprises. The pandemic also sparked interests of government agencies to migrate workloads to cloud environments, increasing demand for private and hybrid clouds.

**Big Data and IoT**

- With rapid adoption of artificial intelligence, IoT and big data analytics, demands for more bandwidth and more reliable and scalable data centres surged. By 2025, the number of IoT devices is expected to reach ~75 million and big data analytics will reach $68 billion [2]

*Source: [1] TRAI, [2] NASSCOM*

## Data security – Key concern for the industry

**Data privacy**

As data centres store sensitive and confidential client data, any breach can cost millions. Risk mitigation and cyber and physical protection of stored data are the primary concerns of every data centre.

**Power management**

To reduce the unplanned downtime of data centres, proper planning, analysis and implementation of power back-up is necessary. Unplanned downtime affects the reliability of data centres. Proper analysis of power requirement of IT and cooling equipment is a challenge in the constantly changing technology era.

**Capacity planning**

For data centres to deliver optimal performance, they should be run at a desired capacity. Data centre infrastructure management tools are an efficient way of doing the same. Data Centre infrastructure management systems can identify the computational, storage and cooling requirements.

**Adani**

Adani Enterprises commenced data centre operations business in 2020. Pursuant to a joint venture with EdgeConneX, a global data centre firm in the US with more than a decade of experience in service serving global technology giants, Adani ConneX was formed. Adani ConneX is engaged in building reliable data centre networks supported by renewable energy, to service this growing sector. The company has plans to develop data centres across Chennai, Noida, Navi Mumbai, Hyderabad, Vizag, Pune, Kolkata and Bengaluru. The first data centre in Chennai was commissioned in October 2022.

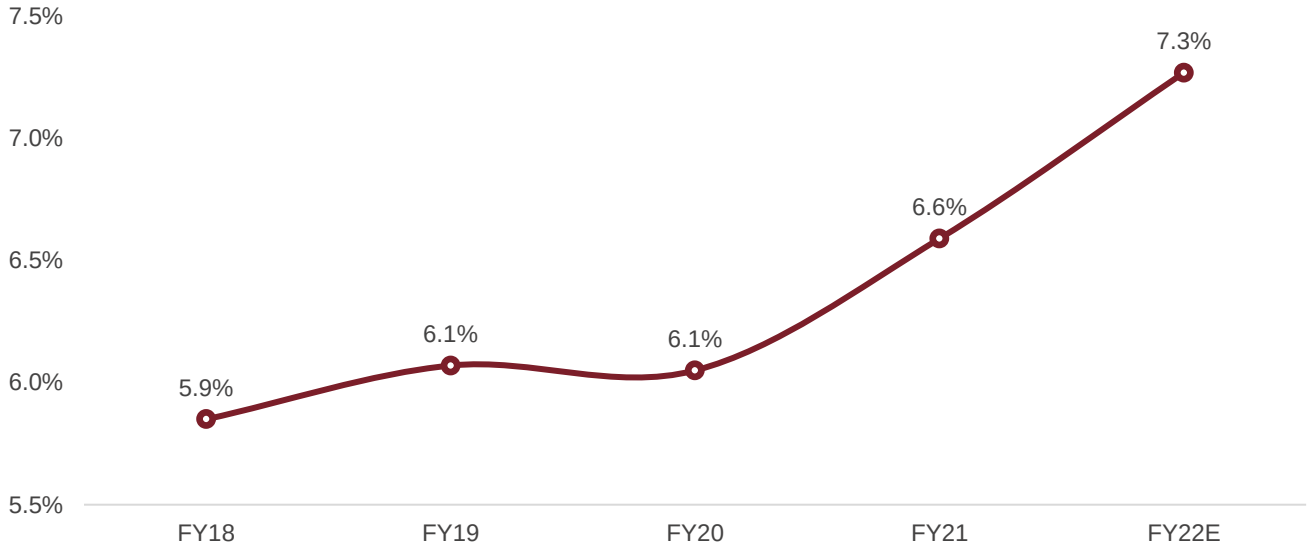
The Adani group possesses experience in delivering large projects with unique full-stack capabilities in power generation, transmission and distribution, including renewable power. On the other hand, EdgeConneX brings unique capabilities in operating and designing over 50 global data centres in more than 40 markets. As a validation of this capability, the joint venture is well-positioned to attract reputed clientele.

# Roads

## Review of road infrastructure in India

### Road sector contribution to Indian GDP

**Figure 61: Infrastructure investments as % of real GDP**




*Source: CRISIL MI&A Research, NSO*

Investments in the infrastructure sector as a percentage of real GDP have increased from 5.9% in fiscal 2018 to 7.3% in fiscal 2022. Infrastructure investments shot up in fiscal 2021 and fiscal 2022 as the government undertook widescale capital expenditure in the infrastructure segment in order to revive the economy ravaged by the onset of the Covid-19 pandemic. Given the government's undeterred thrust towards infrastructure development, investments in infrastructure are expected to remain robust going forward. As a matter of fact, infrastructure investments as a percentage of real GDP are expected to comfortably cross the 8% mark by fiscal 2025. Roads, power and railways are expected to drive the bulk of these investments.

The road sector is among those with the highest share in infrastructure investments in the country. It alone accounts for close to 30% of total infrastructure investments in the country. Investments in roads amount to 2% of the country's GDP. In line with overall infrastructure investments, investments in roads are also expected to scale up owing to the government's concentrated focus on improving the national highways network in the country and the ambitious Bharatmala programme.

### Total length and break-up into national, state and rural roads

India has the second largest road network in the world, aggregating 6.2 million km. Roads are the most common mode of transportation and account for about 87% of passenger traffic and close to 63% of freight traffic.

In India, national highways, with a length of close to 140,995 km, constitute a negligible percentage of the road network but carry about 40% of total road traffic. On the other hand, state highways, city roads, rural roads and major district roads are the secondary system of roads; they carry another 60% of traffic and account for nearly the entire road length.

The road network in India can be divided into the following categories:

**Table 20: Road network in India as of fiscal 2022**

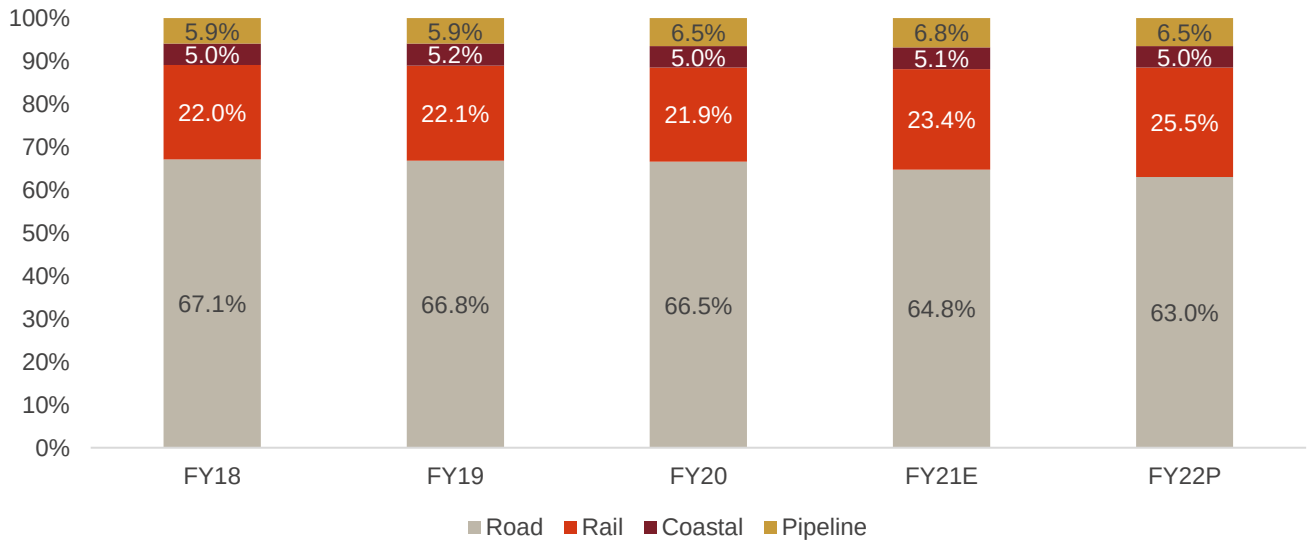
| Road network | Length (km) | Percentage of total length | Percentage of total traffic | Connectivity to: |
|---|---|---|---|---|
| National highways | 140,995 | 2.2% | 40% | Union capital, state capitals, major ports, foreign highways |
| State highways | 171,039 | 2.7% | 60% | Major centres within states, national highways |
| Others | 6,059,813 | 95.1% | | Main roads, rural roads, production centres, markets |
| **Total** | **6,371,847** | **100%** | **100%** | |

*Source: MoRTH Annual Report 2021-22, CRISIL MI&A Research*

## Share of roads in Indian freight traffic

Road transport is the most frequently used mode of transport for freight traffic. For fiscal 2022, it is estimated that out of total freight (in terms of BTKM), ~63% was carried by roads, 25.5% by rail, 6.5% through coastal mode, and the remaining 5% by pipelines with Air accounting for a miniscule 0.01-0.02% share of the total domestic freight movement.

**Figure 62: Share of different modes of transport in Indian freight traffic**




*Source: CRISIL MI&A Research*

Railways gained share in fiscal 2021 as rail freight traffic was more resilient amid the Covid-19 outbreak. Rail share further increased in fiscal 2022 due to increased rail capacity, partial commissioning of the dedicated freight corridor , soaring diesel prices and higher road freight rates. Commissioning of the dedicated freight corridor is likely to aid in the increase in rail share. Impact is expected to be witnessed from fiscal 2024 onwards and would help railways to claw back share it had earlier lost owing to capacity constraints.

## Challenges faced by the road sector

The major challenges faced by the road sector are listed below:

- **Tardy land acquisition and clearances:** The process of acquiring land for road projects in India is cumbersome. The process often moves at a slow pace due to mismatch in the valuation of the land by the owner and the authorities. The delay in land acquisition has delayed and/or cancelled numerous projects in the past. The problem is further compounded by the delays caused in getting other approvals such as forest and environmental clearances.
- **High exposure to fluctuations in international commodity prices:** Cost of key raw materials such as bitumen are highly dependent on the international prices of commodities such as crude oil. The high exposure to geopolitical tensions and other factors influencing the international prices induces volatility in margins of the players. Due to geopolitical tensions and other supply-side issues, the prices of key input materials such as bitumen, cement and steel have soared. As a result, margins of the players have experienced severe downward pressure.
- **Quality and availability of raw materials:** Some of the roads and highways constructed in the recent past have been plagued by poor quality due to the use of raw materials of inferior quality. Additionally, certain policies such as ban on mining of certain key input materials like sand have led to a shortage of raw materials, which has, in turn, impeded execution of the projects.
- **Intense competition:** The competition in the HAM projects space has intensified owing to the NHAI relaxing the bidder eligibility criteria. The number of bidders per HAM project went up to 10-15 in fiscal 2022 from 7-10 in fiscal 2021. Consequently, the average bid premium fell from 10-12% to 3-5%. While the steps taken by the NHAI have alleviated the problem of excessive competition to an extent, the drastic fall in bid premiums in the projects awarded last fiscal combined with the inflated input prices would render margins of the concerned companies susceptible to contraction. Intense competition has also been witnessed in the projects awarded under the EPC model, with as many as 15-20 bidders vying for certain projects. This has naturally resulted in many projects being awarded at a significant discount to the RFP cost.
- **Traffic risk:** BOT projects have been fraught with challenges related to vehicular traffic, wherein lower-than-expected traffic has suppressed returns for the developers. Furthermore, projects have also faced financing-related issues since bankers have been reluctant to finance BOT projects given the high traffic risk and existence of other relatively less-riskier models such as HAM and EPC. Moreover, inflationary pressures and higher-than-expected maintenance costs have further plagued the prospects of BOT projects.

## Institutional framework for roads at the central level and for specific states

In January 2015, the NDA government replaced the Planning Commission with NITI (National Institution for Transforming India) Aayog, a multi-tiered structure that provides strategic and technical advice to the Central and state governments. At the central government level, several line ministries will handle transport planning, co-ordination and policy setting; overall coordination is by NITI Aayog.

At the central level, NITI Aayog, in consultation with the Ministry of Road Transport and Highways (MoRTH) and the Ministry of Rural Development (MoRD), is responsible for overall policy, programme development and resource planning. MoRTH's duties relate to policies on road transport and development and maintenance of national highways.

The NHAI is the agency for implementation, operation and maintenance of national highways. The NHAI was constituted and operationalised in February 1995; it was given the status of an autonomous corporate body under the control of the road transport ministry. However, the central government has powers to divest the NHAI of its responsibilities.

At the state level, the overall policy, programme development and resource planning are done by the state planning cell, in consultation with the Centre (NITI Aayog) and the state ministry of roads.

National Highways and Infrastructure Development Corporation (NHIDCL) was incorporated in July 2014. NHIDCL is a fully owned company of MoRTH. Its mandate is to design, build, operate and maintain national highways and roads in the north-eastern region and other parts of the country that share international boundaries with neighbouring countries.

State public works departments (PWDs) and road development corporations are implementing agencies at the state level, implementing, operating and maintaining the state highways, major district roads and rural roads in some states.

A few states such as Maharashtra, Madhya Pradesh, Karnataka and Rajasthan have implemented the HAM model in awarding of state highway projects.

**Maharashtra:** Maharashtra's HAM model, implemented by the state PWD, is structurally largely similar to the NHAI HAM model, albeit with a few differences. In the NHAI HAM model, 40% of the contract amount is paid in 10 instalments during the construction period, while in the Maharashtra PWD HAM model, 60% of the contract amount is paid in five instalments during the construction period. Budgetary allocation is the major source of funding for HAM projects in the state.

**Madhya Pradesh:** The HAM model in Madhya Pradesh, implemented by Madhya Pradesh Road Development Corporation Limited (MPRDC), has 60% funding through government contribution during the construction period, similar to the model seen in Maharashtra. ADB funding is one of the key sources of funding for HAM projects in the state.

**Karnataka:** In Karnataka, Karnataka Road Development Corporation Limited (KRDCL) and Karnataka PWD, through its flagship Karnataka State Highways Improvement Project (KSHIP), implement the HAM projects. While the government contribution to the project funding during the construction period is 40% in projects implemented by KRDCL, it is as much as 75% for projects implemented under KSHIP. ADB funding is one of the key sources of funding for HAM projects in Karnataka as well.

**Rajasthan:** Rajasthan's HAM model, implemented by the Government of Rajasthan PWD, requires equal contribution from the government and the developer during the construction period. HAM projects in the state have also benefited from ADB funding.

MoRD is responsible for policy development as well as monitoring and coordination of rural roads. Apart from state PWDs, the Panchayati Raj ministry also constructs and maintains rural roads. Allocation for Pradhan Mantri Gram Sadak Yojana (PMGSY), which is focused on rural roads, is provided by MoRD.

The ministries allocate and release funds, for the development of roads, to the respective implementing agencies.

## Policy framework for the infrastructure sector

### Budget 2022

The fiscal 2023 capital allocation for MoRTH stood at Rs 1,99,107.71 crore, which is the highest-ever for the ministry. In fiscal 2022, this stood at Rs 1,08,230 crore. The total allocation, including revenue expenditure, for fiscal 2022 stood at Rs 1,18,101 crore, up from Rs 1,01,823 crore in fiscal 2021. Of the total allocation, the NHAI will get 1,34,015 crore (~67%), up from Rs 57,350 crore (revised estimate) in fiscal 2022. Between fiscals 2018 and

2022, the NHAI borrowed an average of Rs 63,300 crore per year. Due to the excessive borrowings, the NHAI's leverage has increased considerably. To limit the rise in borrowings, the NHAI's budgetary support in the form of cess and toll plough-back was increased by 106% for fiscal 2022 (budgeted) and its IEBR was kept at nil.

**Impact**

The increase in allocation is expected to improve road connectivity across the country, and will have favourable spillover effects on allied sectors such as construction-focused companies as well as boost demand for steel and cement.

**Key policy measures for private participation**

In order to encourage and facilitate private sector investment and participation in the road sector, the central government has undertaken certain policy measures and provided certain fiscal incentives within the sector. The most significant policy reforms in recent times are discussed below.

Amendments to Build-Operate-Toll (BOT) Model Concession Agreement (MCA), August 2020

**Land acquisition:**

1. The authority shall grant vacant access and right of way (RoW) for minimum 90% of the construction zone before the appointed date as opposed to 80% previously.
2. The balance 10% land should be granted within 180 days of the appointed date, and in the event of delay beyond the said 180 days, the balance RoW would be removed from the scope of work. The descoping clause was not present in the earlier agreements. Automatic descoping enables the developer to receive PCOD/ COD on the completed stretch and start tolling.
3. If the appointed date is not received within the first anniversary of the date of signing the concession agreement (or extended period), the project would be deemed to be terminated. This termination clause was not present in earlier agreements; it was introduced in HAM and is similar in the new BOT agreement.

**Traffic risk:**

1. Another major change in the MCA is the provision of assessing the revenue of a project every five years instead of 10 years or once in the lifetime of the project. In case of traffic shortfall from the target traffic, the concession period would be adjusted accordingly.
2. The new clause states that in the event the actual average traffic has fallen short of the target traffic by more than 5%, then for every 1% shortfall, the remaining concession period will be increased by 1%. But shall not exceed 20% of the concession period.

**Additional clause for stuck projects:**

1. In case the project has not achieved COD one year post its scheduled completion date and proceedings have been started against the concessionaire before the NCLT, the project will be mutually foreclosed and the authority shall pay the concessionaire an amount equal to:
   - **a.** 90% of debt due less insurance cover, and
   - **b.** Value of work done
2. This will prevent dragging of projects that would lead to time and cost overruns, which happened in the earlier BOT projects era.

**Impact of the policy**

- The automatic descoping as well as making 90% of land available before the appointed date would nullify land acquisition issues that were prevalent in earlier BOT projects. Plus, the clause to terminate the project if the appointed date is not achieved within a year would also weed out unviable projects and avoid cost and time overruns.
- Revenue assessment based on target traffic every five years instead of 10 years makes it more viable for developers to bid for BOT projects and maintain their IRRs.
- The additional clause on stuck projects, especially due to developers' default, would also enable the NHAI to weed them out and rebid them viably.

**Recent policy amendments related to HAM projects:**

Operation and maintenance (O&M) bids have been removed as an award criterion since many players were quoting excessively low O&M bids in order to win projects. Furthermore, additional performance security is now required for abnormally low bids below 20%. Additionally, the government has contemplated adjusting the calculation of net worth by deducting balance equity commitments from the actual net worth before awarding projects.

**Impact of the policy**

These measures are likely to reduce bidding intensity and prevent projects being awarded at abnormally low quotes to developers not possessing sufficient resources to complete the projects.

**GST on HAM projects:**

The GST Council has made 12% GST applicable on annuity payments for HAM projects received during the operations period.

# National highways: Review and outlook

## Overview of the PPP framework and models in operation

**Hybrid annuity model:** MoRTH introduced the hybrid annuity model (HAM) model in June 2015. HAM is a PPP framework in which 40% of the project cost is funded by the government while the balance is arranged by the developer through a debt-equity mix. Upon completion of construction, the government makes 30 semi-annual payments to the developer.

The developer is responsible for maintaining the road for 15 years post construction. The government will make annual operations and maintenance (O&M) payments to the developer, and the payment is increased each year taking inflation into account.

**Build-operate-transfer (BOT) – Toll:** In the BOT – Toll model, the entire project cost is borne by the developer and the viability gap funding is capped at 40%. Toll collections arising from vehicular traffic during the operational period are the only source of revenue for the developer. Since the developer bears the entire cost of construction, it is highly exposed to cost overruns, inflationary pressures and interest rate risk. The developer is also exposed to traffic risk in this model since lower-than-anticipated traffic can suppress revenue and negatively impact returns.

**Build-operate-ransfer (BOT) – Annuity:** Similar to the BOT-Toll model, the developer bears the entire project cost in the BOT – Annuity model. However, the developer is entitled to assured annuity payments in this model, thereby limiting exposure to traffic risk. Since the developer bears the entire cost of construction, it is highly exposed to cost overruns, inflationary pressures and interest rate risk. This model has now been replaced by HAM.

**Toll-operate-transfer (TOT):** Under this model, the NHAI transfers ownership of operational highways to private entities (the concessionaire) for a fixed period (the concession period), which is usually 20-30 years. The concessionaire makes a one-time upfront payment (concession fee) to the NHAI in exchange for the right to collect toll on the stretch during the period, during which the concessionaire will also be responsible for maintaining the road.

**Engineering, procurement and construction (EPC):** The government undertakes the total funding of the project while the private developer is responsible for the engineering and construction of the road. Since the entire funding is done by the government, the financial risk for the private player is minimal relative to the other models.

## Overview of National Highways Development Program (NHDP) and Bharatmala

### National Highways Development Program (NHDP)

The NHDP encompasses building, upgradation, rehabilitation, and broadening of existing national highways. The project is executed by the NHAI, in coordination with the public works departments of various states. The NHAI also collaborates with the Border Roads Organisation to develop certain stretches. The NHDP is being implemented in seven phases.

NHDP projects are awarded to private players either on EPC (cash) or BOT basis, and now on the newly introduced HAM. NHDP cash contracts are mainly financed through budgetary allocations from the Central Road Fund, negative grants/premium received and toll revenue. Loans and grants are also received from the World Bank and Asian Development Bank.

### Bharatmala Pariyojana

Bharatmala Pariyojana (BMP) is a new umbrella scheme, superseding the existing NHDP. The programme envisages construct ~65,000 km of highways under the following categories: national corridor (north-south, east-west and Golden Quadrilateral), economic corridors, inter-corridor roads, feeder roads, international connectivity, border roads, coastal roads, port connectivity roads, and expressways. This will include the existing NHDP programme as well.

The Government of India had approved Bharatmala Pariyojana Phase-I in October 2017 with an aggregate length of about 34,800 km (including 10,000 km residual NHDP stretches) at an estimated outlay of Rs 5,35,000 crore. It was for the development of:

- ~9,000 km length of economic corridors
- ~6,000 km length of inter-corridor and feeder roads
- ~5,000 km length of national corridor efficiency improvements
- ~2,000 km length of border and international connectivity roads
- ~2,000 km length of coastal and port connectivity roads
- ~800 km length of expressways

Total of 255 road projects with an aggregate length of 10,699 km have been approved till October 2019 under Bharatmala Pariyojana with total cost of Rs 2,64,916 crore. As of May 2022, ~40% of the detailed project report-ready projects are yet to be awarded. A limited rise in budgetary support, coupled with higher capex for 70% of high-value expressways currently under construction, could defer NHAI awards under Bharatmala Phase 1 beyond fiscal 2024 — the year construction was originally scheduled to be completed.

**Table 21: Components of Bharatmala Pariyojana (Phase-1)**

| Category | Description | Total length (km) | Upgrade proposed in phase 1(km) |
|---|---|---|---|
| National corridor efficiency improvement | Lane expansion. De-congestion of national corridor | 13,100 | 5,000 |
| Economic corridors development | Connection of economically important production & consumption centres | 26,200 | 9,000 |
| Inter-corridor and feeder routes development | Inter-connection between economic corridors, and first- and last-mile connectivity | 15,500 | 6,000 |
| Border and international roads | Connectivity to border areas and boosting trade with neighbouring countries | 5,300 | 2,000 |
| Coastal and port connectivity roads | Connectivity to coastal areas to enable port-led economic development | 4,100 | 2,000 |
| Expressways | Greenfield expressways | 1,900 | 800 |
| Total | | 64,200 | 24,800 |

*Source: MoRTH Annual Report 2021-22, CRISIL MI&A Research*

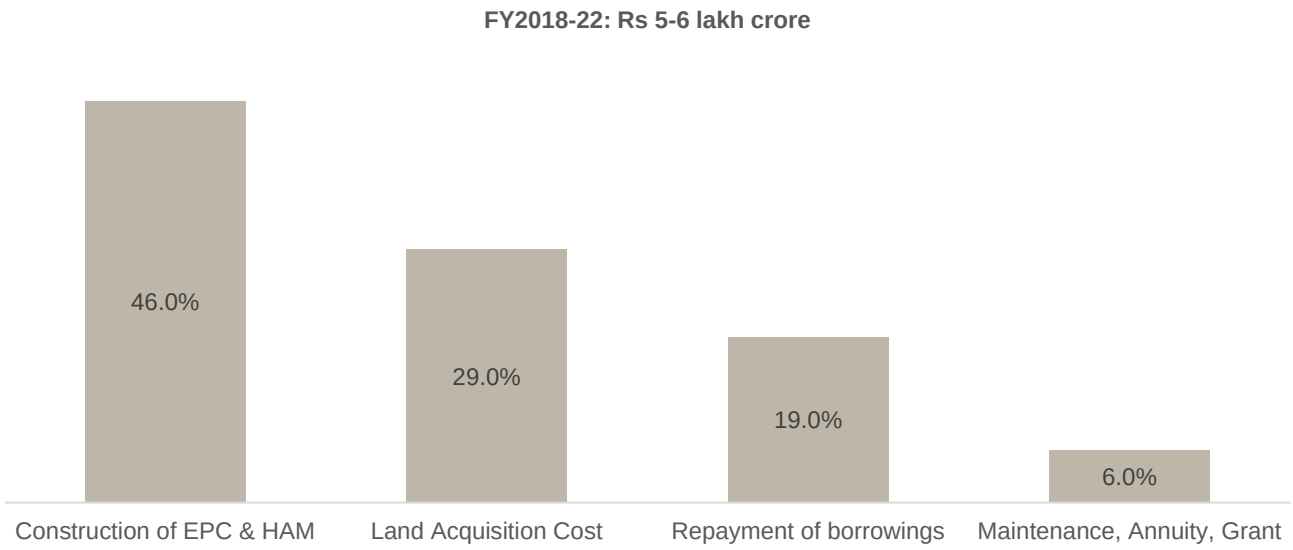
As of May 2022, ~40% of the detailed project report-ready projects are yet to be awarded. A limited rise in budgetary support, coupled with higher capex for 70% of high-value expressways currently under construction, could defer NHAI awards under Bharatmala Phase 1 beyond fiscal 2024 — the year construction was originally scheduled to be completed.

## Review and outlook of NHAI funding

CRISIL Research estimates Rs 17-19 trillion will be invested in national highways between fiscals 2023 and 2027, with public funds dominating the overall spending. With the NHAI awarding more projects under the HAM and on cash-contract basis, it is now relying more on external borrowings and asset monetisation. While asset monetisation via TOT and now the InVIT route is challenging in itself, raising external funds is increasing the debt to equity of the authority and repayments now form a large outflow for NHAI. Timely asset monetisation is critical for NHAI to meet its ambitious Bharatmala targets.

Out of the Rs 5-6 lakh crore spent over the 5 years (Fiscals 2018-22E), 46% were toward milestone payments for EPC and HAM (40% of HAM) projects. ~29% were toward land acquisition expenditures and 19% toward interest and repayment of borrowing.

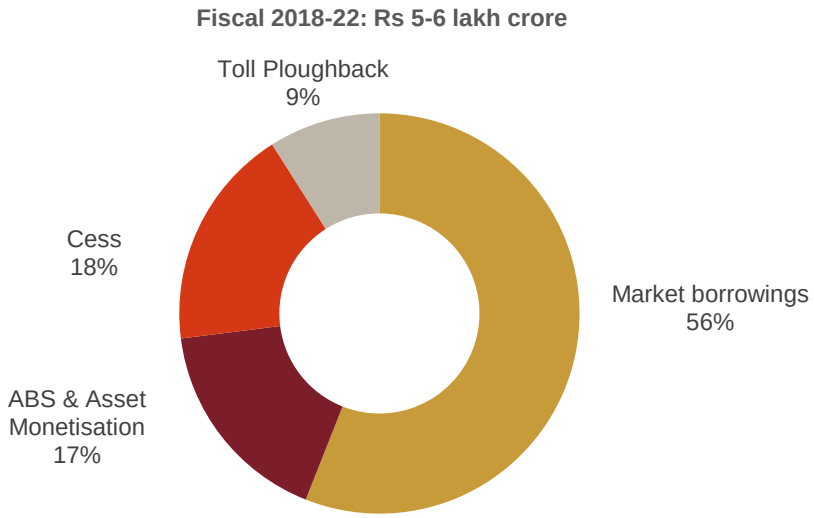
**Figure 63: NHAI application of funds: 46% of NHAI outflows towards construction**




*Source: NHAI, CRISIL MI&A Research*

Looking at the sources, while toll plough back and cess (budgetary allocation) contributed 18% and 9%, respectively, to the sources, market borrowings is where the maximum amount (56%) of NHAI's funding came from. Additional budgetary support and asset monetisation were 17% of total. With NHAI's requirement expected to increase with ambitious construction targets, additional support via monetication is critical for its future requirements.

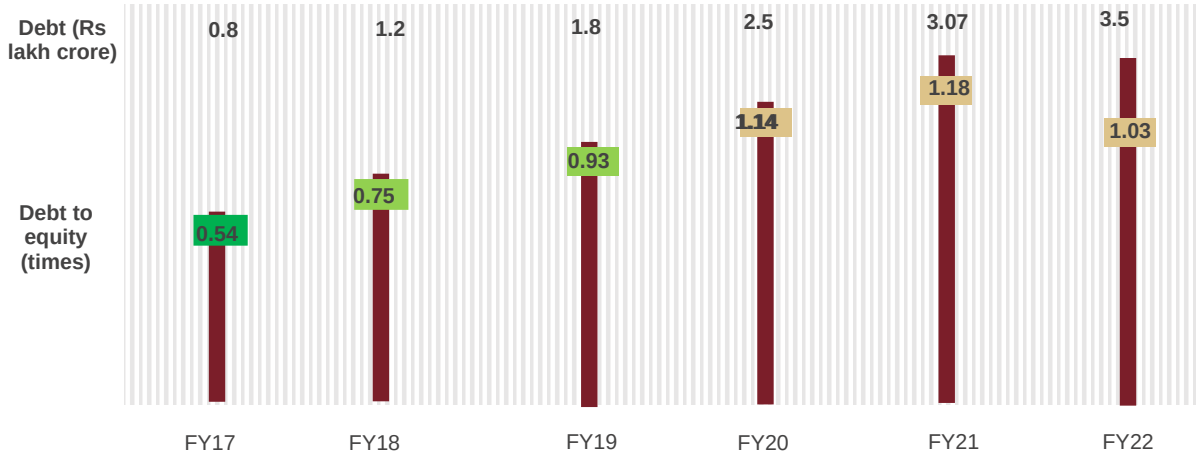
**Figure 64: NHAI sources of funds: Market borrowings accounted for 56%**




*Source: NHAI, CRISIL MI&A Research*

With the high dependence on market borrowings to fund EPC and HAM projects, NHAI's debt to equity had risen to 1.18 times in fiscal 2021. While it has improved slightly to 1.03 in FY22, it still remains at elevated levels.

**Figure 65: NHAI borrowings on the rise**

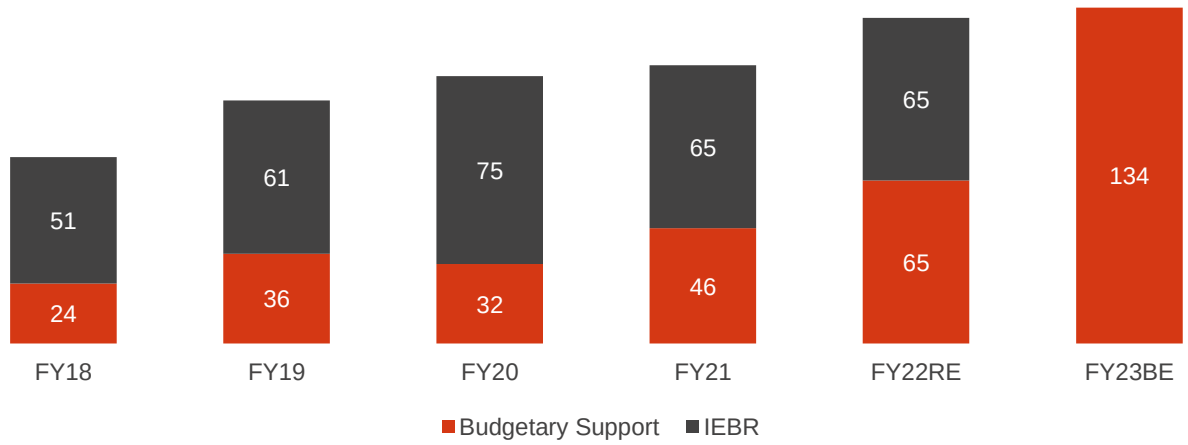



*Source: NHAI, CRISIL MI&A Research*

To limits the rise in borrowings, NHAI's budgetary support in the form of cess and toll plough back has been increased by 106% for fiscal 2022 (budgeted) and its internal and extra budgetary resources (IEBR) has been kept at nil.

**Figure 66: Budgetary support to NHAI up by 17%, IEBR done away with in fiscal 2023 Budget**

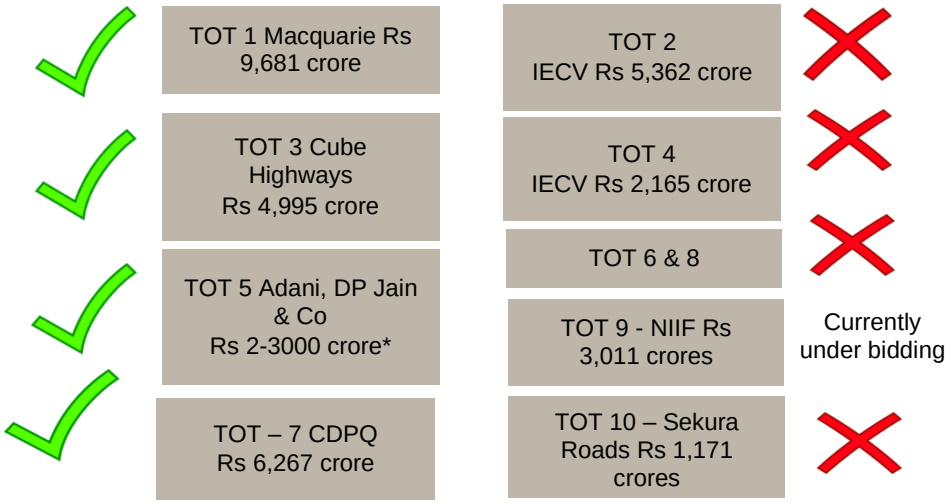
(Rs thousand crore)




*Source: Union Budget, CRISIL MI&A Research*

Other modes of funding such as TOT have seen only limited success. Over the past four years, the NHAI has been able to successfully monetise ~1,542 km and raise ~Rs 17,000 crore through TOT. Additionally, NHAI has been able to successfully monetise another 390 km of operational BOT assets at an enterprise valuation of Rs 8,000 crore via InvITs. With the implementation of Fastags, TOT becomes more attractive since it is able to eliminate cash handling and plug leakages in the system. However, of late, the awarding of TOT bundles have encountered impediments with certain TOT bundles such as TOT-6 and TOT-8 getting cancelled due to low bids. Therefore, the convergence of the expectations of the government authorities and private bidders remains a key monitorable as well as a major requirement for this mode of funding to become truly successful.

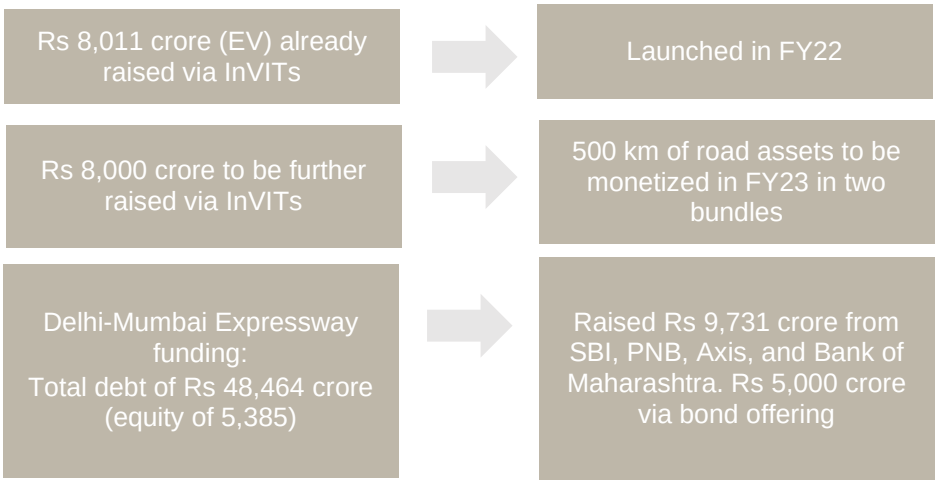
**Figure 67: Budgetary support to NHAI up by 17%, IEBR done away with in fiscal 2023 Budget**




*Source: CRISIL MI&A Research*

The authority has also tied up debt via special purpose vehicle (SPV)-level funding for the Delhi-Mumbai expressway where it has already raised Rs 9,731 crore.

**Figure 68: InvITs and SPV level financing gaining traction**




*Source: NHAI, CRISIL MI&A Research*

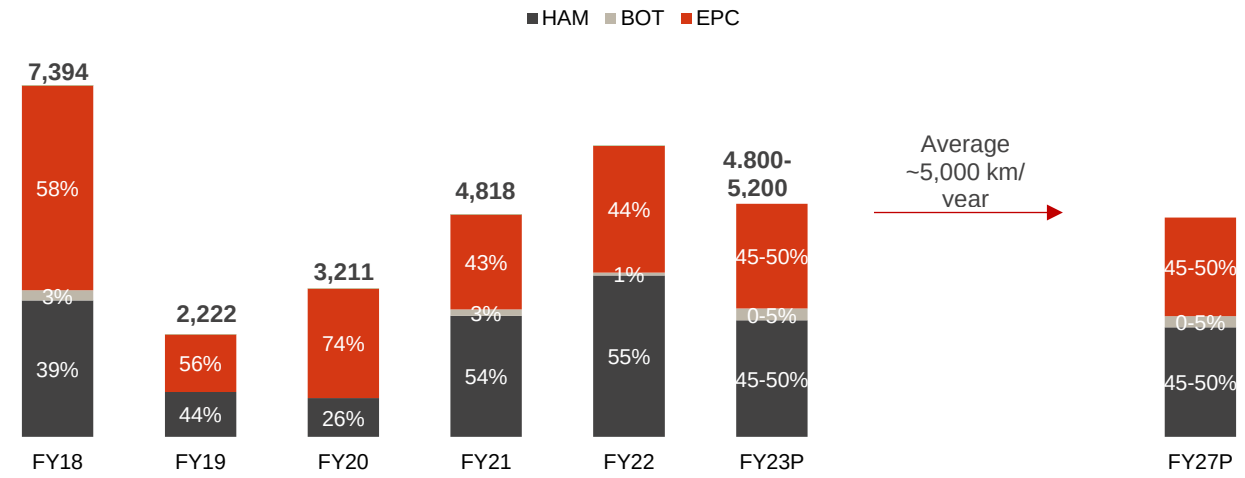
## Review of investment in NHAI projects (fiscals 2017-22)

NHAI's awarding activity has increased sequentially, from merely 2,222 km in fiscal 2019 to 6,306 km in fiscal 2022. Fiscal 2021 was a pivotal year since despite the pandemic-induced disruptions, there was a healthy growth in awarding. The NHAI awarded 4,818 km in fiscal 2021, which was a three fiscal high. Of these, 54% were awarded under HAM, 3% under BOT mode and the rest under EPC. Additionally, favourable changes in the BOT and HAM agreements, and relaxation of bidder eligibility criteria not only indicated a clear policy shift to improve private sector participation but also aided the spurt in HAM awards. In fiscal 2022, the awarding momentum continued unabated as the NHAI awarded 6,306 km in the fiscal. The share of HAM and EPC in the awarding increased marginally to 55% and 44%, respectively, while projects under the BOT model accounted for only a paltry 1%.

## Outlook on investments in national highways (FY23-27)

In fiscal 2023, as per CRISIL Research estimates, NHAI awarding is expected to slow down to ~5,000 km while the respective shares of HAM, EPC and BOT in the total awarding are expected to remain at similar levels vis-à-vis fiscal 2022. A limited rise in budgetary support, coupled with the higher capex for 70% of high-value expressways currently under construction, could defer NHAI awards under Bharatmala Phase 1 beyond fiscal 2024 — the year construction was originally scheduled to be completed. Over the medium term, it is expected NHAI would continue to award ~5,000 km per year on average between fiscals 2024 and 2027. Furthermore, the shares of HAM, EPC and BOT in the awarding are expected to remain largely stable without any significant deviations. Additionally, developers will be able to free up capital through stake sales, supported by the strong pipeline of projects under Bharatmala and the NIP.

**Figure 69: 55% of projects awarded under HAM in fiscal 2022, share is expected to remain similar**




*Source: NHAI, CRISIL MI&A Research*

## Key growth drivers for toll traffic at national highways

The key drivers for growth in toll traffic at national highways are outlined below:

- Industrial and economic development in areas surrounding the national highways and the corresponding increase in economic activity is a major driver for traffic growth
- Improved quality of roads would reduce the risk of accidents and enable vehicles to move faster. This would make highways a preferable mode of transport and act as a tailwind for traffic on national highways
- Four- and six-laning of national highways would increase the capacity of Indian highways and reduce congestion, enabling a greater number of vehicles to use the highways without a delay in travelling time
- Higher surveillance and security on national highways would increase safety and reduce the occurrence of theft. This would improve the acceptability of highways as a mode of transport and encourage more drivers to use the national highways
- Less frequent toll plazas and a reduction/waiver in toll fees would make transportation through highways more favourable, which would lead to more people using the national highways for transportation. In this regard, FASTAG has also helped by facilitating easy identification, quicker turnaround times at toll plazas and plugging leakages. An increase in FASTAG penetration will be further beneficial for traffic on the national highways

- A pick-up in tourism activities in areas in and around the national highways would lead to an increase in the recreational/passenger traffic on national highways

## Competition profile and AEL's positioning

### Dilip Buildcon

Dilip Buildcon undertakes road construction under EPC, BOT and HAM. It also provides EPC services for bridges, buildings, dams, canals, water supply, and mining. The company has a presence across 17 states and till date has executed over 100 EPC projects and laid over 15,000 km of road. As of fiscal 2022, it had Rs 90 billion in revenue and an order book to sales ratio of 2.83.

### KNR Constructions

KNR Constructions Ltd (KNRCL) is a construction company with expertise in EPC services across roads and highways, irrigation and urban water infrastructure management. Its order book is dominated by road projects (75%), followed by irrigation. The company is an established player in the south, especially in Andhra Pradesh, Karnataka, Kerala, Telangana, and Tamil Nadu, which account for 90% of its order book. As of fiscal, it had revenue of Rs 33 billion and an order book to sales ratio of 2.73.

### PNC Infratech

PNC Infratech executes infrastructure projects, including highways, bridges, flyovers, power transmission lines, airport runways, and industrial area development. It has expertise EPC projects in roads and highways. As of fiscal 2022, it had revenue of Rs 61 billion and an order book to sales ratio of 2.39.

### Ashoka Buildcon

Ashoka Buildcon (ABL) is an infrastructure development company with a widespread presence in eleven states. It develops and builds infrastructure facilities on design, build, finance, operate and transfer (DBFOT) basis in the highways sector, and on EPC basis in the highways and power sectors. As of fiscal 2022, it had revenue of Rs 46 billion and an order book to sales ratio of 2.98.

### Adani Enterprises

Adani Enterprises entered the business of road and highway construction in January 2018 and has bagged a portfolio of more than 5,000 lane km spread over 10 states. Adani Enterprises has a balanced portfolio of 14 projects comprising a mix of eight HAM projects, five BOT projects and one TOT project, making it one of the top 5 listed roads players in India.

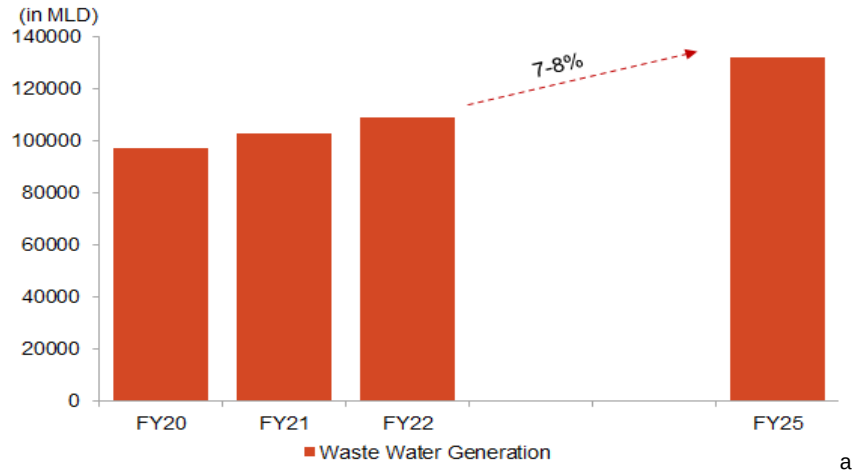
# Water industry

Water touches every aspect of development and it links nearly all Sustainable Development Goals of the UN. It drives economic growth, supports a healthy ecosystem, and is essential and fundamental for life itself. The Indian economy is undergoing rapid urbanisation and industrial growth. Water, a key resource, is garnering attention from the Government and policy makers.

## Wastewater treatment market overview

- In India, use of water is broadly for two purposes: domestic (household purposes) and industrial usage. The water treatment industry comprises activities related to the provision of fresh and clean water and management of wastewater for commercial/residential customers and industries.
- About 1.3 lakh MLD of waste water is estimated to be generated in India in fiscal 2025. Waste water can be classified into that generated from sewage and from industrial segments. Waste water treatment includes sewage treatment and effluent treatment.
  - **Sewage treatment** includes treating wastewater produced by community of people, which can be characterised based on volume, physical conditions, chemical and toxic constituents, and its bacteriological status. The Central Pollution Control Board (CPCB) carries assessment of quantities of sewage generation and its treatment with the help of state pollution control boards.
  - **Effluent treatment** includes waste generated from the industrials segment. CPCB has set regulations and guidelines such as limits for various impurities, biological oxidation demand (BOD) and chemical oxidation demand (COD) for different industries in India depending on which, effluent treatment plants (ETP) plants are set up by these industries.

**Figure 70: Growth in waste water generation**

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*Source: CPCB reports, Department of Water Resources, CRISIL MI&A Research*

- About 1,00,000 MLD of waste water was generated in India in fiscal 2021, with sewage water accounting for almost three-fourths of it. Sewage wastewater is expected to clock a CAGR of 5-6% between fiscals 2022 and 2025, whereas industrial wastewater is expected to grow at a CAGR of 8-9%, taking total wastewater generation to ~131,000 MLD

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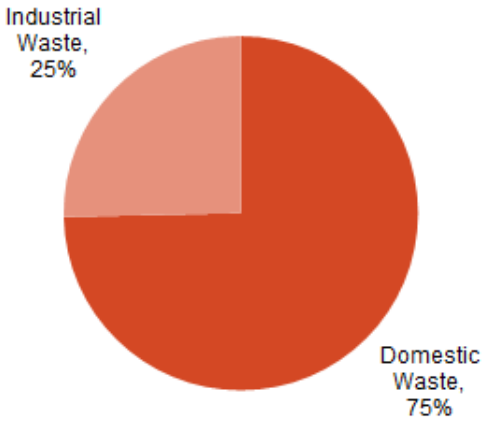
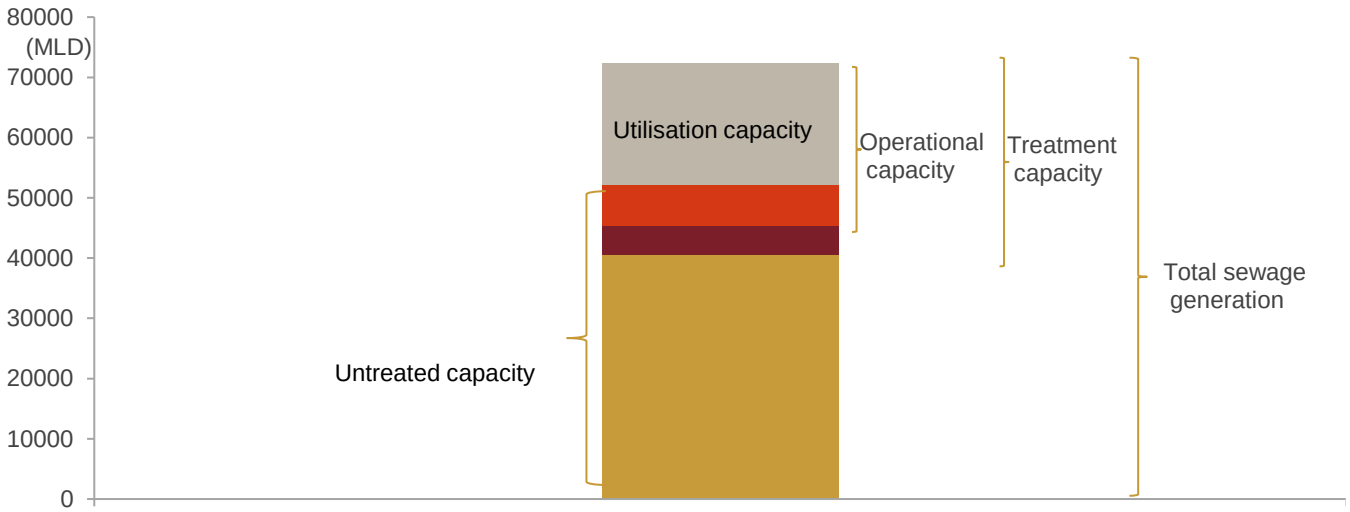
**Figure 71: Municipal waste accounts for 3/4th of the total water waste generation**




*Source: CPCB reports, CRISIL MI&A Research*

- Despite extensive use across domestic and industrial segments, the treatment capacity for domestic waste is less than 50% of the generated waste, whereas the operational capacity is ~84% of the treatment capacity, thus accounting for ~37% of the domestic waste generated. The utilisation capacity accounts for a meagre ~28% of the generation, thus nearly 70% of domestic wastewater generated goes untreated
- Industrial wastewater accounts for ~25% of the total wastewater generated, on average, out of which ~40% of water goes untreated

**Figure 72: Nearly 72% of sewage generation is untreated**

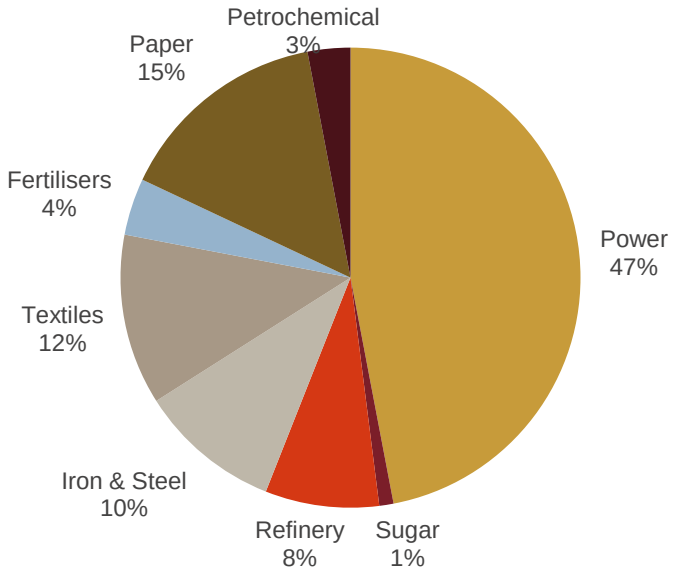



*Source: CPCB reports, Department of Water Resources, CRISIL MI&A Research*

- The power sector's contribution to industrial wastewater generation is the highest, with almost half of the wastewater generation capacity in the paper industry
- Rising urbanisation and expansion of industries by capacity coupled with lack of access to usable water will increase the demand of water. The government has initiated stringent regulatory norms for ETPs, creating an opportunity for expert players to enter in the wastewater treatment market

- The central government has launched Namami Gange Programme that aims to develop sewage treatment plants (STPs) with a capital outlay of Rs 25,000 crore. Under the National Infrastructure Pipeline (NIP), wastewater treatment plants have been allocated Rs 80,000 crore, creating a huge potential for this growing market
- Despite policies such as Ganga Action Plan and Yamuna Action Plan, and adoption of AMRUT, the operational STPs were only 64% of the 846 municipal STPs in fiscal 2021. Lack of infrastructure capacity and operational maintenance remain challenges for this industry

**Figure 73: Break-up of waste water generation as per industrial usage**




*Source: CRISIL MI&A Research*

## Key trends and drivers

- Rising population will lead to increasing water usage and consequently increase waste water generation on the municipal side
- According to a NITI Aayog study, per-capita water available for India is going to decline to 1,465 $m^3$ in 2025 from 1,544 $m^3$ in 2011, implying India is one of the most water stressed countries in the world, making waste water treatment imperative as the usage of water is on the rise
- The ground water table is depleting whereas the quality of water is getting deteriorated, which will impact sustainability of both urban and rural water supply. Overexploitation of ground water problems such as scarcity of water for irrigation during summers, decrease in wells and tube well yields, and increase in costs of pumping water will drive the reuse and recycling of waste water
- Increasing number of manufacturing units will lead to increased water consumption and waste water generation. Most industries require gallons of water, such as textile, paper, oil and gas, fertiliser, brewery, cement, automotive, mining, sugar, chemical, steel, pharmaceutical, semiconductor, and power industry. For instance, to make one gram of paper pulp, 99gm of water is used. This enormous requirement needs processing of water as well as recycling
- Fresh water being scarce, treated or partially treated water can be utilised for industries or for irrigation. With advancement in technology for recovery of nitrates and phosphorous from sewage, the manure which comes out as by product post waste water treatment can be utilised for plants

- The central and state governments have stringent regulations for illegal discharge of waste water causing pollution. Laws related to drinking, potable and waste water will encourage industries to integrate waste water management systems, thereby keeping pollution in control

## Risks and challenges

- Lack of awareness and hesitation to reuse treated waste water for domestic and industrial purposes hampers its adoption
- Utilisation of the existing STPs to their full potential is lacking, as despite a rise in operational capacity of sewage treatment, the treated waste water accounts for ~28% of the generated waste
- Along with building new infrastructure for both STPs and ETPs, operation and maintenance (O&M) for the same remains a concern. Nearly 40% of STPs did not comply with general standards prescribed by Environment (Protection) Rules for discharge of waste water into streams. Inadequate knowledge of the personnel maintaining the plant makes timely evaluation of the plants difficult. Thus, even the existing capacities for treatment of waste water goes underutilised
- The gap between sewage generation and treatment capacity has been widening at an accelerated pace, and thus the time frame to fill the gap should be minimum and efficient
- Effluents generated from different industries require different treatment, setting up a common ETP will not help in tackling different types of waste generated
- Identification of waste water management as a state subject can cause of mismanagement and lot of ambiguity in the absence of clear definition of roles and responsibilities of who is the concerned stakeholder, where lack of action by one state can affect the interest of another state
- The cost of centralised waste water treatment is significant, building up the same is labour intensive and time consuming, and requires a well-developed inter-connected sewers and drainage system

## Government policies and regulations

**Table 22: Policies**

| Policies | | |
|---|---|---|
| NUSP, 2008 | National Urban Sanitation Policy (under revision) | Emphasises on recycling sewage and water from domestic and industrial sources before discharging it, preparation of action plans for major cities addressing water pollution, having regulatory systems with a combination of incentive-based instruments, projects and partnerships |
| NWP, 2012 | National Water Policy (under revision) | Focuses on reducing water pollution, imperative use of water recycling and reuse |
| FSSM, 2017<br>MGWB, 2005, 2017 (draft) | National policy on Faecal Sludge Septage Management<br>Model Groundwater (Sustainable Management) Bill, 2017 | Achieving 100% access to safe sanitation, safe disposal of faecal waste in urban areas of India, with strict environmental discharge standards |

## Other policies

- Under the 2016 Tariff Policy by the Ministry of Power, thermal power plants located within 50 km radius of STP are mandated to use treated used water (TUW)

- Under the Ministry of Housing and Urban Affairs (MoHUA), as per Service Level Benchmarks (SLBs), the extent of reuse and recycle of sewage in urban areas is mandated at 20%
- The National Guidelines on Zero Liquid Discharge (ZLD), developed by CPCB, reinforce no mixing of industrial waste water with municipal waste
- Namami Gange Policy was launched in 2014-15 to treat River Ganga and its tributaries, under which it plans to have one city, one operator framework to maintain all STPs in the city along the river

## Adani's positioning

Foreseeing the massive need for water infrastructure capacity augmentation, Adani is implementing a waste water treatment project at Prayagraj, Uttar Pradesh and Bhagalpur, Bihar under the 'Namami Gange, One City One Operator' framework. The Prayagraj project comprises the construction of three new STPs of cumulative 72 MLD capacity and rehabilitation of six existing STPs of cumulative 254 MLD capacity with 15 years of O&M. The Bhagalpur project comprises the construction new STPs of 45 MLD along with associate infrastructure such as pumping stations and rising mains/ gravity mains.

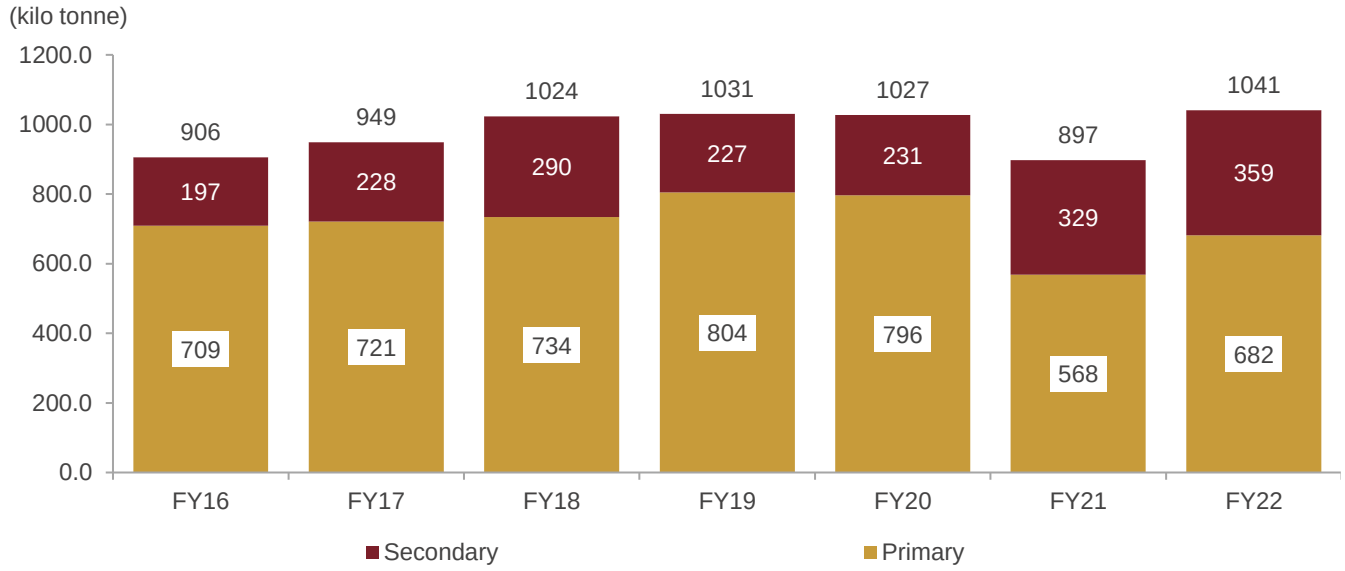
# Copper

## Review of domestic consumption

Domestic copper consumption is met through primary and secondary copper. Primary copper is produced through refining and smelting process to convert copper concentrate to copper, whereas secondary copper is produced through copper scrap.

### Demand segregation by primary and secondary copper

**Figure 74: Overall domestic copper consumption**




*Source: Industry, CRISIL MI&A Research*

Domestic copper demand logged 1.9% CAGR between fiscals 2017 and 2022. The share of secondary copper is seeing rising gradually since 2017 owing to better scrap availability and increasing primary copper prices.

Overall domestic demand increased 4.2% CAGR between fiscals 2017 and 2019 before falling marginally by 0.4% on-year in fiscal 2020. The demand fell sharply by 12.6% in fiscal 2021 owing to nationwide lockdown in first half of fiscal 2021 amid the pandemic. Demand revived 16% in fiscal 2022 owing to strong revival from end-user industries.

**Fiscal 2017**: Demand grew 4.8% on-year owing to strong consumer durables production and healthy automobile production led by two wheelers and three wheelers. The increased focus on infrastructure spending also supported the overall copper demand. The growth was limited owing to slowdown in construction segment amid demonetisation announced in November 2016.

**Fiscal 2018:** Demand grew 7.8% despite slowdown from infrastructure segment owing to stalled execution from IL&FS due to revival from construction segment and strong demand from automobile and consumer durables segments. The slowdown in infrastructure segment also impacted demand from primary copper, as more than 65% of infrastructure segment demand is met through primary copper.

**Fiscal 2019:** Demand grew marginally by 0.7% on-year despite continued momentum of automobile segment with increasing copper intensity amid increasing electronics systems owing to falling demand from power and building construction segments.

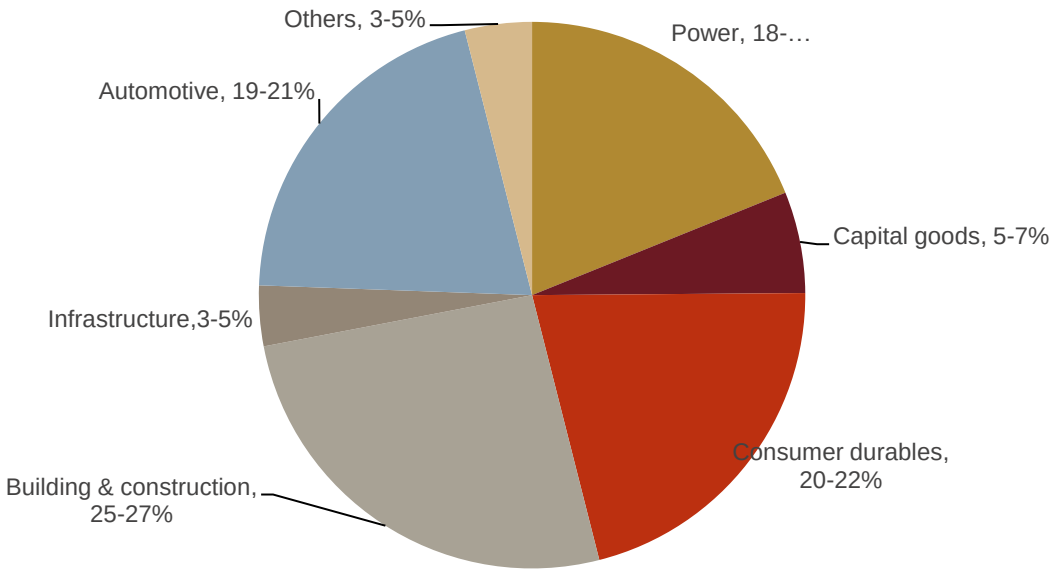
**Fiscal 2020:** Demand fell marginally by 0.4% on-year owing to a moderate decline from the automobile segment coupled with sharp decline from power, capital goods and infrastructure segments. However, continued momentum from consumer durables owing to increasing rural spending limited the decline overall.

**Fiscal 2021:** Demand witnessed a sharp decline of 12.6% on-year owing to demand destruction from end-use segments owing to the nationwide lockdown in the first half of fiscal 2021. However, sharp demand revival in the second half of fiscal 2021 partly stemmed the fall.

**Fiscal 2022:** Demand revived 16% on-year. But the rise was limited by semi-conductor shortages affecting automobile production coupled with the second wave of Covid-19 in the first quarter leading to partial lockdowns in some states.

**Key end-use industries**

**Figure 75: Shares of key end-use industries (FY22)**




*Source: Industry, CRISIL MI&A Research*

**Power:** The power segment accounts for 18-20% of overall copper demand. Copper is used as an alloy with aluminium in power distribution lines. During fiscals 2017-2022, demand from the power sector fell slightly owing to fall in capex by PGCIL. Addition of transmission lines fell 8.9% CAGR during the period owing to lower orders from PGCIL and state electricity boards. The production of power transformers and distribution transformers fell 4.5% and 4% CAGR, respectively, during the period. On the other hand, the production of power cables logged 4.6% CAGR owing to higher domestic demand and export orders.

**Transport:** The transport segment is one of the major demand drivers for the domestic copper industry. Copper is used for wiring, connectors, batteries, radiators and bearings. This segment is a major growth driver of secondary copper. Production of car and utilities vehicles fell 0.8% CAGR between fiscals 2017 and 2022 owing to semiconductor chip shortage experienced since fiscal 2021. Production of two-wheelers and commercial vehicles remained flat. However, copper intensity increased marginally, which boosted the overall copper demand. Copper is

heavily used in railway electrification. The electrification expenditure clocked a strong 24% CAGR during the period owing to the government's intention to reduce usage of diesel engines.

**Building & construction:** Copper is used to make industrial roofing, heating systems, expansion joints and wall cladding. Copper is costlier than other alternatives and so, is used only in the premium urban construction projects. Copper is also used in various industrial projects. During fiscals 2017-2022, various government schemes focused on housing, such as the Pradhan Mantri Awaas Yojana-Urban (PMAY-Urban) witnessed significant growth. The scheme, along with industrial developments, spearheaded overall copper demand from the construction segment.

**Infrastructure:** Copper is used for broadband cables, telecom cables, electrification of various infrastructure projects such as road, airports, and ports. During fiscals 2017-2022, copper demand from this segment fell 5.3% CAGR despite increasing road, airport and port investments. The decline was owing to higher usage of optical fibre, an alternative for copper wire in the telecom industry

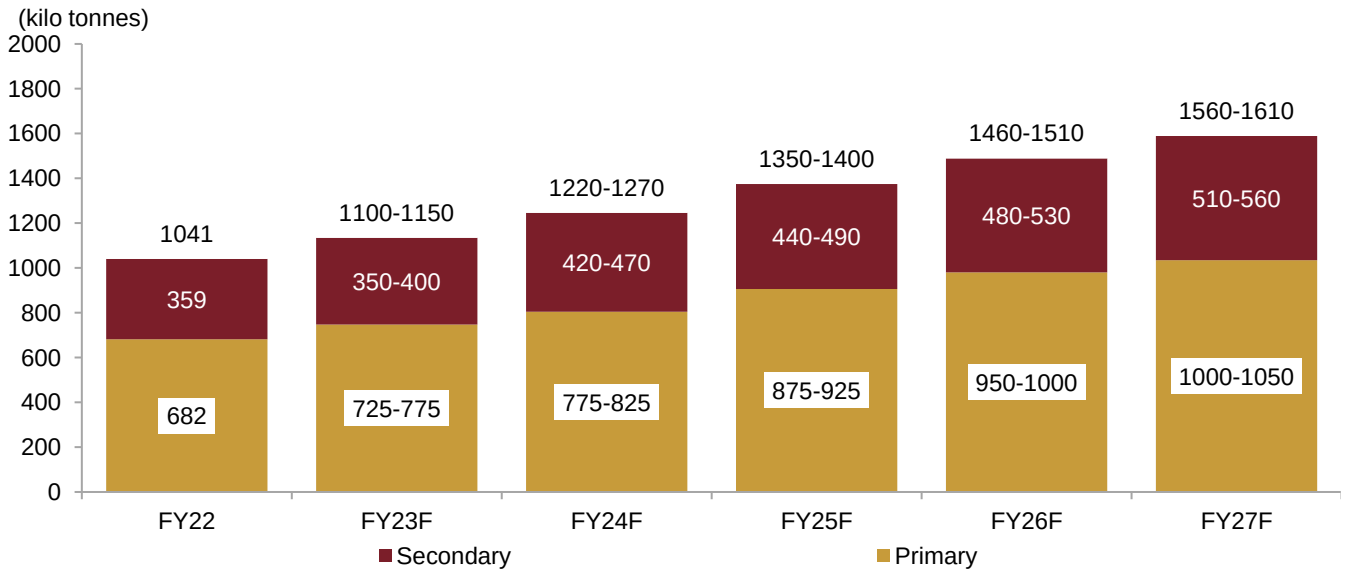
**Capital goods:** Copper is used to make bearings, gears, hydraulic tubing, and fasteners. During the period under review, demand from capital goods fell a moderate 2% CAGR owing to higher production of motors and agriculture equipment.

**Consumer durables:** Copper is used to make tubes for heat exchange systems in refrigerators and air conditioners and also in electric motors in washing machines. During the period, production of refrigerators increased 2.3%, air conditioners 3.5% and washing machines 2.1% owing to higher demand from rural areas.

## Outlook for domestic copper consumption

### Demand segregation by primary and secondary copper

**Figure 76: Domestic copper consumption outlook**




*Source: Industry, CRISIL MI&A Research*

The per capita consumption of copper in India in fiscal 2020 was 0.5 kg compared with Russia's 3.3 kg, China's 5.4 kg, the US's 5.5 kg and the global average of 3.2 kg. Average per capita consumption of developed economies is ~10 kg. Thus, going forward, the country is expected to witness healthy domestic consumption. Overall, copper demand is expected to log 8.5-9.5% CAGR between fiscals 2023 and 2027 to reach 1,560-1,610 KT, driven by

strong demand from consumer durable, automobile and construction segments. The demand may see significant upside depending on renewable energy investments and EV penetration.

## Key end-use industries

**Power:** Over fiscals 2023-2027, the power sector is likely to clock a CAGR of 6-8% mainly driven by renewable energy grid projects focused on solar and wind projects undertaken by PGCIL, supported by state transmission projects. While financial stress on discoms is likely to be a deterrent for demand in the short term, the Rs 3.03 trillion discom reform scheme launched in June 2021 will support demand growth in the long term.

**Transport:** The transport segment is expected to grow 13-15% CAGR between fiscals 2023 and 2027. Production of cars and utility vehicles is expected to clock 6-8% CAGR during this period. Copper intensity is also expected to increase in various components to improve fuel efficiency. Production of two-wheeler is expected to register 8-10% CAGR owing to better domestic demand, especially from rural areas and healthy export orders. Production of tractor is expected to remain robust with 4-6% CAGR in export orders and 5-7% CAGR in domestic demand owing to better rural income. During the period, increasing railway electrification and adoption of electric vehicles are expected to drive the growth for this segment.

**Building & construction:** Over fiscals 2023-2027, copper demand from the construction sector is expected to record a healthy 6-8% CAGR primarily driven by increasing housing schemes under the PMAY. As the government is targeting house for every citizen, it will be a key driver for copper demand from this segment.

**Infrastructure:** Over fiscals 2023-2027, copper demand from the infrastructure segment is expected to see a decline in growth of 2-4% CAGR owing to higher usage of optical fibre in the telecom industry. However, the decline is expected to be limited owing to increasing electrification of roads, airports, and ports.

**Capital goods:** Over fiscals 2023-2027, the capital goods segment is expected to log 4-6% CAGR owing to healthy production of industrial machinery and material handling equipment amid the government's focus on improving domestic manufacturing. The government's Make in India scheme will be a key monitorable for copper demand from this segment.

**Consumer durables:** Over fiscals 2023-2027, the consumer durables segment is expected to clock an 8.5-10.5% CAGR owing to robust production amid improving income and affordability, especially from rural areas. Copper usage in the segment is expected to be driven by higher copper intensity in various consumer durables, such as ACs, refrigerators and washing machines.

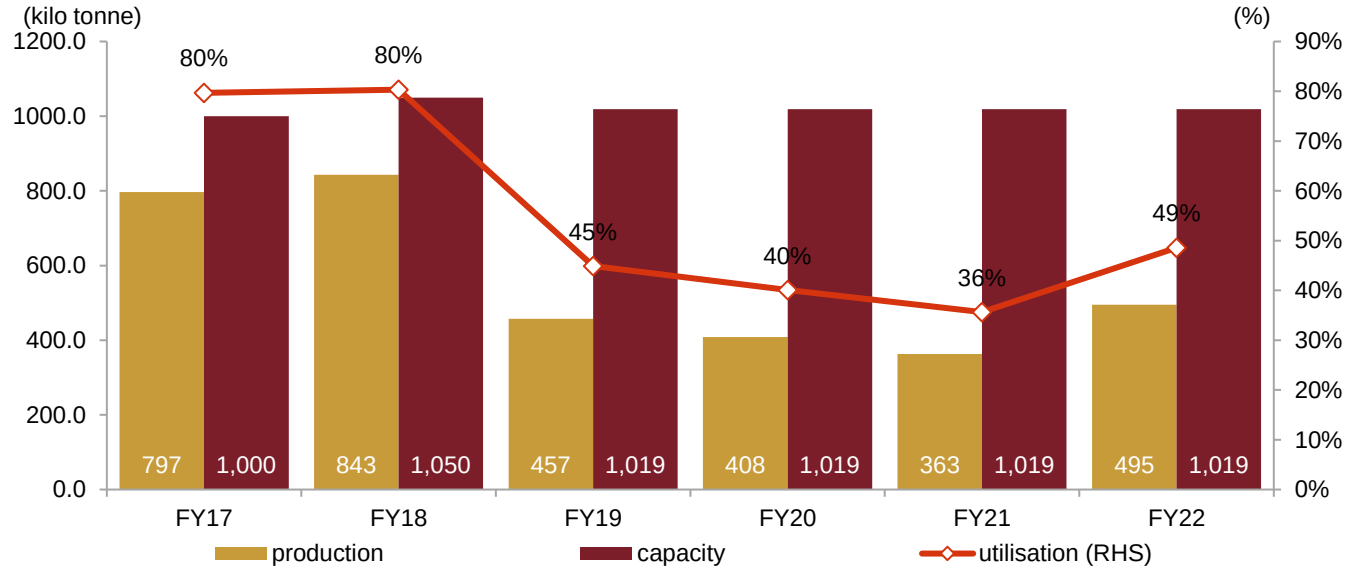
### *New-age industries*

- **Renewable energy:** This sub-segment in the overall power segment will be a major factor in determining copper demand over the medium term. Copper is used to make solar modules, electric motors for wind and hydro power generation. Currently, India is importing solar modules to meet most of its requirement. China accounts for more than 85% of the imports. However, after the government published the Approved List of Module Manufacturers (ALMM) for projects approved after April 10, 2021, more than 50% of the module demand has the potential to be met through domestically produced solar modules over the medium term. This will boost overall copper demand from the power segment. Over fiscals 2023-2027, the country is expected to add 18-20 GW capacity of wind energy with over Rs 1.43 trillion investments. The government also aspires to reach 134 GW wind capacity by fiscal 2032 under its National Electricity Plan (NEP), which will also lead to significant copper demand uptake.
- **Electric vehicles:** This sub-segment of the transport segment will be a major factor in copper demand growth over the medium term. Copper usage in EVs increases significantly compared with conventional vehicles as

copper is used for batteries, electric motors, inverters and charging infrastructure. Currently, EV penetration is lower in the country. As of fiscal 2021, EV adoption in cars segment stood at 0.2%, in two-wheelers at 0.3%, buses 3% and other commercial vehicles 0%. These are expected to reach 2-4%,11-14%,4-6% and 0-2%, respectively, by fiscal 2027.

## Review of domestic copper supply

**Figure 77: Domestic primary copper supply trend**




*Source: Industry, CRISIL MI&A Research*

Domestic copper capacity logged a marginal 0.4% CAGR over fiscals 2017-2022 from 1,000 KT to 1,019 KT. During the period, Vedanta added 50 KT through debottlenecking in fiscal 2018 to reach 450 KT. HCL closed a 31 KT copper smelter at Khetrinagar in December 2018 owing to operational profitability issues. Hindalco had not added any capacity during the period.

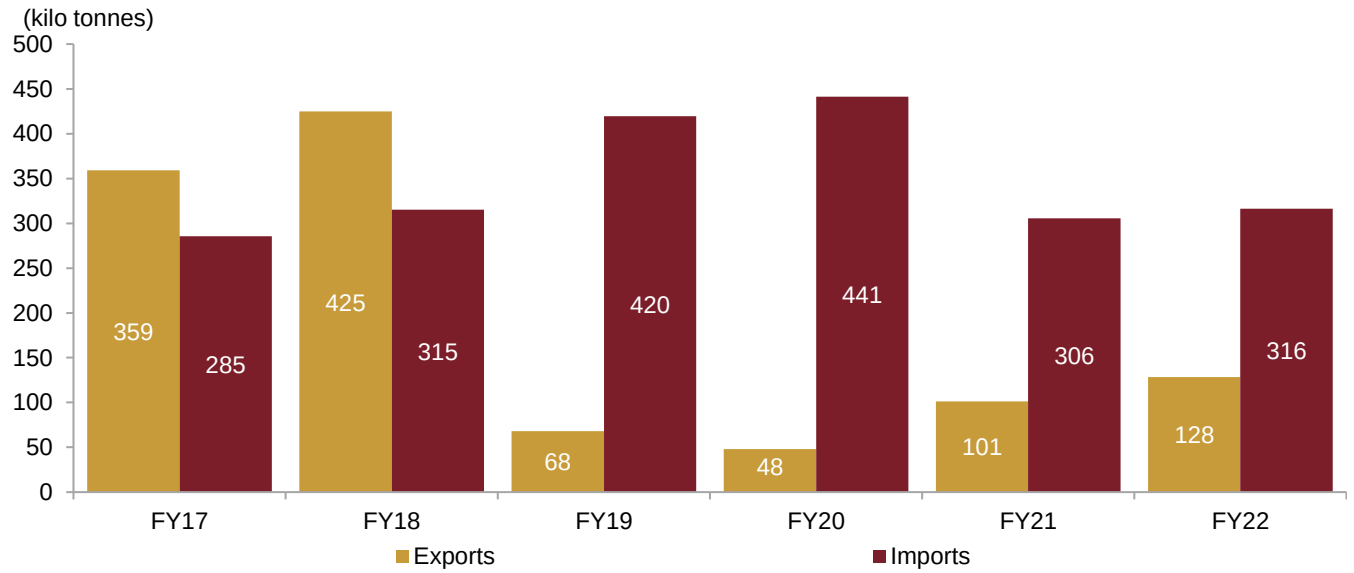
Domestic copper production fell a sharp 9.1% CAGR between fiscals 2017 and 2022 from 797 KT to 495 KT in fiscal 2022. During the period, Vedanta's copper production witnessed a sharp 20.8% decline owing to closure of Thoothukudi plant amid environmental concerns. HCL's copper production fell a sharper 49.3% as profitability issues in cathode manufacturing led the company to focus on the copper concentrate segment.

Utilisation rate in the domestic copper segment remained 80% until fiscal 2018 as robust utilisation of Vedanta offset low utilisation rate of HCL. However, the utilisation rate fell sharply to 45% in fiscal 2019 owing to closure of Vedanta's Thoothukudi plant. The utilisation rates since then have remained low as HCL stopped producing copper cathode and Hindalco is operating at 70-75% utilisation owing to copper concentrate supply concerns.

# Copper trade assessment

## Review of primary copper trade

**Figure 78: Primary copper trade review**

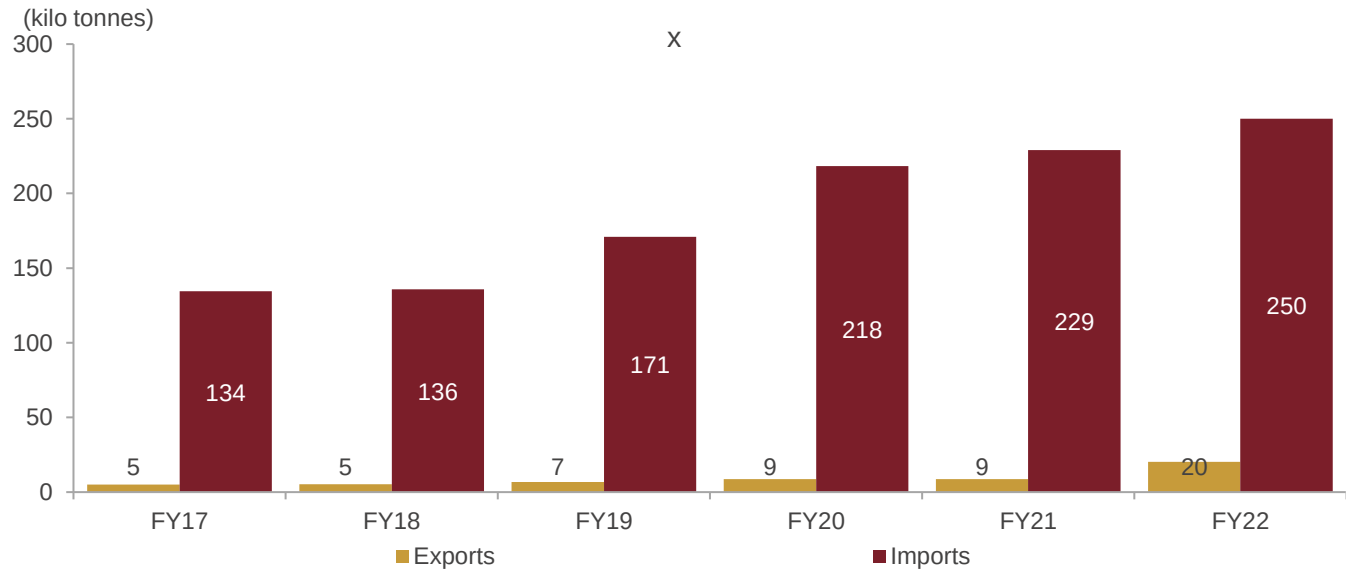



*Source: DGFT*

Primary copper exports fell a drastic 18.6% CAGR between fiscals 2017 and 2022 from 359 KT to 128 KT owing to closure of Vedanta's Thoothukudi plant amid environmental concerns in fiscal 2019. On the other hand, imports logged a 2.1% CAGR from 285 KT to 316 KT. During fiscals 2019 and 2020, imports stood more than 400 KT owing to low production from Hindalco. Vedanta was driving the overall primary copper exports. After, the closure of Thoothukudi plant, India turned into net importer of primary copper.

## Review of copper scrap trade

**Figure 79: Domestic copper scrap review**




*Source: DGFT*

India’s copper scrap exports are negligible as scrap collection is a neglected area in the country. In fact, copper scrap is essential for producing secondary copper. Thus, India imports copper scrap heavily. During fiscals 2017-2022, copper scrap imports clocked a sharp 13.2% CAGR from 134 KT to 250 KT owing to higher secondary copper production.

## Competitor’s profile and Adani’s positioning

### Vedanta

Sterlite (India) Industries Ltd, an associate company of Vedanta Resources Plc, is one of the largest copper manufacturers in India. It is a leading producer of copper cathode and copper rods. It is the largest mining and non-ferrous metals company in India and has mining operations in Australia and Zambia and oil and gas operations in three countries. Its main products are zinc, lead, silver, oil and gas, iron ore, steel, aluminium and power. Vedanta is the second-largest copper producer in India with a capacity of 450 kilo tonne per annum (ktpa) and holds a 44% market share in terms of capacity. After protests by the local populace alleging environmental violations at Sterlite's copper plant in Tamil Nadu's Thoothukudi, the Tamil Nadu Pollution Control Board (TNPCB) ordered the company to shut down the plant in May 2018. The company, however, continues to operate its refinery in Silvassa, Dadra and Nagar Haveli. Vedanta produces limited primary copper using copper anodes at its Silvassa facility and converts majority of primary copper into value-added products (VAP), such as copper rods.

### Hindalco

Hindalco Industries Ltd was established in 1958 as Hindustan Aluminium Corporation Ltd. The company, a subsidiary of the Aditya Birla Group, commenced operations in 1962 with a plant at Renukoot, Uttar Pradesh. It was renamed Hindalco Industries Ltd in 1989. Subsequent acquisitions and mergers with Indal and Birla Copper strengthened the company's production of primary aluminium, value-added aluminium and copper products. The company has the largest integrated copper smelter with port facilities at Dahej. Hindalco is the only refined copper producer in India after the closure of Vedanta’s plant at Thoothukudi in 2018 and subsequent production halt of copper cathodes by Hindustan Copper. Hindalco produces primary copper as copper cathode and converts cathode into various products such as rods, wires etc.

### Hindustan Copper Ltd (HCL)

Public sector Hindustan Copper Ltd (HCL) was incorporated in 1967 to take over copper operations from National Mineral Development Ltd (NMDC). The company become the only fully integrated copper company of India in 1975 by establishing 31 KT refinery at Khetri. It established downstream facility with 60 KT capacity at Taloja, Maharashtra, in 1989. The company also established 50 KT secondary copper refinery in Gujarat in 2015. HCL is the only fully integrated copper manufacturer in India. However, the company stopped producing copper cathode due to profitability issues. Thus, the company started selling metal in concentrate (MIC) to other local manufacturers.

### Adani Enterprises

Adani Enterprises is setting up plant with 1 million tonnes per annum copper cathode production capacity and 0.5 mtpa continuous cast copper wire rod capacity in Mundra, Gujarat, in phased manner. The company is currently building 0.5 mtpa copper cathode production in phase 1. The company is designing its manufacturing complex towards zero liquid discharge and complete water recycling.

## Risk and challenges for domestic copper industry

- **Raw material sourcing:** Securing copper concentrate is one of the major challenges for the copper industry in India as more than ~40% of the mined copper globally is produced in Latin America and India imports from Latin America and Indonesia. Some players also import copper anode to produce copper cathode. Thus, importing copper anode is a key challenge.
- **Margins:** TC/RC margins will be the biggest factor for profitability as India's copper cathode producers act as copper concentrate converters.
- **Coal sourcing:** Copper manufacturing is a power-intensive process. Thus, coal security also poses a challenge. Because of this, players are entering into coal linkages and actively participating in coal mine auctions.
- **Foreign exchange rates:** Indian copper industry heavily relies on imports. So, fluctuation in foreign exchange rates pose a risk for the industry.

# PVC

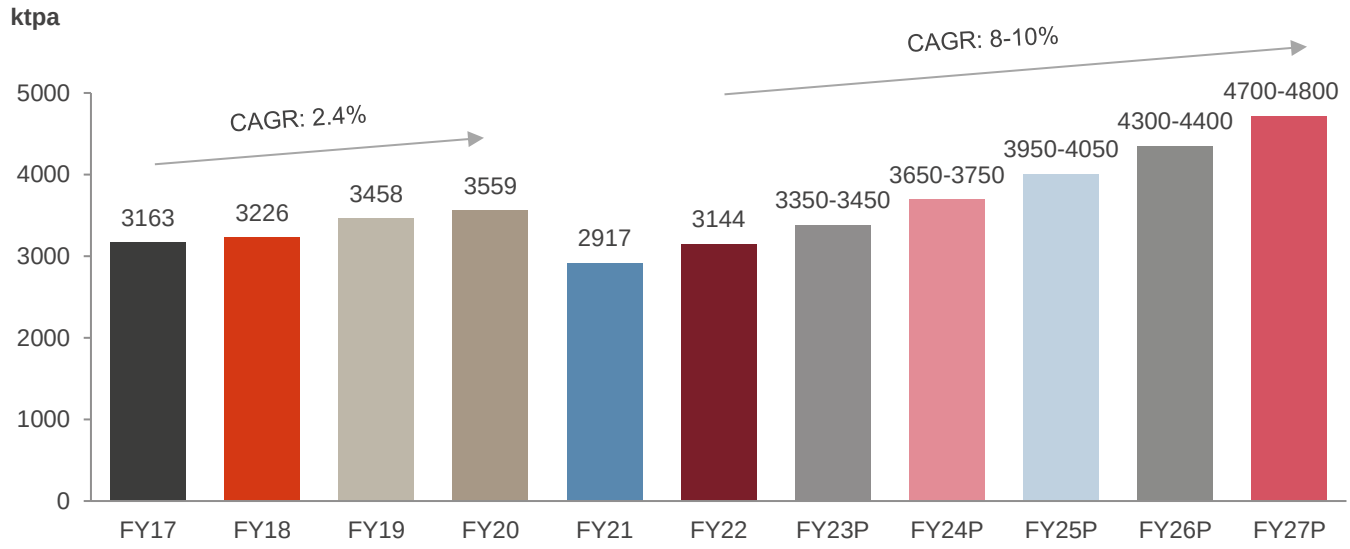
## Industry developments and outlook

### Demand review, fiscals 2017 to 2022

The polyvinyl chloride (PVC) market demand in India stood at 3,559 kilo tonne per annum (ktpa) at the end of fiscal 2020. It logged 2.4% CAGR between fiscals 2017 and 2020, on account of growing demand from the infrastructure segment. However, Covid-related restrictions resulted in a de-growth of ~18% in fiscal 2021.

In fiscal 2022, demand rose ~7.8% on-year on a low base. The rebound was due to rising offtake from the pipes and fittings segment, as construction spends rose across infrastructure sub-sectors. However, demand from the agriculture segment remained subdued owing to an extended monsoon. Any further demand increase was also restricted by unavailability of PVC in the global markets (India meets ~55% of its requirement from imports) because of tight supply and the subsequent steep rise in prices. The price hikes led to a shift in demand from PVC to polyethylene (PE), further impacting demand for PVC.

**Figure 80: Domestic PVC demand in India (FY17-27P)**




E: Estimated, P: Projected

*Source: Industry, CRISIL MI&A Research*

### Demand outlook, fiscals 2023 to 2027

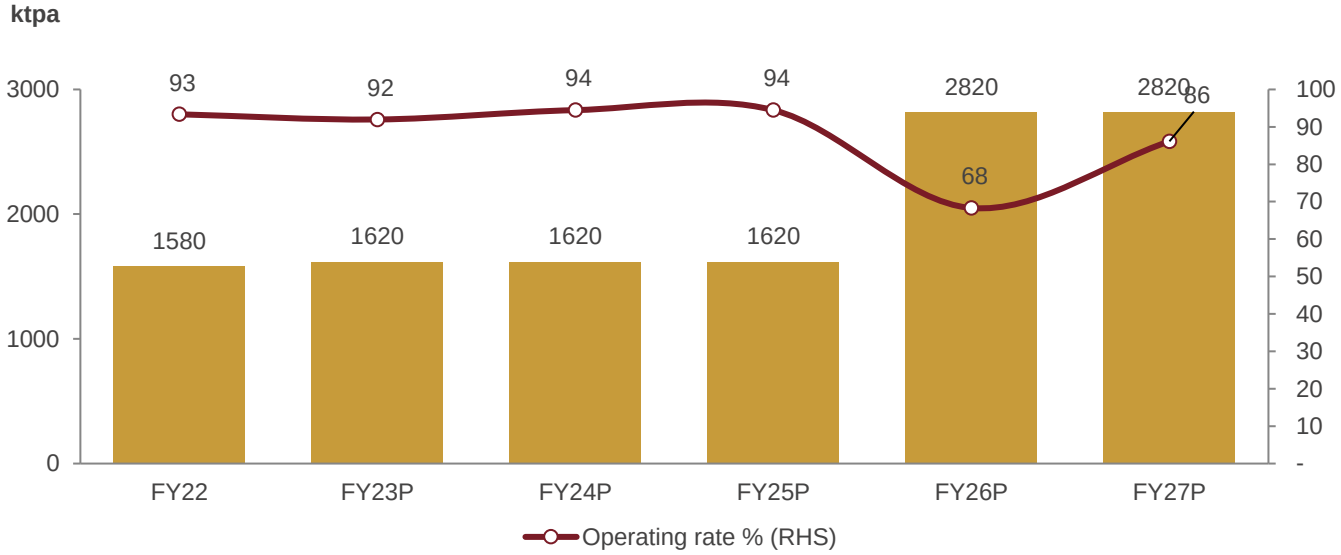
PVC demand is set to increase 7-8% on-year in fiscal 2023 to 3,350-3,450 ktpa. However, it will continue to be lower than 3,559 ktpa recorded in fiscal 2020. A large part of the rise will be on account of higher demand from the pipes and fittings segment, which comprises more than two-thirds of PVC offtake. Further increase in demand would be restricted owing to decadal high PVC prices and subsequent shift in demand from PVC to PE.

Over fiscals 2023 to 2027, PVC demand is expected to clock 8-10% CAGR, on account of increased spending on infrastructure and various government initiatives. The demand would be driven by sectors such as agriculture with increased land under irrigation, infrastructure aided by water supply and sanitation, housing segment with growing focus on housing for all. Other key segments aiding demand growth would be pharmaceutical and packaging segments.

## Capacity and production outlook

Production of PVC started in India in 1961. Since then, production capacity has increased multi-fold, with a large-scale plant commissioned by Reliance Industries in 1990-91, the largest player. The total production capacity in India stood at 1,580 ktpa at end-fiscal 2022.

**Figure 81: Domestic PVC capacity and plant operating rates (FY22-27P)**




E: Estimated, P: Projected

*Source: Industry, CRISIL MI&A Research*

Domestic utilisation rate of the PVC manufacturing industry rose to 93% in fiscal 2022, up from about 88% in fiscal 2021, owing to recovery in demand as economy reopened and restrictions were lifted. CRISIL MI&A Research expects domestic utilisation to remain at same level for fiscals 2023 and 2024. Going forward, over the next five years, operating rates of domestic PVC producers are expected to average around 90%, driven by the expectation of robust growth in the domestic demand. However, we expect the operating rates to be impacted in fiscal 2026, due to an additional capacity of 1,200 ktpa of Reliance Industries coming onstream.

## Outlook on share of India PVC demand by key application

PVC products are widely used in various industries due to its superior strength, non-flammability and ease of processing and moulding. Various government initiatives are also likely to aid the demand growth under each segment. The growth of PVC has historically been driven by the agriculture and infrastructure segments, which is evidenced by the significant contribution of the pipe and fittings segment in the overall demand mix for PVC.

Pipe and fittings segment is the largest consumer of the PVC, constituting more than two-thirds of the overall Indian demand in fiscal 2022. The major application under this segment is the manufacturing of PVC pipes, which have a long product life, are cost-effective, and are easy to handle. With increased spending on infrastructure and usage of PVC for irrigation, water supply, sewerage and plumbing, the contribution of this segment is expected to grow even further by fiscal 2027.

Other key applications include calendars and film sheets, contributing to almost two-third of the remaining demand. It is used for stationary products applications, electrical insulation tapes, tablet and capsule manufacturing, and packaging for industrial and consumer goods.

PVC is also used in wires and cables segment for insulation and sheathing purpose. Insulated wires are used for residential, industrial, and commercial purposes as it is flame retardant, easy to install and are tough. It is also used in high temperature environment for kitchen appliances.

**Figure 82: Segment-wise demand of PVC (FY22)**

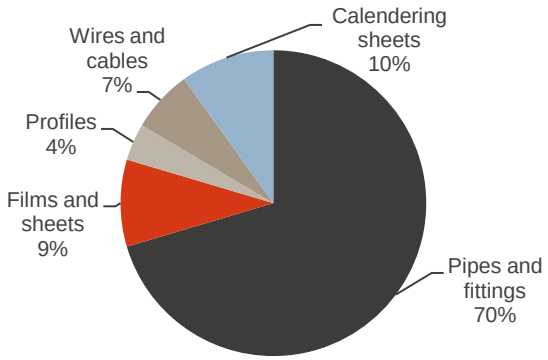
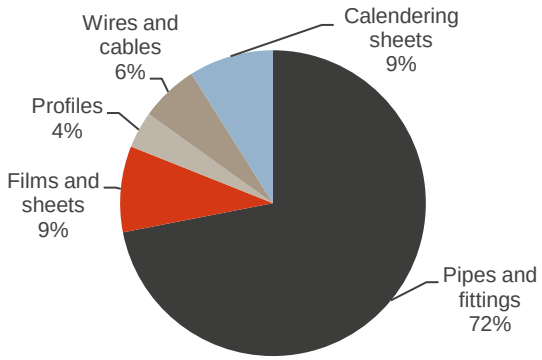



**Figure 83: Segment-wise demand of PVC (FY27P)**




E: Estimated, P: Projected

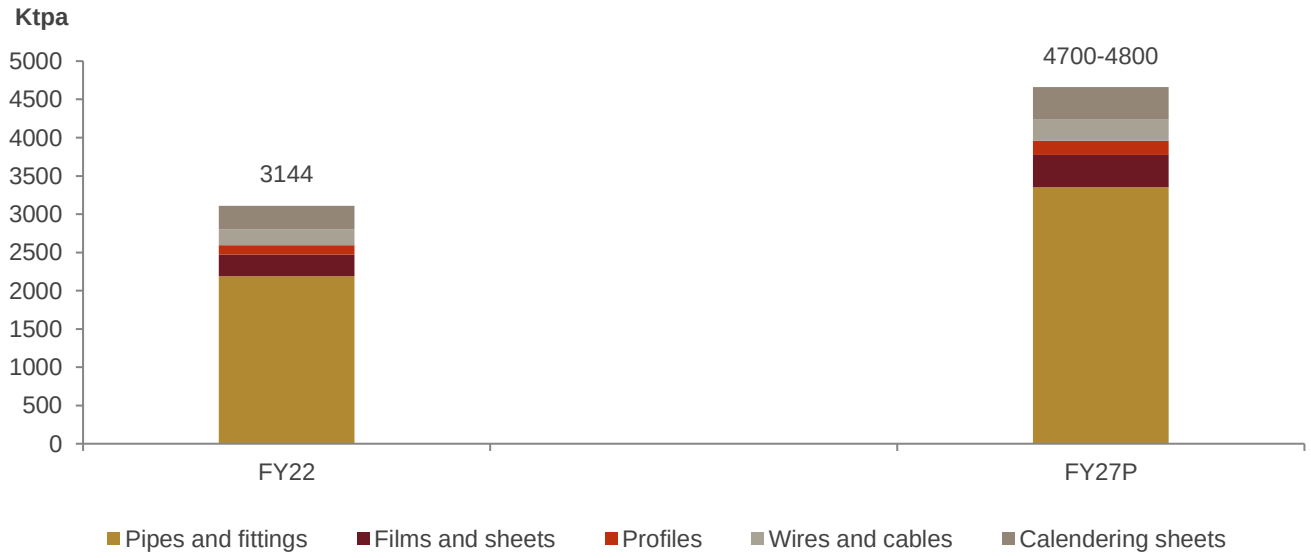
*Source: Industry, CRISIL MI&A Research*

## Growth drivers

### Application growth outlook

Segment-wise offtake projections are as follows:

**Figure 84: Segment-wise growth for PVC (FY22-27P)**




E: Estimated, P: Projected

*Source: Industry, CRISIL MI&A Research*

- Pipes and fittings segment is projected to register 8.5-9.5% CAGR over the forecast period. Offtake will be supported by investment in the irrigation, water supply and sanitation segments, as well as continuing substitution

of metal pipes with PVC. The government's focus on increasing irrigation in non-rainfed areas through the Prime Minister Krishi Sinchayee Yojana is expected to increase demand for PVC pipes as well

- Films and sheets segment is projected to clock 7.5-8.5% CAGR, led by demand from consumer-driven sector such as packaging
- Calendaring segment is projected to log 5.5-6.5% CAGR, owing to demand from pharmaceuticals segment
- Profiles, wires and cables segment is expected to rise at 7-8% CAGR

### Government initiatives

Government measures which would aid the growth of PVC are as follows:

- **Housing for All:** Acknowledging the gravity of the issue of homelessness in India, the government has initiated a scheme to provide housing for all. The aim is to bridge the demand-supply gap in the housing sector. Housing shortage and lack of proper water management system (sewage/drainage) in slums create ample opportunities for the piping industry in India. A major application of PVC pipes is in the water management for the housing and agricultural sectors, and this can thereby be a strong driver for growth.
- **Swachh Bharat Mission (SBM):** This is a programme aimed at stopping open defecation through construction of individual household latrines (IHHL), cluster toilets and community toilets (especially via PPP mode). Solid and liquid waste management is also an important component of the programme. Focus on sanitation and drinking water facilities creates a huge opportunity for PVC pipe manufacturers.
- **Atal Mission for Rejuvenation and Urban Transformation (AMRUT):** The government launched AMRUT to provide basic services to households and build amenities in urban areas. The need for the improvement in infrastructure of the country could result in future growth of the plastic piping industry.
- **Jal Jeevan Mission:** This Mission is being implemented in partnership with States to make provision of tap water supply to every rural household and public institutions in villages such as schools, anganwadi centres, ashramshalas (tribal residential schools), health centres, and gram panchayat buildings. Demand for distribution pipes for water supply could aid growth of the PVC industry.

**Anti-dumping duty:** The government had imposed anti-dumping duty on PVC imports in 2008 to aid domestic growth of domestic producers. However, the duty was not extended on its lapse in February 2022 after various extensions during the last decade. But, with increased inflationary pressure, the government in May 2022 decided to reduce the customs duty on PVC from 10% to 7.5%. However, this resulted in increase in imports from China in fiscal 2022.

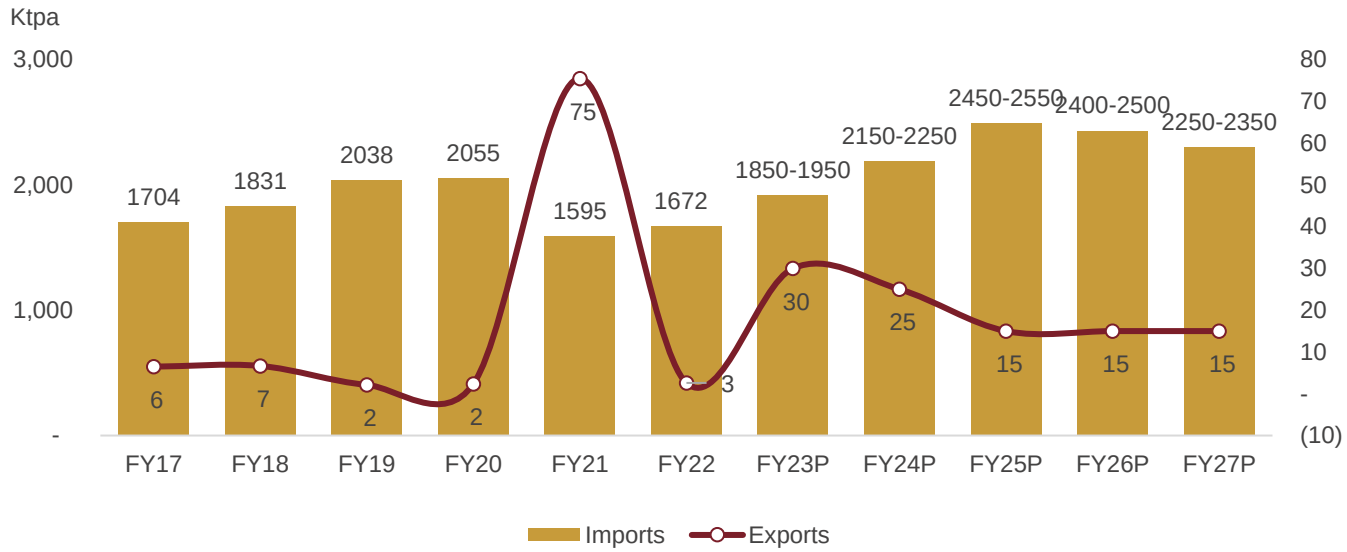
## Trade outlook

### PVC imports and exports

India is one of the largest importers of PVC in the world. With increasing domestic demand and limited production capacity to cater to the growing needs, Indian players are dependent on imports for as much as half of their consumption requirement. Imports are expected to grow at 6-7% CAGR between fiscals 2022 and 2027 rising to over 60% of demand in fiscal 2025, at 2,450-2,550 ktpa (total demand: 3,950-4,050 ktpa). Decline in imports is expected from fiscal 2026 onwards owing to commissioning of Reliance Industries' 1,200 ktpa plant.

India is not an exporter of PVC and hence no major exports are noticed, expect in fiscal 2021, owing to reduced domestic demand due to Covid-related restrictions.

**Figure 85: PVC imports and exports (FY17-27P)**



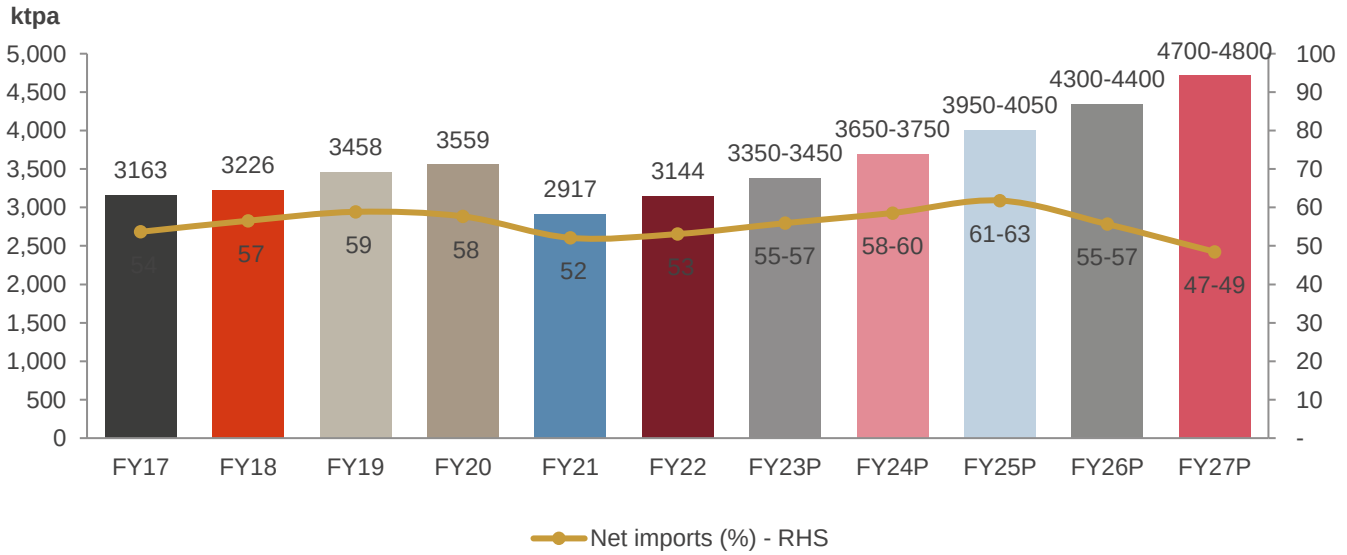

E: Estimated, P: Projected

*Source: Industry, CRISIL MI&A Research*

## Imports as a percentage of overall demand

India has a huge demand-supply gap, and the share of imports is expected to remain high despite the commissioning of domestic capacities.

**Figure 86: PVC net imports, % of demand (FY17-27P)**




E: Estimated, P: Projected

*Source: Industry, CRISIL MI&A Research*

The demand for PVC logged 2.5% CAGR between fiscals 2017 and fiscal 2020, and subsequently, share of net imports in demand rose from 54% to 58% in fiscal 2020 on account of limited growth in production capacity.

Over the next few years as well, though operating rates of domestic PVC producers are expected to remain high, dependence on imports is expected to continue increasing and reach 60-65% by fiscal 2025 because of healthy demand growth of 8-10% CAGR

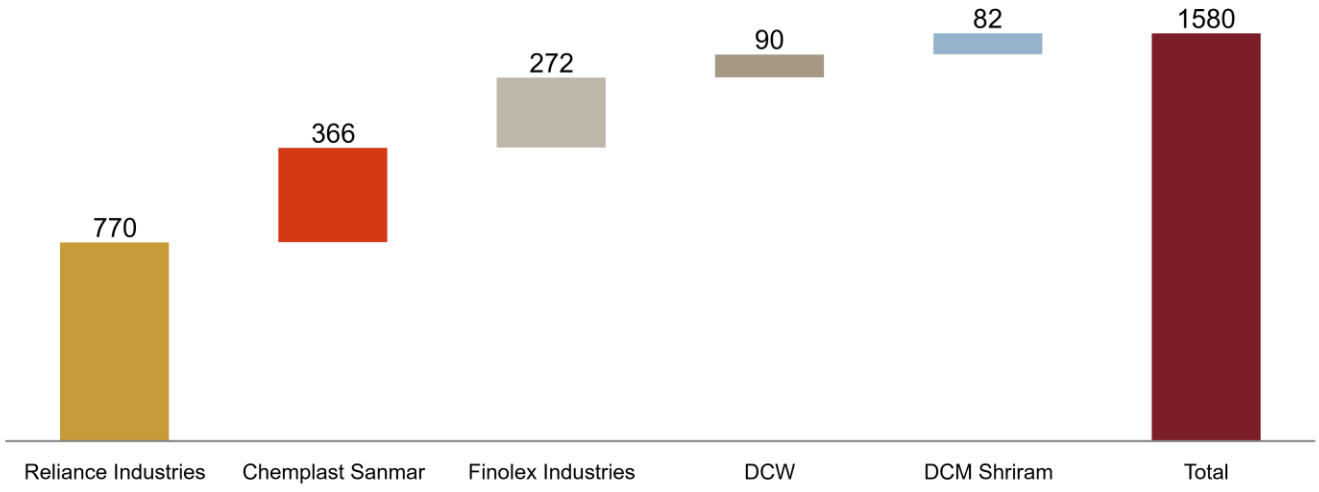
That said, CRISIL Research expects imports to decline to ~47-49% in fiscal 2027, with Reliance Industries expected to add capacities of 38 ktpa by debottlenecking in fiscal 2023 and 1,200 ktpa in fiscal 2026.

## Competition landscape

### Key leading manufacturers

The domestic capacity of PVC in India was 1,580 ktpa at the end of fiscal 2022, with Reliance Industries contributing ~51% to the total capacity. Other key players are Chemplast Sanmar (22%), Finolex Industries (17%), DCW (5%), and DCM Shriram (5%).

**Figure 87: PVC manufacturers in India (FY22)**




*Source: Industry, CRISIL MI&A Research*

### Capacity of leading players

There have been fewer capacity additions in India owing to uncertainty around import duty fluctuations. The details of demand and capacity shares of leading manufactures in India are given below:

**Figure 88: Company-wise capacity (FY22)**

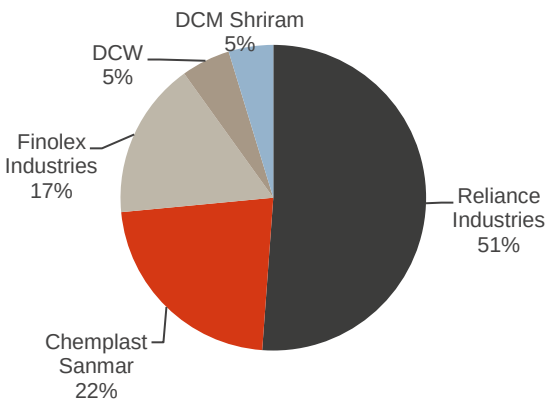
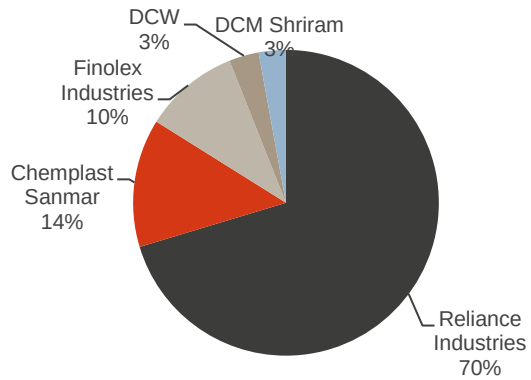



**Figure 89: Company-wise demand (FY27P)**




E: Estimated, P: Projected

*Source: Industry, CRISIL MI&A Research*

- Reliance Industries, with its three plants at Dahej, Hazira and Jamnagar, and a combined production capacity of ~770 ktpa, is the leading producer of PVC in India. The 1,200 ktpa capacity addition planned for commissioning by fiscal 2026 would strengthen its position as the leading PVC manufacturer with ~70% share.
- Chemplast Sanmar has two manufacturing facilities for PVC resin in Mettur in Tamil Nadu and Karaikal in the Union Territory of Puducherry. With a total capacity of 366 ktpa, the company is the second largest manufacturer in the country
- DCW's plant is situation at Sahupuram in Tamil Nadu with a production capacity of ~90 ktpa
- DCM Shriram's sole plant with capacity of ~70 ktpa is based at Kota in Rajasthan

Owing to fewer domestic players in the market, there is limited competition within the industry. However, high imports and absence of duty protection for the manufacturers in India has led to increased linkage with international market movements.

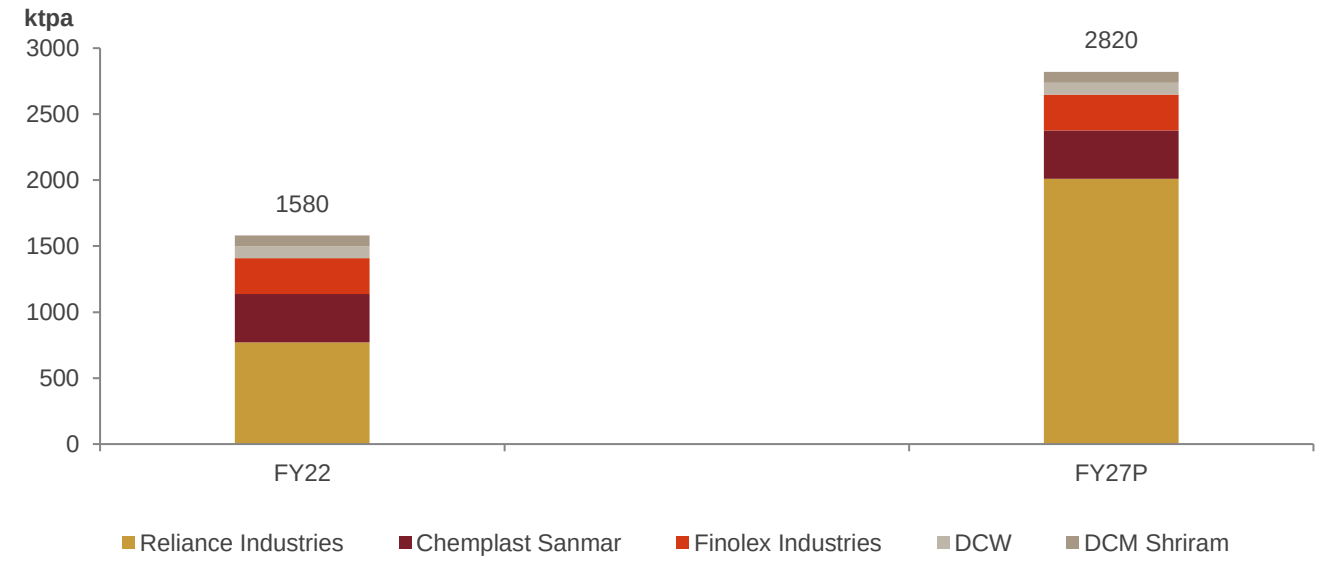
## Positioning of Adani Enterprises in the PVC segment

Seeing opportunity in import substitution, the company ventured into the petrochemicals business in 2021 with an intention to develop a petrochemical cluster at Mundra. The first proposed project of 2 MT green PVC capacity is scheduled to be constructed in phases. Phase I will comprise development of 1,000 ktpa PVC (2x500 ktpa in each sub-phase). With growing opportunity in green fuels to move towards Net Zero as a country, Adani Enterprises intends to build and operationalise the first phase, leveraging group resources and the Mundra locational advantage.

### Planned expansions in short- to mid-term

PVC capacity in India had remained rather stable between fiscals 2017 and 2022 due to high entry barriers and uncertain duty applicability on imports.

**Figure 90: PVC capacity additions (FY22-27P)**




E: Estimated, P: Projected

*Source: Industry, CRISIL MI&A Research*

We expect capacity to rise from ~1,580 ktpa in fiscal 2022 to ~2,820 ktpa by end of fiscal 2027. No major capacity additions are expected other than Reliance Industries' ~1,200 ktpa plant in the next five years. Further, CRISIL MI&A Research believes that owing to high cost of infrastructure and increased cost of capital, aided by knowledge intensive nature of the industry, extensive capacity additions are not envisaged in this sector.

## Opportunities for Adani Enterprises in India's PVC segment

Between fiscals 2023 and 2027, demand is expected to grow from all key end-use segments, led by pipes and fittings (8.5-9.5% CAGR), supported by favourable government measures. Other segments such as films and sheets, profiles, wires, and cables are expected to log 7-9% CAGR, driven by consumer driven growth. Calendering segment is also expected to grow 5.5-6.5%, driven by pharmaceutical demand. Thus, overall PVC demand is projected to log 8-10% CAGR in this period.

The current production capacity in India at 1,580 ktpa represents only about half of the domestic demand. Even with 1,200 ktpa capacity is expected to come onstream, demand is expected to reach 4,700-4,800 ktpa by end fiscal 2027 leading overall imports to stay above ~50%. With growing demand, imports is expected to play an important role in supply-mix. Japan, China, Taiwan, and Korea are the major suppliers to India for PVC, and overall imports are expected to grow at 4-5% CAGR between fiscal 2023 and 2027. Such high level of imports is typically unsustainable owing to ever-changing geopolitical circumstances and possibility of dumping by various nations. To sustain domestic production capacity, government had imposed anti-dumping duty, but this has to be brought down due to rising demand this calendar year 2022

## Risks and challenges

One of the major factor impeding the development of the PVC industry is the lack of a consistent policy surrounding anti-dumping duty. The setting-up of a PVC plant entails significant capex, and the government decisions regarding anti-dumping duties might turn out to be a significant factor. The dependence on import for raw materials is another major factor preventing capacity expansion.

CRISIL MI&A Research believes there is massive scope for adding to the domestic PVC capacity due to the increased demand supply imbalance. However, absence of protection from dumping, volatile raw material prices, and higher exposure to forex rates is expected to weigh on any extensive capacity additions and have a deleterious effect on domestic consumption.

# Mining – Coal and iron ore

## An overview of the mining industry structure – coal

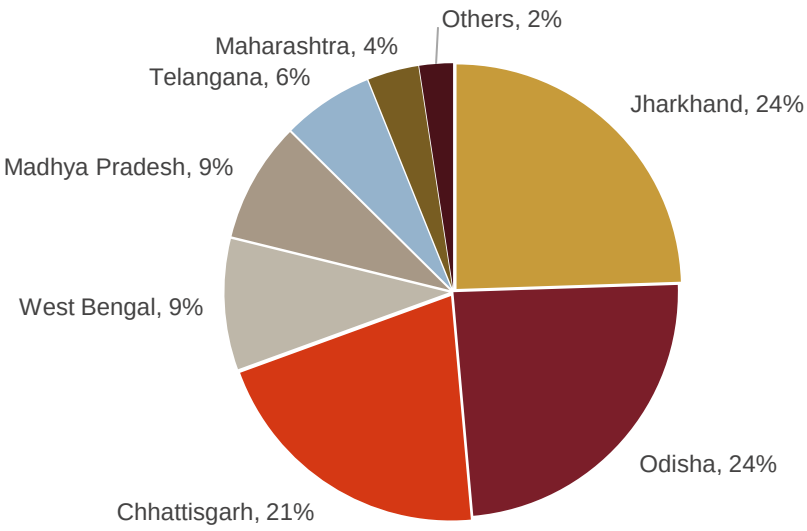
Coal is naturally occurring sedimentary rock found within the earth's crust and is one of the most abundant fuels on earth with proven reserves of ~1,070 billion tonne at the end of 2019. The world's proven reserve base can last more than 100 years at the current pace of production. Coal reserves are widely distributed across globe, making it one of the cheapest fuel for consumption in production of electricity. In 2021, coal accounted for ~36% in electricity generation across globe and ~275 on overall energy consumption.

Coal is classified by two major categories: coking and non-coking coal. Coking coal is primarily used in production of steel whereas large share of non-coking coal is used for electricity generation. In India, coking coal is categorized or graded on the basis of ash while non-coking coal is categorised as per gross calorific value of the coal.

### An overview of India's coal sector

As of fiscal 2021, India has coal reserves of ~352 billion, of which ~35 million tonne is coking coal, while ~317 million tonne is non-coking coal. Coal deposits are mainly concentrated in eastern and south-central parts of the country. The states of Jharkhand, Odisha, Chhattisgarh, West Bengal, Madhya Pradesh, Telangana and Maharashtra account for ~98% of the total coal reserves in the country.

**Figure 91: Snapshot of coal resources in India as on fiscal 2021**




*Source: Geological survey of India (GSI), CRISIL MI&A Research*

India is the second largest coal producer in the world. In fiscal 2022, India produced ~777 million tonne of coal an increase of 8.5% from the ~716 million tonne in fiscal 2021.

Coal production in India is dominated by public sector enterprises like Coal India Limited (CIL) and Singareni Collieries Company Limited (SCCL). In fiscal 2022, CIL and SCCL accounted for 80% and ~8.4%, respectively, of India's total coal production.

The remaining ~11.6% of coal was produced by captive players where both public sector and private sector have ownership of mines. Captive miners could mine coal only for their operations / own consumption and could not sell

produce in the open market. However, recently the government has relaxed this norm and allowed captive miners to sell 50% of the coal produced in a financial year to other entities commercially.

Despite having abundant reserves of coal, domestic coal production in India has consistently lagged due to various issues such as delays in getting environment and forest approvals, hurdles in land acquisition, construction delays etc. Consequently, India has had to increasingly rely on coal imports to meet domestic coal demand. However, post fiscal 2014, India's domestic coal production has improved consistently following the government's focus on reducing dependence on imported coal.

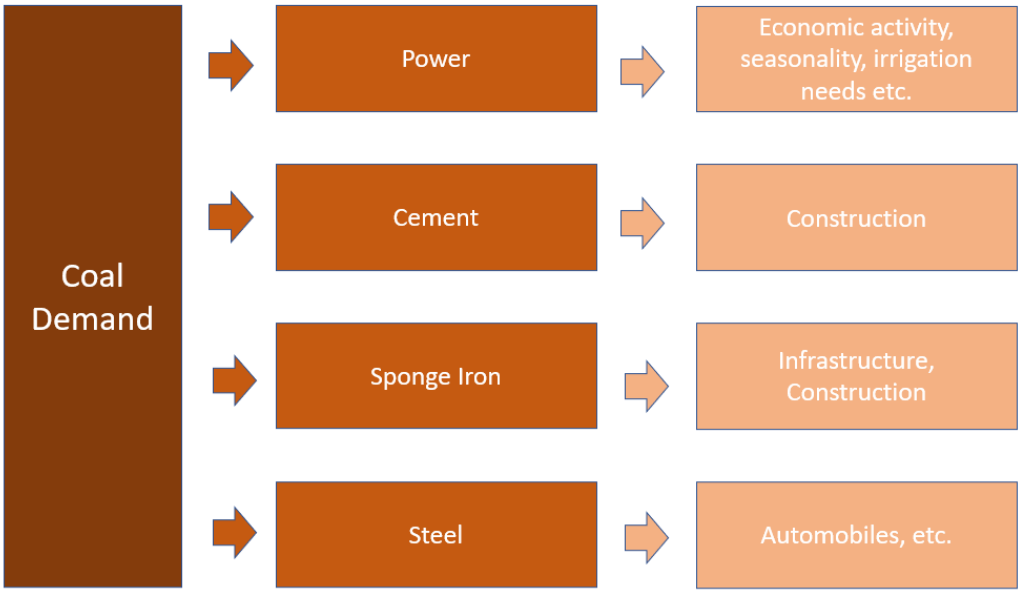
As a result, India's domestic coal production increased at a CAGR of 3.7% over last decade. However, domestic production could not keep pace with rising demand from both power and non-power sectors leading to an increase in both coking and non-coking coal imports at CAGR of 3.7% and ~8% over the same period.

## An assessment of key demand drivers of India's coal sector

Demand for non-coking coal is driven by demand from the power segment, where the segment accounts for ~70% of India's non-coking coal demand. The remaining stems from non-power sectors, such as sponge iron, cement, aluminium, etc. In some of these segments, coal is used as an input for production like in sponge iron and cement while it may also be used to generate power from captive plants like in aluminium and cement. Demand for coking coal is driven by steel production cycles as it is a key input in the production process.

Growth in coal demand from these segments is dependent on their respective growth aspects, for instance improved economic activity would lead to higher electricity consumption coupled with spending on infrastructure which would spur power, steel, and cement demand, consequently leading to requirement of coal.

**Figure 92: End-user segments for coal**



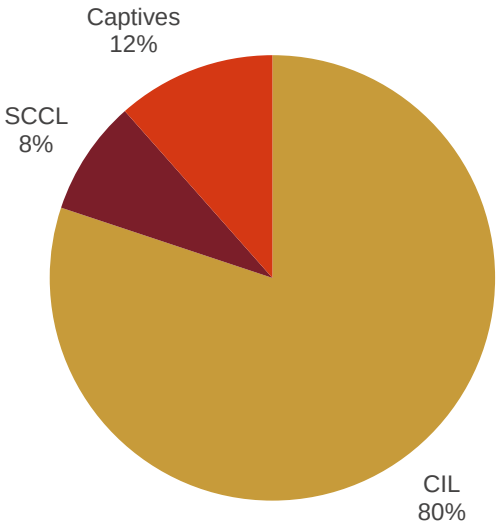

*Source: CRISIL MI&A Research*

## Overview of pricing regime of coal sector

In India, coal produced domestically by CIL and SCCL is sold via two mechanisms – long-term fuel supply agreements (FSA) and e-auctions (spot coal market). Both these supply streams have different pricing

mechanisms. Captive coal mine production is consumed by the mining entity for its own operation and is not sold in the open market.

**Figure 93: Coal production by sources in FY22 (777 million tonne)**




*Source: Ministry of Coal, CRISIL MI&A Research*

Prices of coal via the FSA route are notified by CIL, which is primarily based on a cost-plus model. This is revised by CIL from time to time. FSAs account for 85-90% of the total sales volume of CIL and SCCL combined.

These FSAs were earlier allocated through the Standing Linkage Committee route under the Ministry of Coal. The Standing Linkage Committee under the Ministry of Coal decides long-term coal linkages as well as short-term coal linkages. The agreements were entered into based on recommendations by the ministries of steel, cement, power and various state governments. However, in February 2016, the Cabinet Committee on Economic Affairs (CCEA) modified the mechanism to promote transparency in the allocation of coal linkages. As per the new mechanism, the FSAs in non-regulated sectors (sponge iron, steel, cement and captive power plants) are signed/renewed on the basis of an auction. Also, for consumers in the power sector, the government launched a new scheme in May 2017 for linkage allocation -- Scheme for Harnessing and Allocating Koyala (Coal) Transparently in India (SHAKTI). Under SHAKTI, power plants that do not have an assured linkage of thermal coal can participate in auctions conducted by coal-producing companies and secure supply via competitive bidding.

Under e-auctions, which account for the remaining 10-15% of CIL and SCCL's sales volume, coal is typically sold at a premium to that sold under the FSA route. This is essentially the Indian spot market for coal, where bidders submit their pricing bid above the base pricing notified by the respective nodal entities (various subsidiaries of CIL, SCCL).

## Review and outlook of mining industry - Coal

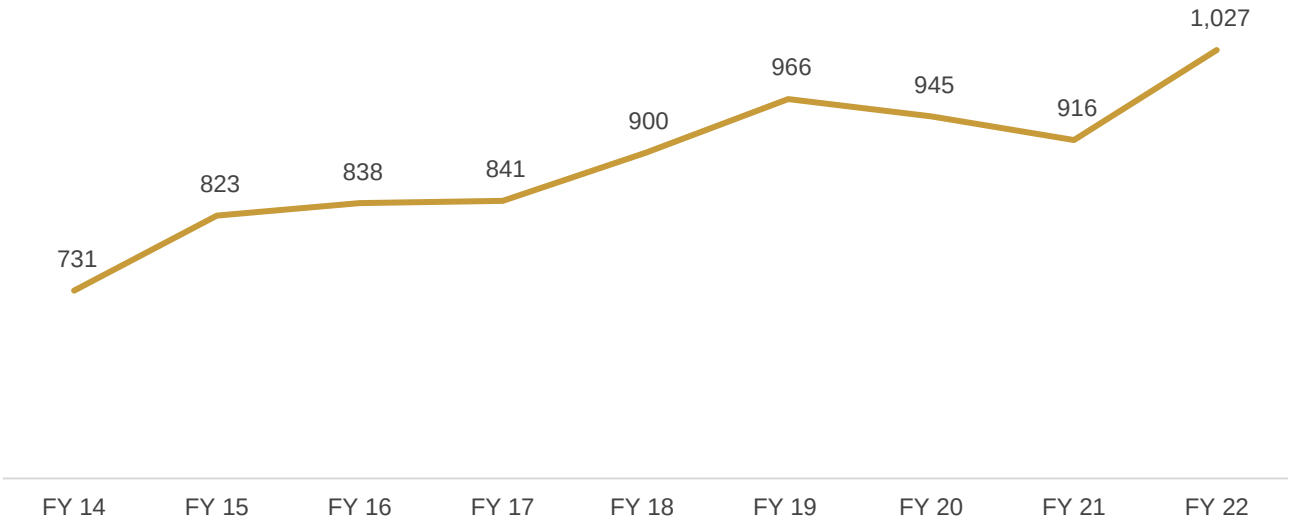
### Review of coal demand in India

Domestic consumption of coal (both coking and non-coking coal combined) has seen healthy growth of 4.8% in the past decade to reach ~1,027 million tonne by fiscal 2022. Of this, around 957 MT of non-coking coal was consumed in fiscal 2022.

Going forward, non-coking coal consumption is expected to grow at 2-3% CAGR to reach ~1,105 million tonne by fiscal 2027, driven by growth in power demand and key end-use industrial segments. India's base power demand grew at a 3.6% CAGR from fiscal 2012 to 2022 to reach ~1,380 billion units. Growth has been led by economic growth, improvement in T&D infrastructure coupled with extensive rural electrification under various schemes. Demand from the power and non-power sectors such as cement, sponge iron, aluminium and other industries has led to non-coking coal consumption increasing at a CAGR of ~4.9% over the past 10 years.

Coking coal, which is mainly used by steel players for production of steel, saw consumption grow at a CAGR of 3.8% over the past decade, in line with India's crude steel production which increased at a CAGR of 4.8% over the same period.

**Figure 94: Domestic coal consumption, FY13-22 (million tonne)**

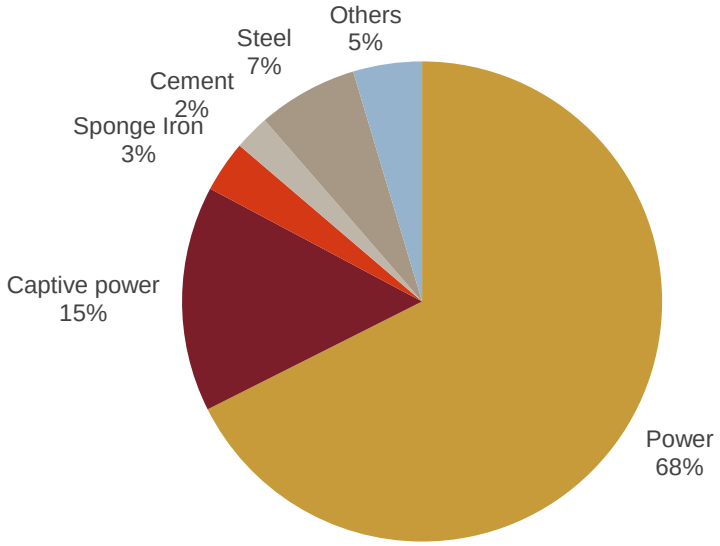



*Source: CRISIL MI&A Research*

## Break-up of coal demand into end-use segments

Demand for coal is dominated by the power sector which accounts for more than two-thirds of domestic coal demand, followed by captive power generation across various industrial segments.

**Figure 95: Sector-wise break-up of coal demand in FY22 (~1,027 million tonne)**




*Source: CRISIL MI&A Research*

**Power –** Coal-based capacities accounted for 51.0% or 204 GW of the total installed base of ~401 GW at the end of fiscal 2022. CRISIL Research expects 20 coal-based capacities to be added (excluding captive power plants) until fiscal 2027.

Power demand is expected to grow at a CAGR of 5.5-6% between fiscals 2022 and 2027, driven by a recovery in economic activity, intensive rural electrification, power transformation, capacity augmentation, urbanisation, and the government's focus on manufacturing and urban infrastructure. Capacity additions of coal-based power plants will also support demand for coal. PLFs are expected to remain in the range of 60-65% resulting in coal demand from the power sector continuing to grow at 1-2% CAGR over fiscals 2022 and 2027, with high consumption levels already witnessed in fiscal 2022. Coal demand in fiscal 2022 grew at 23% on-year owing to a sharp increase in power demand because of increased economic activity post pandemic and to meet pent-up demand in the industrial sector.

**Captive plant –** Captive plants account for 15% of overall coal demand. Over fiscals 2022 to 2027, about 2.5-3GW (compared with around 4-5 GW over fiscals 2015 to 2020) of captive power capacities are expected to be commissioned, increasing demand for non-coking coal at a CAGR of 7-8%. Most of the captive power capacity additions are expected in the aluminium, cement, and steel sectors.

**Cement –** Cement accounts for 2% of demand (for its production process not inclusive of captive power demand). Cement demand is expected to remain healthy and witness growth of 5.5-6.5% over the next five years, driven by a raft of infrastructure investments and healthy revival in housing demand. Comparatively, non-coking coal consumption from cement is expected to increase at a 3-4% CAGR over fiscals 2022 to 2027, constrained by the increasing usage of alternative fuels such as pet coke, instead of non-coking coal.

**Sponge iron –** Sponge iron accounts for 3% of demand (for its production process not inclusive of captive power demand). The sponge iron industry is expected to grow at a CAGR of 4-5% over the next five years, driven by demand from rural and urban housing. Demand for coal from the sponge iron sector is expected to grow at a 4.5-5.5% CAGR over fiscals 2022 to 2027.

**Steel –** Steel accounts for 7% of overall coal demand. Coal used in the process is coking coal. Going ahead, coking coal demand will be limited (the proportional rise in steel production will not be in line with the historical trend) on account of increased PCI rate among players. PCI injections can be directly fed into the blast furnace to reduce the coke rate.

**Other –** Other sectors such as paper, fertilisers, brick kilns, etc. are also key consumers of coal. These segments account for ~5% of non-coking coal consumption. Performance of the overall economy drives demand from these industries and demand from these segments is expected to grow at 8-10% CAGR over fiscals 2022 to 2027.

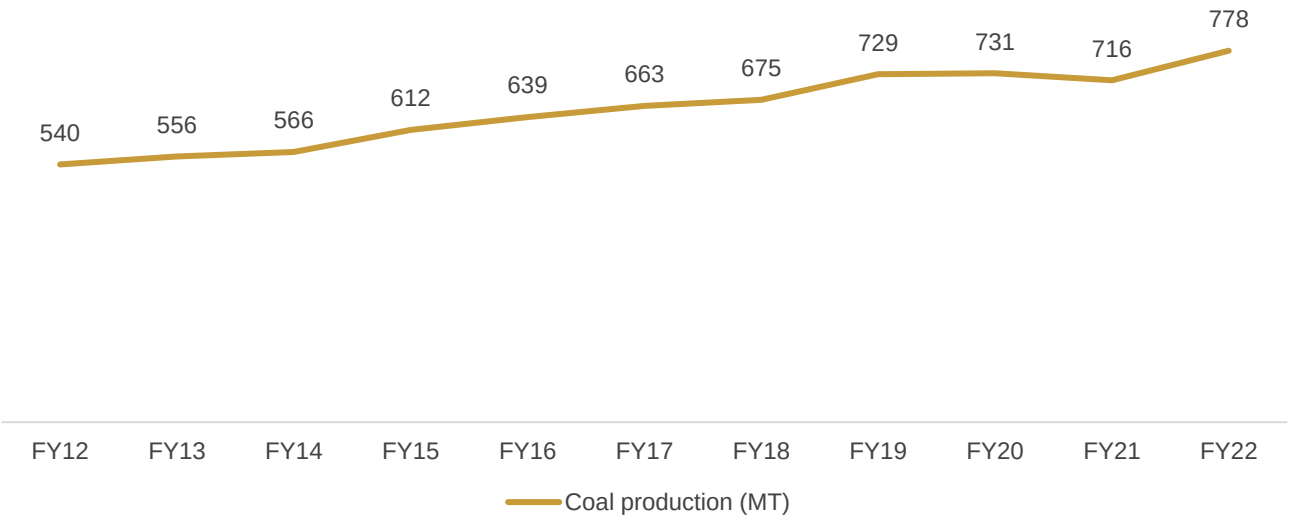
## Review of coal production

India's coal production has witnessed a growth of 3.7% CAGR from fiscal 2012 to fiscal 2022 to reach 778 million tonne. In fiscal 2022, CIL accounted for 80% of domestic production, followed by SCCL with 8%, and remaining 12% by captive mines.

Coal production has been led by CIL, which saw its production increase by 187 million tonne over the same period with a CAGR of 3.6%. SCCL has seen marginal growth of 2.2% CAGR over the same period to reach production of 65 million tonne in fiscal 2022. Captive mine production has seen growth of 5.7% with allocation of new mines over the same period reaching production of 89 million tonne in fiscal 2022.

The government also opened up the sector to commercial mining for private players in February 2018, enabling participation for a wider set of participants. Further, on June 18, 2020, the government launched auctions for commercial mine blocks with no restrictions on end-use, thereby meaning that the coal produced at such mines need not be used for captive consumption and can be sold to other entities, including end-users such as power plants and cement plants. This is expected to encourage competition in the coal sector whilst boosting coal production, thereby increasing domestic coal availability in the longer run.

**Figure 96: Domestic coal production[1], FY12-22 (million tonne)**




*Source: Ministry of Coal, CRISIL MI&A Research*

[1] This includes both non-coking and coking varieties of coal

## Risks and challenges

Coal mining in India faces significant risks from natural perils to governmental policies to other risks:

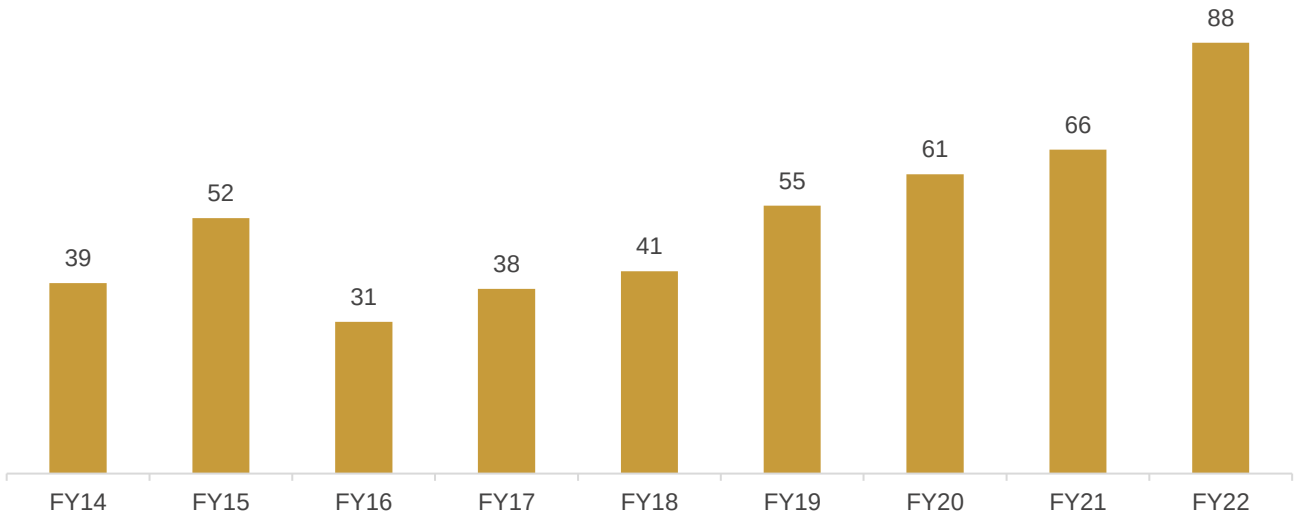
- **Offtake risks:** Coal is utilised in various industries, primarily as a source of fuel or as feedstock, in some cases. Offtake by coal-based power plants is a key to sustenance of the coal sector as it accounts for ~70% of the overall coal consumption in India. Any fluctuation in coal-based power generation directly impacts demand for non-coking coal. The government's increased focus on renewables, especially solar, and slowdown in coal-based capacity additions is expected to pose significant risk to coal-based power generation.
- In addition, offtake demand from other sectors such as steel and cement, is another key monitorable. The growth of competitive fuels, such as PCI injection in the steel sector and pet coke in the cement sector, can obstruct coal demand growth in the future.
- **Infrastructure risk**: While domestic coal production has improved significantly over the last few years, the end-user industries still face some issues pertaining to coal supply, primarily owing to constraints in coal dispatch infrastructure. Reliance on rail infrastructure remains high as a large quantity of coal is transported via rail. Consequently, the lack of railway lines and coal rakes can impact growth of the coal sector, in spite of the timely development of coal mines.
- **Manpower risk**: The coal mining sector in India is highly dependent on manual labour for carrying out production operations. The relatively low levels of automation as compared to international standards in the older mines requires higher dependence on manpower.
- **Natural perils**: The coal mining sector faces a significant threat from natural perils owing to the nature of its primary operations. Over the past decades, there have been numerous instances of mine collapse, mine fires, gas leaks, etc., that have posed a serious threat to mining operations. Another peril is in the form of flooding, especially in the monsoons, that severely constrains coal production and dispatch during heavy rain.

## Overview of the captive coal mining and coal logistics segments

### *Captive coal mining and associated operations*

Apart from production of coal from CIL and SCCL, presently there are coal blocks also allocated to other stakeholders (state and private enterprises) to mine coal for consumption in their own operations. For instance, state power generation companies such as Rajasthan Rajya Vidyut Utpadan Nigam Ltd (RRVUNL), Telangana State Power Generation Corporation Ltd (TSPGCL) and the central power generator - National Thermal Power Corporation (NTPC) own mine blocks for production of coal to utilise for power generation operations. Other participants from industries such as aluminium and cement also own certain blocks to utilise such coal production for their manufacturing operations.

**Figure 97: Captive non-coking coal production, FY14-22 (million tonne)**




*Source: Ministry of Coal, CRISIL MI&A Research*

In this segment, participants for whom this may not be a core business operation often contract third party mine developers and operators (MDO) who help in mining and production of coal from such blocks. The operator enters into arrangements with third parties who have been allocated coal blocks, where it is responsible for developing the mine, mining the coal, washing the coal, transporting and dispatching the washed coal to the required destination. The primary difference here is in terms of ownership, an MDO would be in most cases, a third party contractor engaged to carry out mining and associated operations while the mine ownership would rest elsewhere. This is different from commercial or captive mining. Captive mining refers to mines owned and utilised by entities for captive coal production and consumption. Commercial mine allocations, which the government has introduced recently in the sector, is where mine ownership is being allocated to interested bidders (private and otherwise) for mining of coal for sale in the market at large. Both a captive or a commercial mine owner may then engage a third party contractor, such as an MDO, to handle the operations as defined above.

Adani Enterprises also has presence in the Indian MDO service sector where they mine, develop and operate coal mines. Adani Enterprises provides mining services in coal mines with a capacity of 45 million tonne which are operational and coal mines with a capacity of 43 million tonne which are under development. (Source – Company filings, CRISIL MI&A Research). Major mines for which Adani Enterprise acts as a developer and operator are as below, where the entity had a book size of 88 MTPA in coal blocks with respect to MDO services as of September 2022.

**Table 23: Mines where Adani Enterprises functions as an MDO**

| Type | Name | Capacity (MMT) | Location | Status |
|---|---|---|---|---|
| Coal mining services | Parsa East Kente Basen coal block | 15 | Chhattisgarh | Operational |
| | Gare Pelma III coal block | 5 | Chhattisgarh | |
| | Talabira II and III coal Block | 20 | Odisha | |
| | Suliyari coal block | 5 | Madhya Pradesh | |

| | | | | |
|---|---|---|---|---|
| | Parsa coal block | 5 | Chhattisgarh | Under development |
| | Gidhmuri Pituria coal block | 5.6 | Chhattisgarh | |
| | Kente extension coal Block | 9 | Chhattisgarh | |
| | Gare Pelma II coal block | 23.6 | Chhattisgarh | |

*Source: Company filings, CRISIL MI&A Research*

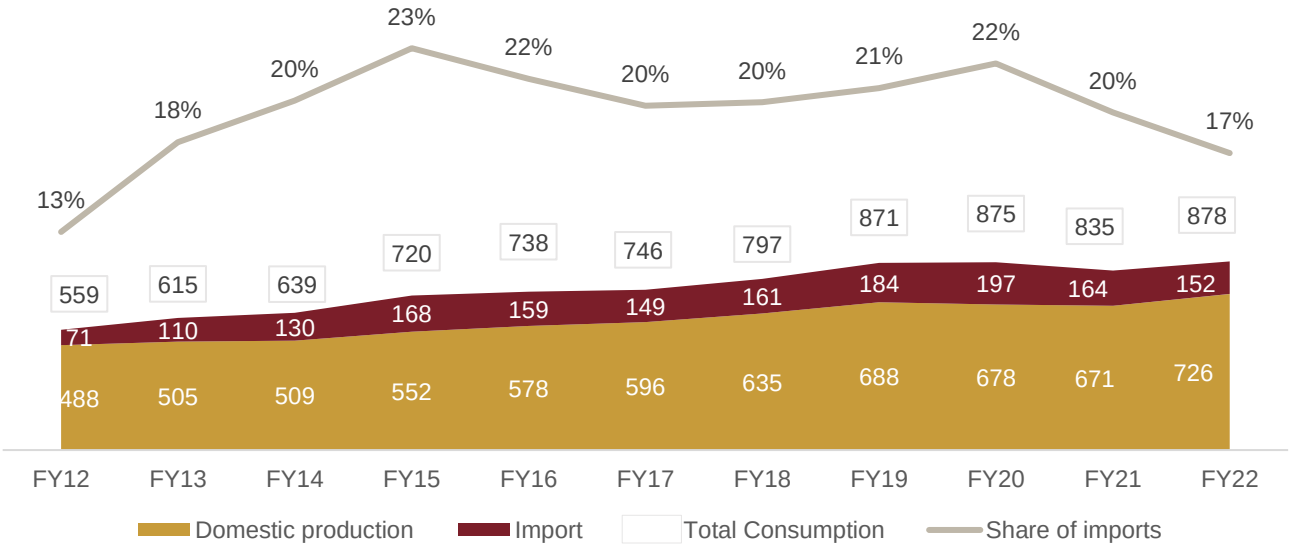
Adani Enterprises has, in its capacity as an MDO, serviced a volume of 14MT and 28MT, respectively, in fiscals 2023 (April to September) and 2022 (full year) from the operational mines in its portfolio. (Source – Company filings, CRISIL MI&A Research). This, when compared with total captive coal production, results in a share of 25% and 31%, respectively, for fiscals 2023 (YTD) and 2022. On average, Adani Enterprises has maintained a 25% share in coal production within the captive coal production segment over fiscals 2018 to 2022.

### *Coal resource management*

Coal supply also requires appropriate management of sourcing from suppliers and logistics of the same. This involves the responsibility and accountability of sourcing resources (such as coal) from suppliers, managing sea-borne logistics, providing an intermediate holding facility at discharge ports and delivering resources to customers. Efficiency in such activities may result in cost and resource savings, especially in logistics, aiding sustainability in operations.

Historically, in India, consumption of non-coking coal has been higher than the supply available from domestic resources, leading to the need for imports. Over the past decade, on average, 20% of domestic non-coking coal requirement (the major variety of coal used in India) has been imported.

**Figure 98: Non-coking coal supply avenues, FY12-22 (million tonnes)**



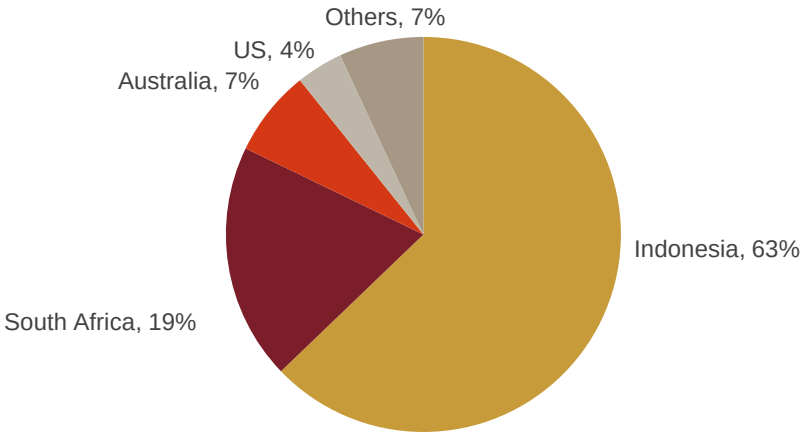

*Source: Ministry of Coal, CRISIL MI&A Research*

The government has been pushing for substitution of coal imports through domestic resources by investing in better infrastructure and mine expansions through CIL, recently allowing commercial coal mining via allocation of coal blocks to private enterprises and pushing for more captive coal production in times of shortfall.

Despite this, power demand rebound has been sharp over fiscals 2022 at 8.2% on-year with expectations of 7-9% demand growth this fiscal as well compared with a three decadal average growth rate of 5.4% for the Indian market. This has led to stress on coal supplies, leading to sustained imports where non-coking coal has seen a growth of 12% on-year over the April–October period in fiscal 2023 through imports.

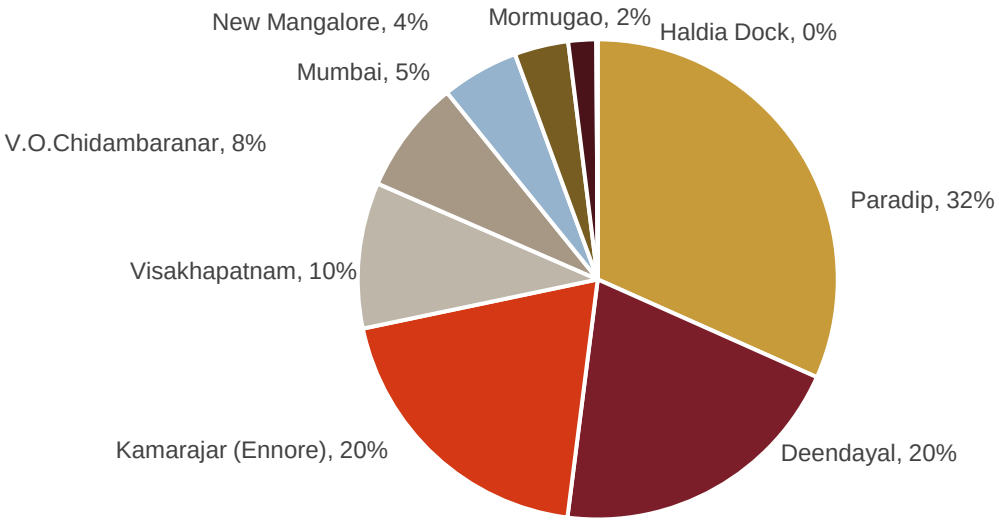
These imports are sourced from multiple coal-producing countries with Indonesia accounting for a majority share. Certain industries have specific requirements with respect to coal due to which imports are also high from South Africa and Australia (coal exports with higher gross calorific value).

**Figure 99: Share of non-coking coal exports to India**




Note: The above is the average share of the corresponding country in non-coking coal exports to India over fiscals 2013 to 2022
*Source: Ministry of Trade and Commerce, CRISIL MI&A Research*

**Figure 100: Significance of major ports in imports of non-coking coal**

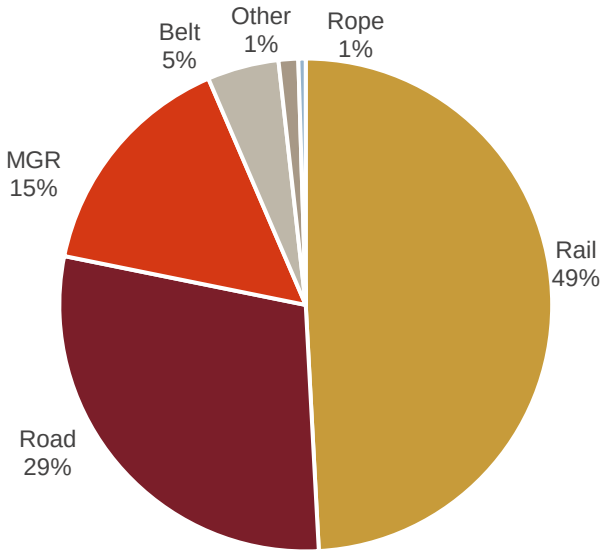



Note: The above is data corresponding to FY22
*Source: Indian Ports Association, CRISIL MI&A Research*

These imports are handled across most of the major ports of India with the East and South of the country witnessing maximum traffic through the Paradip, Deendayal and Ennore ports in fiscal 2022. While shipping of coal

would be the main transportation method for coal imported from other countries, inland transportation is also undertaken through various methods with rail being the dominant one used to transport coal to its destination.

**Figure 101: Share of various methods of transportation of coal**




Note: The above is data is on average across fiscals 2013-2022

*Source: Ministry of Coal, CRISIL MI&A Research*

Consequently, the supply of coal requires stakeholders to manage operations including sourcing of coal supply and handling logistical operations related to the same. Total non-coking coal imports in India accounted for ~152 MT in fiscal 2022. The organisation handled coal volume of 64.4 MT under its Integrated Resource Management operations (a division dealing with coal resource management and logistics) which would account for ~42% of India's total non-coking coal imports in fiscal 2022. (Source – Company filings, CRISIL MI&A Research).

## Assessment of regulatory framework in the coal industry

Coal is a highly regulated sector in India with various regulations impacting the industry.

### 3. Coal Mines (Nationalisation) Act, 1973

This Act was formulated after all private mines were nationalised and laid down the eligibility to mine coal in the country. This Act allowed mining by only the following entities:

- The central government
- A government company (including a state government company)
- A corporation owned, managed and controlled by the central government
- A person to whom a sub-lease has been granted by the central government
- A company or corporation having a coal mining lease, subject to the condition that the coal reserves covered by the sub-lease are in isolated small pockets or are not sufficient for scientific and economic development in a coordinated manner and that the coal produced by the sub-lessee will not be required to be transported by rail.

This Act was further amended in 1976, 1993 and 1996, permitting coal mining for captive use by private companies engaged in power generation, coal washing and cement production.

**4. Coal Mines (Special Provisions) Act, 2015**

The Supreme Court passed a judgment in August 2014 cancelling the allocation of almost all the coal blocks allotted from 1993 to 2010, declaring the process to be illegal. Following this, the central government passed the Coal Mines (Special Provisions) Bill, 2015 to allot mines to players operating in eligible end-use sectors so as to ensure adequate availability of domestic coal and limit imports. The key features of this regulation are highlighted below:

- Allows captive mining by private companies engaged in power generation (including for captive use), production of steel, cement and coal washing
- Coal mines will directly be allotted to the public sector units (PSUs) whereas allotment to private players will be done through auctions
- Private power producers will be awarded captive coal blocks through the reverse auction method whereas forward auction will be used for allocating mines to companies in the non-power sector

Captive coal blocks are classified into three schedules: Schedule I mines includes all the 204 coal mines cancelled by the Supreme Court in August 2014. Schedule II includes 42 Schedule I mines that are currently under production or about to start production. Schedule III mines include the 32 Schedule I mines that have been earmarked for a specified end-use.

**5. Mines and Minerals Development and Regulation Amendment Bill, 2016**

The Mines and Minerals (Development and Regulation) Amendment Bill, 2016 was introduced in the Lok Sabha on March 16, 2016. The bill amends the Mines and Minerals (Development and Regulation) Act, 1957.

- The bill allows for the transfer of mining leases which have been granted through an auction process. The holder of these mining leases may transfer the lease to any eligible person, with the approval of the state government, and as specified by the central government.
- The bill also allows for the transfer of mining leases which have been granted through procedures other than auction, and where the minerals are used for captive purpose. Captive purpose has been defined as the use of the entire quantity of mineral extracted in the lessees' own manufacturing unit. Such lease transfers will be subject to terms and conditions, and transfer charges as prescribed by the central government. Also, these transfers will be in addition to the existing transfers that are allowed.
- Thus, this provision would allow for merger and acquisition of companies with captive mining leases.
- The bill adds a definition of the leased area, as the area within which mining operations can be undertaken. This will also include the non-mineralized area required for the activities defined under mine in the Mines Act, 1952.

**6. Mines and Minerals Development and Regulation Amendment Act, 2020**

The Mineral Laws (Amendment) Act, 2020 was enacted to amend the Coal Mines (Special Provisions) Act, 2015 [CMSP Act] and the Mines and Minerals (Development and Regulation) Act, 1957 [MMDR Act]. The amendments in the Acts enabled following:

- Allocation of coal blocks for composite prospecting license-cum-mining lease which will help in increasing of the inventory of coal, lignite blocks for allocation. Repetitive and redundant provision requiring previous approval of the central government in cases where the allocation or reservation of coal/lignite block has been made by the central government itself has been done away with.

- Provided flexibility to the central government in deciding the end-use of Schedule II and III coal mines under the CMSP Act. Companies which do not possess any prior coal mining experience in India can now participate in auction of coal blocks.
- The government abolished the restrictions related to the end-use of captive and non-captive leases.
- Methodology for auction of coal and lignite mines/blocks for sale of coal/lignite on revenue-sharing basis under the CMSP Act and the MMDR Act was approved by the CCEA.

## Commercial coal mining in India

To boost private participation in the sector, the government has been actively taking steps to open up the mining sector to private enterprises. Under the same, the government aims to auction 500 mineral blocks by the end of 2024 as per a plan released by the Press Information Bureau in 2022. An assessment by the Niti Aayog in August 2021 indicated that a potential 160 projects under coal mining with an indicative worth of Rs 28.747 crore could be monetised over fiscals 2022 to 2025.

In November 2020, the Indian government conducted an auction under the first tranche of commercial mines. While 41 mines were initially included in the auction, the number was brought down to 38 after excluding three non-coking coal mines, owing to environmental issues, ultimately comprising 34 non-coking coal mines and four coking coal mines. Since then, allocations of coal mines for commercial use have happened through four auctions that have already been executed and the fifth which is underway as on date of the report.

**Table 24: Commercial mining auction: Tranche-wise details**

| Tranche name | Date | Number of mines on offer | Number of allocated mines |
|---|---|---|---|
| 1st tranche | November 2020 | 71 | 20 |
| 2nd tranche | August 2021 | 75 | 10 |
| 3rd tranche | February 2021 | 86 | 10 |
| 4th tranche | April 2022 | 95 | 15 |
| 5th tranche | Underway | | |

*Source: Ministry of Coal, CRISIL MI&A Research*

The mines are expected to be operationalised by fiscal 2025, although the actual schedule is likely to depend on the winning bidder's profile and capabilities. Though implementation is key, private participation through commercial mine auctions is expected to increase efficiency and domestic production, thereby improving coal availability, particularly to non-power sectors, in the longer run. Utilisation of mines will depend on the peak rated capacity of the mine, miner's capabilities and on-ground restrictions. In subsequent years, with increased efficiency and utilisation rates, production from these allocated mines is expected to touch 45-50 million tonne by fiscal 2027.

Players who have participated in the commercial coal auctions have been from various sectors such as commodity trading, steel, aluminium, power generation, mine developers and operators. Apart from these, companies from diverse segments such as real estate and petroleum also participated in the allocations.

**Table 25: Profile of mine coal commercial auction winners**

| Mine | PRC | Bidder name | Bidder profile |
|---|---|---|---|
| Bandha | 5 | EMIL Mines and Mineral Resources Ltd | Iron ore mining |
| Brahmadiha | 0.15 | Andhra Pradesh Mineral Development Corporation Ltd | Mining and quarrying |
| Chakla | 5.3 | Hindalco Industries Ltd | Aluminium manufacturing |

| Mine | PRC | Bidder name | Bidder profile |
|---|---|---|---|
| Dhirauli | 3 | Stratatech Mineral Resources Pvt Ltd | Commodity trading |
| Gare-Palma-IV/1 | 6 | Jindal Power Ltd | Power generation |
| Gare-Palma-IV/7 | 1.2 | Sarda Energy and Minerals Ltd | Steel manufacturing |
| Gondulpara | 4 | Adani Enterprises Ltd | Minerals trading - Diversified |
| Gotitoria (East) & Gotitoria (West) | 0.3 | Boulder Stone Mart Pvt Ltd | Mining and quarrying |
| Marki Mangli-II | 0.3 | Yazdani International Pvt Ltd | Commodity trading |
| Radhikapur (East) | 5 | EMIL Mines and Mineral Resources Ltd | Iron ore mining |
| Radhikapur (West) | 6 | Vedanta Ltd | Minerals trading - diversified |
| Rajhara North-Central & Eastern | 0.75 | Fairmine Carbons Pvt Ltd | Petroleum products |
| Sahapur East | 0.7 | Chowgule and Company Pvt Ltd | Minerals mining |
| Sahapur West | 0.6 | Sarda Energy and Minerals Ltd | Steel manufacturing |
| Takli-Jena-Bellora (North) and Takli-Jena-Bellora (South) | 1.5 | Aurobindo Realty and Infrastructure Pvt Ltd | Real estate |
| Urma Paharitola | 10 | Aurobindo Realty and Infrastructure Pvt Ltd | Real estate |
| Urtan | 0.65 | JMS Mining Pvt Ltd | Mine developer & operator |
| Urtan North | 0.6 | JMS Mining Pvt Ltd | Mine developer & operator |
| Kuraloi (A) North | 8 | Vedanta Ltd | Minerals trading - diversified |
| Gondkhari | 1 | Adani Power Maharashtra Ltd | Power generation |
| Jogeshwar & KhasJogeshwar | NA | South West Pinnacle Exploration Ltd | Exploration |
| Jhigador | NA | CG Natural Resources Pvt Ltd | Mining and quarrying |
| Bhivkund | 0.72 | Sunflag Iron & Steel Company Ltd | Steel manufacturing |
| Rauta closed mine | NA | Shreesatya Mines Pvt Ltd | Mining and quarrying |
| Khargaon | NA | CG Natural Resources Pvt Ltd | Mining and quarrying |
| Burakhap Small Patch | 0.4 | Shreesatya Mines Pvt Ltd | Mining and quarrying |
| Bhaskarpara | 1 | Prakash Industries Ltd | Steel manufacturing |
| Beheraband North Extn. | NA | Auro Coal Pvt Ltd | Mining and quarrying |
| Lalgarh (North) | 1 | Adhunik Power and Natural Resources Ltd | Power generation |
| Bankhui | NA | Yazdani Steel and Power Ltd | Steel manufacturing |
| Bijahan | 5.26 | Mahanadi Mines and Minerals Pvt Ltd | Mining and quarrying |
| Brinda and Sasai | 0.68 | Dalmia Cement Bharat Ltd | Cement manufacturing |
| Koilajan | 0.004 | Assam Mineral Development Corporation Ltd | Mining and quarrying |
| Meenakshi | 12 | Hindalco Industries Ltd | Aluminium manufacturing |
| Garampani | 0.02 | Assam Mineral Development Corporation Ltd | Mining and quarrying |
| Majra | 0.48 | BS Ispat Ltd | Steel manufacturing |
| Utkal – C | 3.37 | Jindal Steel and Power Ltd | Steel manufacturing |
| Namchik Namphuk | 0.2 | Platinum Alloys Pvt Ltd | Steel manufacturing |
| Sursa | NA | Madhya Bharat Minerals Pvt Ltd | Metals and minerals |

| Mine | PRC | Bidder name | Bidder profile |
|---|---|---|---|
| Dahegaon/Makardhokra-IV | 1.5 | Avassa Ferro Alloys Pvt Ltd | Metals and minerals |
| Basantpur | NA | Gangaramchak Mining Pvt Ltd | Mining and quarrying |
| Bandha North | NA | Jaiprakash Power Ventures Ltd | Power generation |
| Marki Mangli-IV | 0.2 | Sobhagya Mercantile Ltd | Metal sales |
| Jitpur | 2.5 | Terri Mining Pvt Ltd | Mining and quarrying |
| Rampia and Dipside of Rampia | 15 | Jhar Mineral Resources Pvt Ltd | Mining and quarrying |
| Ghogharpalli and its dip Extension | 20 | Vedanta Ltd | Minerals trading - Diversified |

*Source: Ministry of Coal, CRISIL MI&A Research*

### *Presence of Adani Enterprises in commercial coal mining*

Under the commercial coal mine allocations, Adani Enterprises has also won commercial coal mines through the competitive bidding process conducted by the Government of India. These mines are detailed here under:

**Table 26: Commercial coal mines under Adani Enterprises**

| Type of project | Mine | Capacity (MMT) | State | Project status |
|---|---|---|---|---|
| Commercial coal mining | Gondulpara | 4 | Jharkhand | Under development |
| | Dhirauli | 5 | Madhya Pradesh | |
| | Jhigador | N.A. | Chhattisgarh | |
| | Khargaon | N.A. | Chhattisgarh | |
| | Bijahan | 5 | Odisha | |
| | Gondbahera Ujheni East | N.A. | Madhya Pradesh | |

Note: NA – Not available

*Source: Company filings, CRISIL MI&A Research*

Further, Adani Enterprises also has the Carmichael mine and rail project which is located near the Queensland coast in Australia. The Carmichael project is a thermal coal mine and rail project, which transports coal from the Galilee Basin to countries in Asia, including India. The Carmichael mine has a capacity of 10MTPA which became operational in the fourth quarter of fiscal 2022.

## Overview of the structure of the mining industry – Non-coal

India is well endowed with natural resources, particularly minerals, which serve as a raw material for many industries, paving a path for rapid industrialisation and infrastructural development. The mineral and mining industry of India is a key economic driver as well as enabler for the country. While the mining industry accounts for a little over 2% of India’s GDP, it has far-reaching impacts. Not only does it create a lot of employment in relatively backward states in eastern and central India, but it also sustains behemoth industries such as steel, cement and aluminium.

India's overall mining industry can be classified into two segments - coal and non-coal. While coal continues to account for over 50% of India's mine production, the other minerals have also seen significant growth over the past few years.

The non-coal sector is largely dominated by two minerals – iron ore and limestone, the key inputs to the steel and cement industry, accounting for around 92% of the non-coal mineral output in fiscal 2022. The remaining 8% is largely led by bauxite, copper concentrate, zinc and lead concentrate and manganese ore.

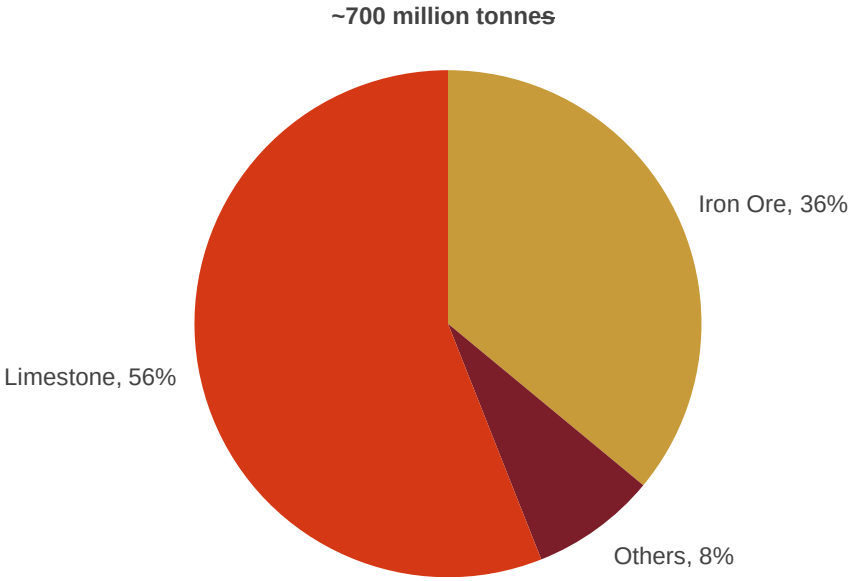
The total number of operating mines in India is estimated at ~1,245, which has come down from 1,427 in fiscal 2019 on the back of the closure of smaller and older mines. Among the states, Madhya Pradesh has the highest number of mines followed by Gujarat, Karnataka, Odisha, Andhra Pradesh, Chhattisgarh, Tamil Nadu, Rajasthan, Maharashtra, Jharkhand and Telangana.

### *Overview of India's non-coal mining sector*

Minerals are valuable natural resources. They constitute the vital raw materials for many basic industries and are a major resource for development.

The Indian mining sector (non-coal) makes a large contribution towards the economy with the total value of mineral production (excluding atomic, fuel minerals and minor minerals) during fiscal 2022 estimated at Rs 1.9 lakh crore. While metallic minerals account for close to 55% of the total value of mineral production while non-metallic minerals (including minor minerals) accounted for the remaining 45%. The total production of all minerals and mines was estimated at ~700 million tonne in fiscal 2022 with iron ore and limestone accounting for 92% of the same.

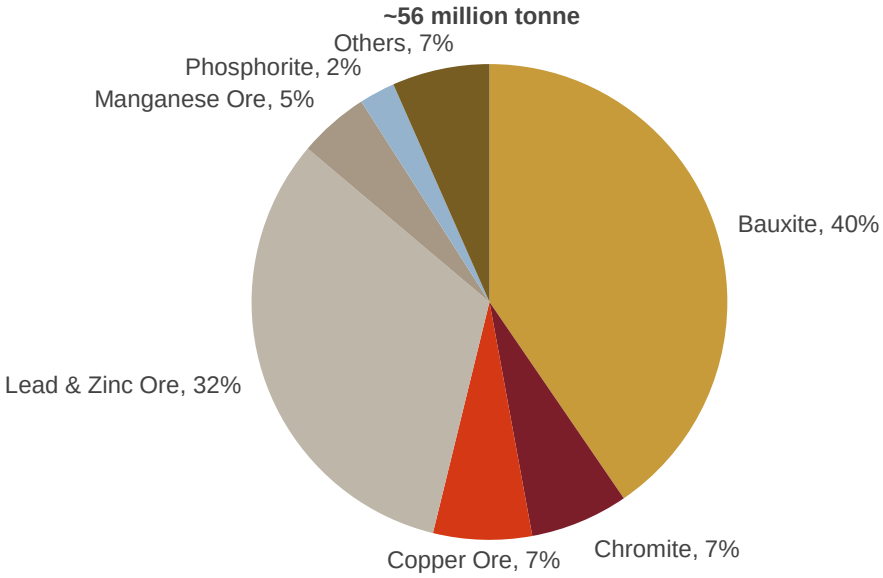
**Figure 102: India's total mineral production in FY22 (million tonne)**




Note: Break-up of Others provided in the next chart

*Source: Ministry of Mines, CRISIL MI&A Research*

**Figure 103: Share of other key minerals in FY22 (million tonne)**

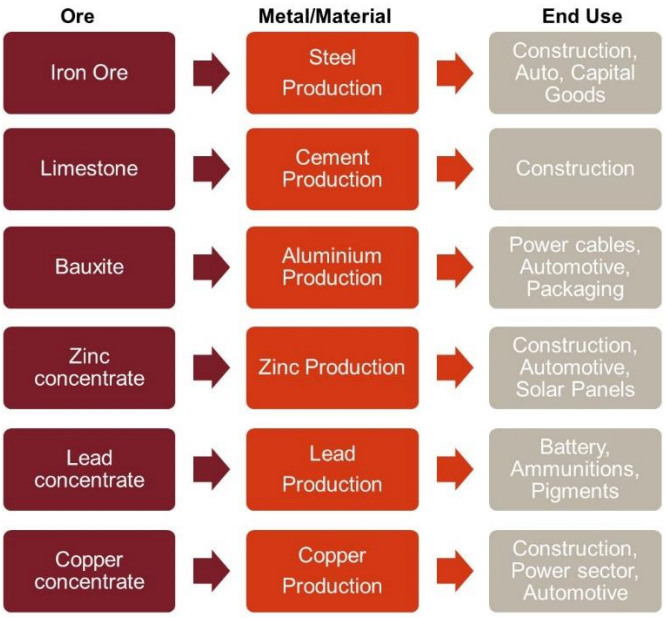



*Source: Ministry of Mines, CRISIL MI&A Research*

### *Assessment of key demand drivers of India's non-coal mining sector*

While the overall economic development remains the key driver for the Indian mining sector each of the different minerals has its own downstream uses. For example, consumer durables and automobiles are key consumers of aluminium which drives demand for Bauxite, however the same would have no impact on limestone which is primarily used in manufacture of cement.

**Figure 104: Key end users for the mining industry million tonnes)**




*Source: CRISIL MI&A Research*

### *Pricing regime overview of the iron ore sector*

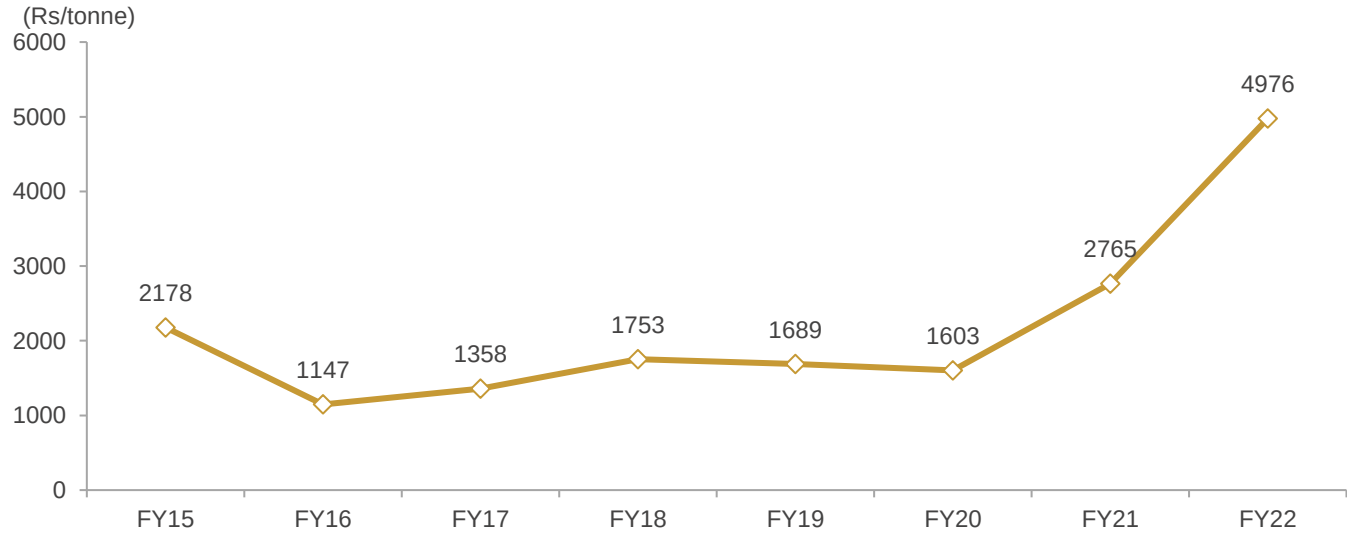
The iron ore sector in India is deregulated. The Government of India has no direct role in fixation of prices of iron ore.

The merchant miners and steel producers with captive mines are allowed to price their products based on the regional demand supply dynamics as well as the quality and grade of the ore.

However, the Indian Bureau of Mines (IBM) releases iron ore prices across grades, based on which the iron ore producers (merchant or captive) contribute towards a district mineral fund (DMF), royalty, and bid premiums are determined for mines acquired post MMDR Amendment Act, 2015. IBM arrives at the iron ore prices based on pricing of the top 10 non-captive producers. There have also been talks of setting up a National Mineral Index to help realise the actual market price of iron ore, which is yet to materialise.

India is a key exporter of iron ore and domestic prices are not at parity with landed cost of imports as in the case of steel. However, the domestic iron ore prices move in line with global prices. Elevated global prices open up opportunities for exports, leading to lower availability in domestic market and thus driving prices upwards.

**Figure 105: Domestic iron ore prices (60-62% Fe fines)**




*Source: CRISIL MI&A Research, IBM*

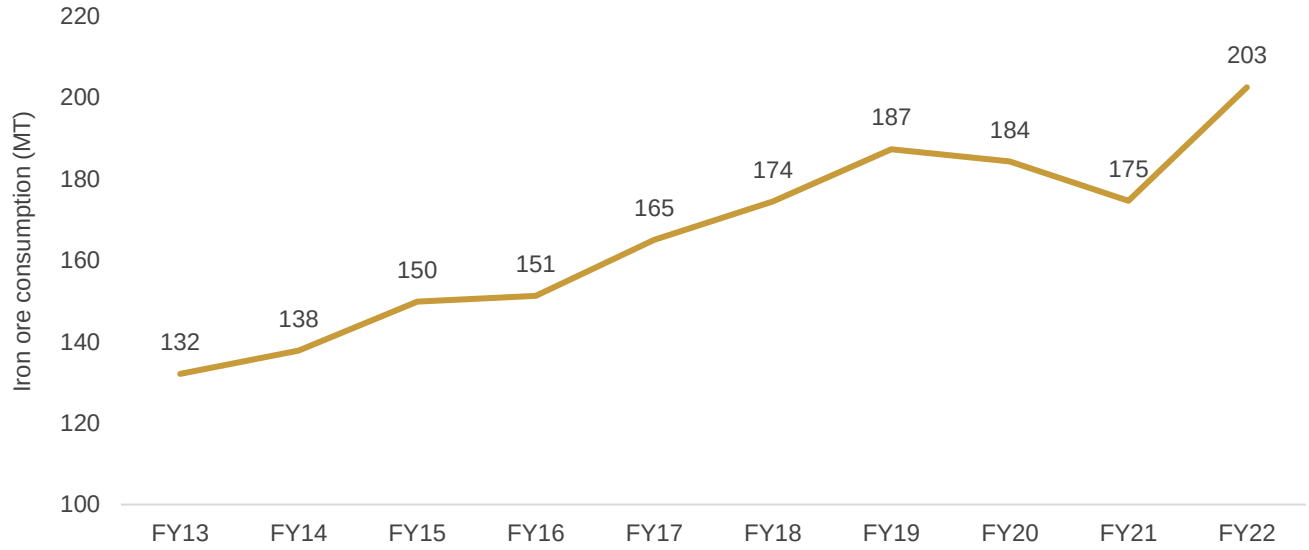
## Review of the mining industry — iron ore

### *Demand review*

India's iron ore demand is driven by the domestic steel industry. The domestic consumption of iron ore has moved in line with domestic steel production over the years, given little change in scrap usage due to lower availability of scrap in the domestic market.

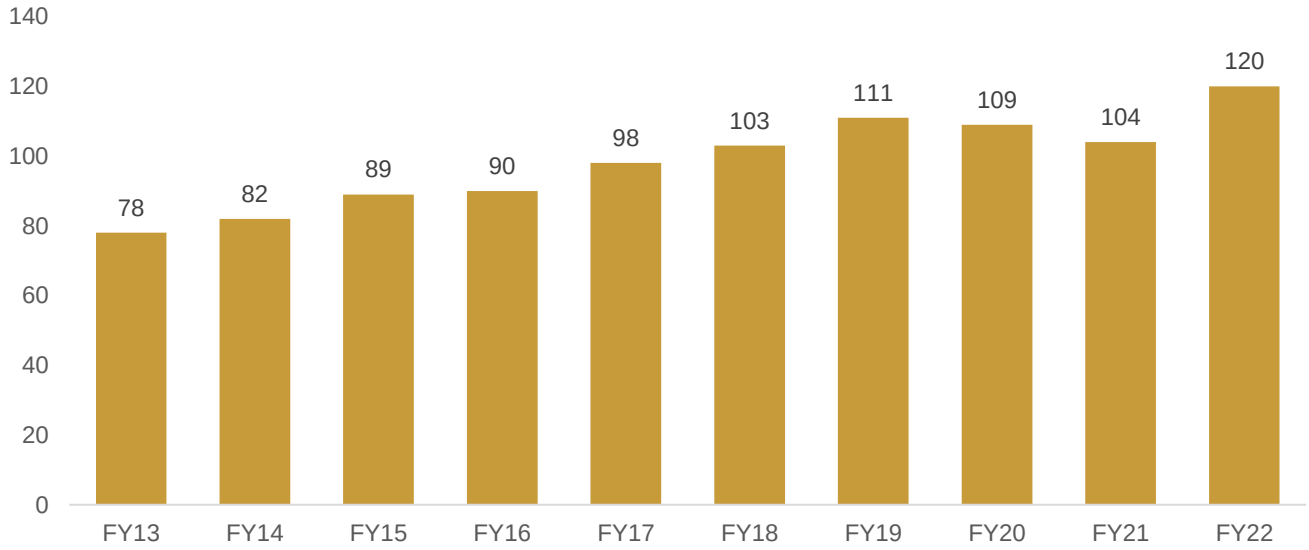
India's consumption has grown at a healthy pace of ~5% over the last decade to ~203 MT as of fiscal 2022. The consumption of iron ore mirrors domestic crude steel production, which has also grown at a similar pace over that period. India's crude steel production has increased at 4.9% CAGR between fiscals 2013 and 2022, from ~78 MT to ~120 MT. Basic oxygen furnace (BOF)'s share was 43-45% and electric arc furnace (EAF) process comprised the rest. Crude steel produced using the BOF process rose at ~5.2% CAGR, what that from EAF increased at ~4.5%.

**Figure 106: India iron ore consumption, FY13-22 (MT)**




*Source: CRISIL MI&A Research*

**Figure 107: India crude steel production, FY13-22 (MT)**



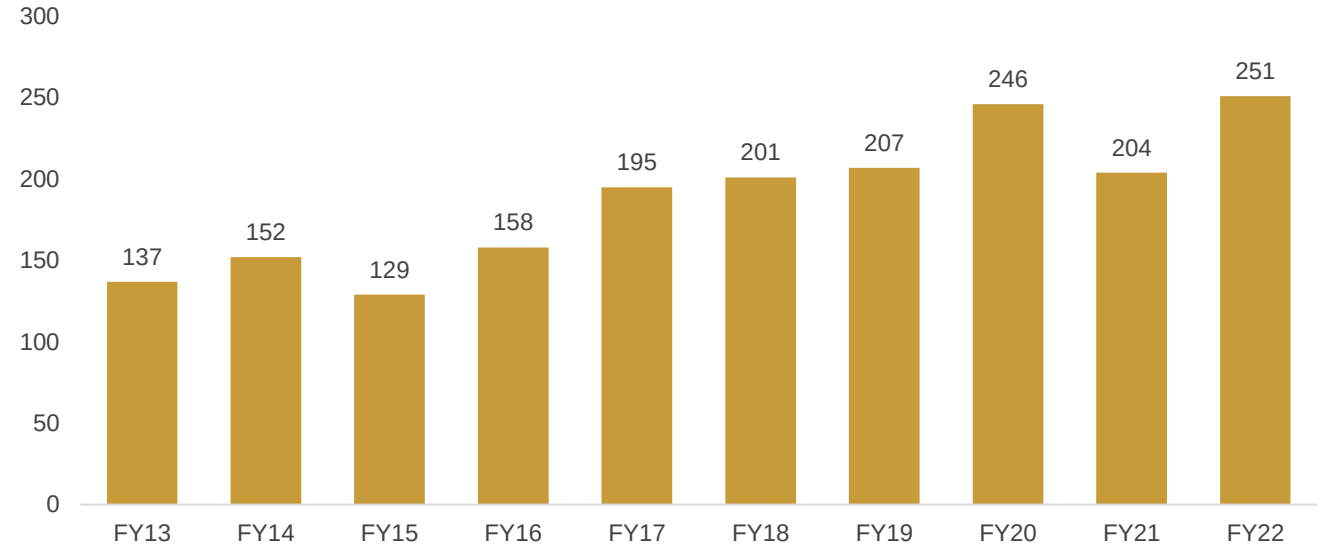

*Source: CRISIL MI&A Research, Joint Plant Committee (JPC)*

## Supply review

Iron ore production in India has increased at ~7% CAGR between fiscals 2013 and 2022, to ~251 MT. While production has been strong over this period, it had witnessed a sharp decline between fiscals 2010 and 2013 owing to mining and exports bans in Karnataka and Goa. In fact, production fell by over 35%, from 219 MT in fiscal 2010 to 137 MT in fiscal 2013.

However, it started to increase in fiscal 2016, after the re-auction of mines in Goa and new auctions in Odisha and Karnataka. Mine operations become more efficient with large steelmakers taking over, leading to a pick-up in production. However, production is likely to decline in fiscal 2023, as export duty levied on pellets and low-grade iron ore will curb exports (~10% of total production).

**Figure 108: India iron ore production, FY13-22 (MT)**




*Source: Indian bureau of mines, CRISIL MI&A Research*

## Assessment of regulatory framework in the iron ore industry

Iron ore is a highly governed industry, with numerous regulations such as export duty changes, mining and export bans affecting it. As a result, the output of the sector has varied significantly over the years. Other major regulatory changes that have impacted the sector is the MMDR (Mines and Minerals Development and Regulation) Amendment Act, 2015 and subsequent amendments.

### Export duty changes

In fiscal 2010, export duty on iron ore lumps, pellets (10%) and fines (5%, irrespective of grade) was introduced to reduce the raw material cost for the domestic steel industry. However, the export duty on iron ore lumps, pellets and fines was hiked to 20% across all grades the following fiscal. In fiscal 2013, the export duty on iron ore lumps and fines was hiked to 30%, while that on iron ore pellets was decreased to 5%. In fiscals 2014 and 2015, the export duty on iron ore lumps and fines with high quality grade continued at 30% while that on iron ore pellets continued at 5% in fiscals 2014 and 2015. While export duty on iron ore lumps and fines have remained at 30% since fiscal 2016, that on iron ore pellets was removed, thereby supporting exports of pellets and low-grade ores. However, in May 2022, the government decided to hike export duty on iron ore lumps and fines across all grades to 50% from 30% and iron ore pellets to 45% from 0%, to bring elevated domestic steel prices under control.

### Export ban and production cap in Karnataka

Karnataka was the second-largest iron ore producer in India after Odisha, producing ~43 MT (20% share in total production) in fiscal 2010. There were multiple environmental impacts such as air and water pollution and infertile lands due to mining activities in nearby areas. There was also a delay in the rehabilitation process for the vegetation and fauna around the mining area. To curb these damages, the Supreme Court of India banned the export of iron ore from Karnataka. It also ordered a temporary ban on production in July 2011. After a year, it allowed 108 mines to restart production with a 30 MT annual production cap. It also directed the miners to sell their iron ore to steel makers only through e-auction. However, due to several pending environmental clearances, only 25 mines were operational for 3-4 years.

In calendar year 2020, the Supreme Court increased the production cap from 30 MT to 35 MT. However, the export ban persisted in the state. In May 2022, the apex court passed a ruling to lift the exports ban from Karnataka. Further, mines that were closed through previous rulings were allowed to operate. The Court took into consideration the fact that Karnataka has remained a net importer, with steel mills resorting to purchasing iron from merchant players in Chhattisgarh and Odisha.

**Goa mining ban**

Goa was the third-largest iron ore-producing state of India in fiscal 2010 after Odisha and Karnataka, with ~38 MT (17% share in total production). The state accounted for more than half of India's total iron ore exports. In September 2012, the Supreme Court of India banned iron ore mining in Goa to curb illegal operations. It also cancelled the mining leases amid multiple irregularities during mining auctions and banned exports. Thus, over fiscals 2014 to 2016, iron ore production from the state was nil.

In fiscal 2017, the Supreme Court allowed the restart of mining operations with a production cap of 20 MT. However, production was limited due to several pending environmental clearances for miners. In calendar year 2018, the Court cancelled 88 mine leases which had been renewed in 2014 and 2015 before the MMDR Amendment Act, 2015 came into effect. Thus, there has been no production since fiscal 2019.

**MMDR Amendment Act, 2015**

The Act aimed to curb illegal mining and make the allocation process more transparent. The major changes were made in the Act were:

- Mine auction was made the only mode for mine allocation, and the auction was made completely online. This increased transparency significantly
- The mine blocks were given for a 50-year lease to the successful bidder
- Captive players were allowed to bid for the mines previously held by non-captive players. However, the captive players could not sell the non-required iron ore production to external buyers
- Captive players had the first right of refusal after the lease expired, and they could get the extension for a 15-year period
- To curb illegal mining, a penalty of up to Rs 5 lakh per hectare and five years of imprisonment was introduced in the Act
- A composite prospecting lease (PL) cum mining lease (ML) licence was introduced for virgin blocks

These reforms were beneficial for state governments since the states earned extra revenue through the auction process through bid premium, vs only royalty earlier.

**Mineral Laws (Amendment) Act, 2020**

The MMDR Amendment Act, 2015 received a positive reaction from the steel industry. To make the auction process easier, further changes were introduced in 2020. Some of the major ones were:

- The government abolished the restrictions related to end-use for captive and non-captive leases
- A new composite licence (Reconnaissance Permit (RP) cum Prospecting License (PL) cum Mining Lease (ML)) was introduced for virgin blocks

- The central government directed state governments to auction mines with pre-embedded clearances to shorten the lead time before the start of mining operations. Here, the state governments were made responsible to obtain all the necessary clearances

Following these changes, more captive players took part in the auctions, as restrictions related to the end-use of production were removed.

**MMDR Amendment Act, 2021**

Post the amendments introduced in 2020, the government introduced new amendments in 2021 to improve the availability of high-grade iron ore for the Indian market:

- Captive mines were allowed to sell up to 50% of the production to external buyers
- Statutory clearances remained valid even after the expiry of lease. This promoted ease of doing business
- The lessee who could not undertake mining operations could transfer the lease to the interested party without any additional charges, thus ensuring continuation of mine production

These changes promoted ease of doing business and boosted mine production.

## Commercial mining of iron ore

The commercial iron ore mining landscape in India is dominated by large government organisations such as the National Mineral Development Corporation (NMDC) and Odisha Mining Corporation (OMC), along with private players such as Rungta Mines, Essel Mining & Industries Ltd (EMIL), and Serajuddin and Company.

Merchant miners used to account for ~70% of India's iron ore till fiscal 2019. However, removal of mine classification (captive/merchant) for re-auction has led to captive players gaining the lion's share. Over, the past three years, the share of captive miners have gone up from ~30% to over 60%.

## Profile of key iron ore commercial miners in India

**NMDC**

The NMDC, a navaratna public sector enterprise under the Ministry of Steel, Government of India, is the largest producer of iron ore in India. It owns and operates  iron ore mines in Chhattisgarh and Karnataka. It also operates the only mechanised diamond mine in India at Panna, Madhya Pradesh.

NMDC produces around 42 mtpa of iron ore from three mechanised mining complexes (two in Chhattisgarh, and one in Karnataka) which supply ore in the form of lumps and fines for production to various steel industries using blast furnace/DRI route.

In fiscal 2022, the company achieved production of 42.19 MT and sales of 40.56 MT. The company is currently constructing a 3 mtpa steel plant under its wholly owned subsidiary NMDC Iron & Steel Plant (NISP). The company's Board of Directors has also accorded in-principle approval for demerger of the steel plant.

**OMC**

OMC was incorporated in 1956 as a JV between the Government of Odisha and Government of India. In 1961, it became a fully owned state PSU of the Government of Odisha. OMC is now the largest state PSU in India's mining sector. It is the fifth largest iron ore producer in the country and the second largest merchant/commercial iron ore miner after NMDC.

The major minerals mined by OMC are iron, chromite and bauxite ores, which cater to the requirements of mineral based downstream industries such as steel, sponge iron, pig iron, ferro-chrome, and aluminium.

Currently, OMC has 34 mining leases (chromite -10, iron - 13, iron & manganese - 05, managnese - 03, limestone - 01, gemstone – 01, and bauxite - 01) containing 1,208 MT of ore reserves. The company derives most of its revenue from the iron ore mining businesses. However, other businesses have made a healthy contribution towards the company's profit as well.

**EMIL**

Incorporated in 1950, EMIL is part of the Aditya Birla Group. It is one of the leading natural resource companies dealing in iron ore mining and contract coal mining (through mine developer and operator, or MDO, model).

EMIL's only iron ore mine is located at Koira in Sundargarh district of Odisha. The company used to operate other iron ore mines as well, which it was unable to win during re-auctioning of the mines in 2020.

EMIL, through its subsidiaries, operates two coal MDO projects, viz., Bhubaneswari and Rajmahal OCP. Bhubaneswari Coal Mining Ltd (BCML) operates the Bhubaneswari open cast coal project of Mahanadi Coalfields Ltd (MCL), a CIL subsidiary located in Angul District, Odisha. BCML has a contract from MCL to mine 269.5 MT tonne of coal over a period of 15 years. Rajmahal Coal Mining Ltd (RCML) operates the 17 mtpa Rajmahal open cast coal project of Eastern Coalfields Ltd (ECL), a CIL subsidiary located in Godda District, Jharkhand. RCML has a contract with ECL to mine 199.8 MT of coal over a period of 12.5 years. The company had participated and was declared successful bidder in two coal blocks in Odisha and Madhya Pradesh as well.

The company's wholly owned subsidiary, Pro Minerals Pvt Ltd (PMPL) operates a 1 mtpa iron–ore beneficiation plant and a 1 mtpa iron ore pelletisation plant located in Keonjhar district of Odisha.

The company also operates in ferro alloys and renewable power segments.

**Adani Enterprises**

Adani Enterprises is a leading MDO player in India with a heavy presence in coal and iron ore. The company is currently operating a 6 mtpa iron ore mine at Kumitar, Odisha, which is owned by OMC. The mine has a concession tenure until April 2046. Further, the company is developing the Bailadila iron ore mine with a capacity of 10 mtpa in Chhattisgarh. The Bailadila mine has a concession tenure until March 2047.

**Table 27: Iron ore mines with Adani Enterprises as MDO**

| Type | Name | Capacity (in MT) | Location | Status |
|---|---|---|---|---|
| Iron ore mining services | Kurmitar iron ore mine | 6 | Odisha | Operational |
| | Bailadila (Deposit -13) iron ore mine | 10 | Chhattisgarh | Under development |

*Source: CRISIL MI&A Research*

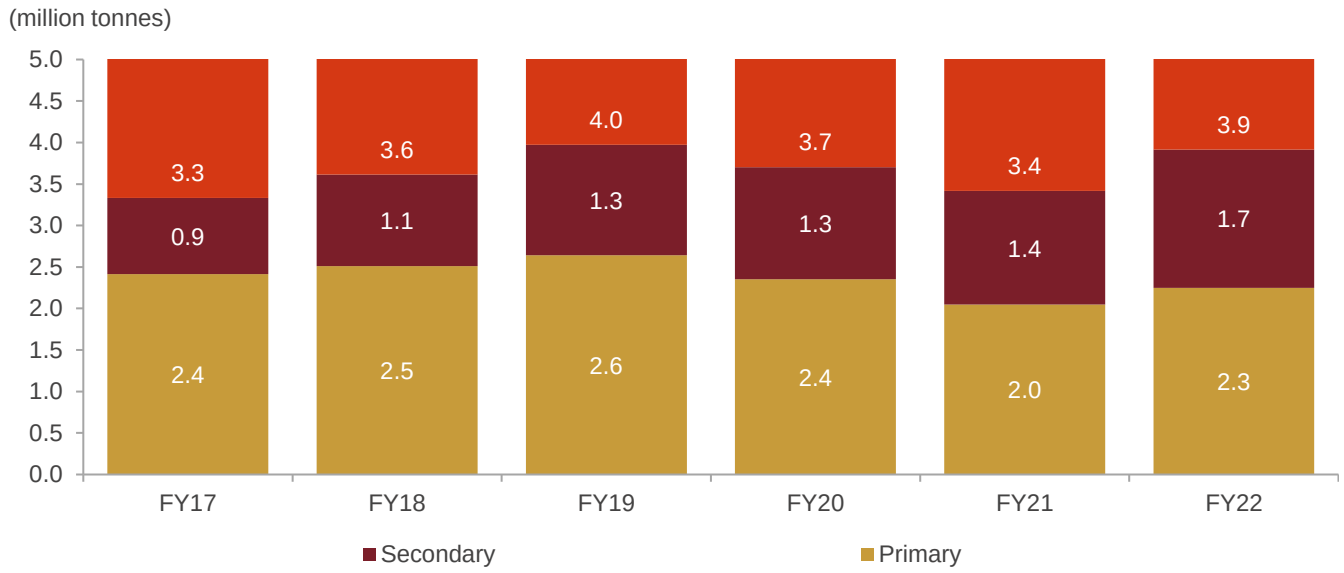
# Aluminium

## Review of domestic aluminium consumption

Domestic aluminium demand is met through primary aluminium and secondary aluminium. Primary aluminium is produced through the refining and smelting process to convert alumina to aluminium. Secondary aluminium is produced from aluminium scrap.

### Demand segregation by primary and secondary aluminium

**Figure 109: Overall domestic aluminium consumption**




*Source: Industry, CRISIL MI&A Research*

Domestic aluminium demand logged 3.3% CAGR between fiscals 2017 and 2022 to 3.9 million tonne. Share of primary aluminium and secondary aluminium changed drastically from 72% and 28%, respectively, in fiscal 2017 to 57% and 43%, respectively, in fiscal 2022 owing to better scrap availability and increasing primary aluminium prices. Domestic aluminium demand logged 9.2% CAGR between fiscals 2017 and 2019 before falling 6.8% on year in fiscal 2020. The demand fell a further 7.7% in fiscal 2021 owing to nationwide lockdown in the first half of the year after the spread of Covid-19. The demand revived 14.6% in fiscal 2022 owing to strong revival in the end-user industries.

**Fiscal 2017**: Domestic aluminium demand grew 4.9% on year in fiscal 2017 owing to higher demand from PGCIL, increasing production of power cables and healthy automobile production led by two-wheelers and three-wheelers. The growth was limited owing to a slowdown in the construction segment amid demonetisation announced in November 2016.

**Fiscal 2018:** Domestic aluminium demand further grew by 8.4% on year owing to robust capital spending from PGCIL, revival from construction segment, strong demand from automobile and packaging segment partially offset by stalled execution due to IL&FS crisis

**Fiscal 2019:** Domestic aluminium demand grew 10% on-year owing to continued momentum in the automobile segment and healthy demand from the packaging segment. However, falling orders from PGCIL limited the demand from the power segment.

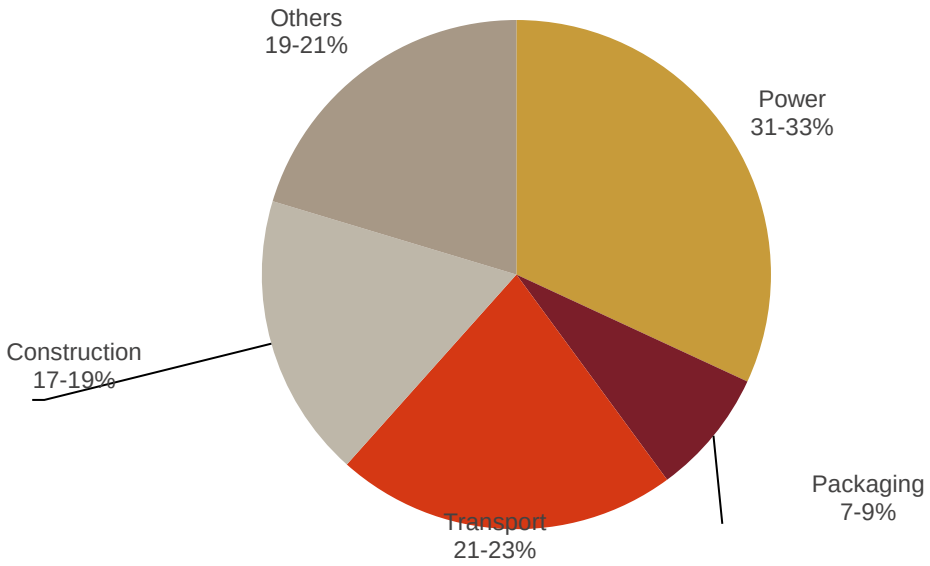
**Fiscal 2020:** Domestic aluminium demand fell a sharp 6.8% on-year owing to a decline in demand from the automobile and power segments. However, moderate growth in demand from the construction segment owing to increasing government spend on infrastructure cushioned the decline in overall aluminium demand.

**Fiscal 2021:** Domestic aluminium demand witnessed a further 7.7% on-year decline owing to destruction in demand from end-use segments after the imposition of nationwide lockdowns in the first half. However, a sharp demand revival from end-use segments in the second half of the fiscal limited the decline in aluminium demand.

**Fiscal 2022:** Domestic aluminium demand witnessed a sharp revival of 14.6% on-year owing to demand revival from end-use industries. The increase in demand was restricted as automobile production did not pick up owing to semiconductor shortage and the second wave of Covid-19 in the first quarter.

## Key end-use industries

**Figure 110: Share of key end-use industries (FY22)**




*Source: Industry, CRISIL MI&A Research*

**Power transmission and distribution:** The power segment is a major driver of domestic aluminium demand. Aluminium is used in production of transmission lines, transformers, and cables. Over fiscals 2017-2022, demand from the sector fell slightly owing to fall in capex from PGCIL. Addition of transmission lines fell 8.9% CAGR owing to lower orders from PGCIL and state electricity boards. The production of power transformers and distribution transformers fell 4.5% and 4% CAGR, respectively, during the period. On the other hand, production of power cables increased 4.6% CAGR owing to higher domestic demand and export orders.

**Transport:** The transport segment is the second largest demand driver for domestic aluminium. Aluminium is used in multiple spare parts of vehicles. Production of car and utility vehicles fell 0.8% CAGR between fiscals 2017 and 2022 because of semiconductor chip shortage since fiscal 2021. Production of two-wheelers remained flat during the period whereas production of tractors increased 4.8% owing to better rural spending and healthy monsoon. Usage of aluminium in commercial vehicles is high as it is lighter than steel and is as strong, improving fuel

efficiency. Production of commercial vehicles remained flat during the period. However, aluminium intensity increased marginally which boosted overall aluminium demand from the transport segment.

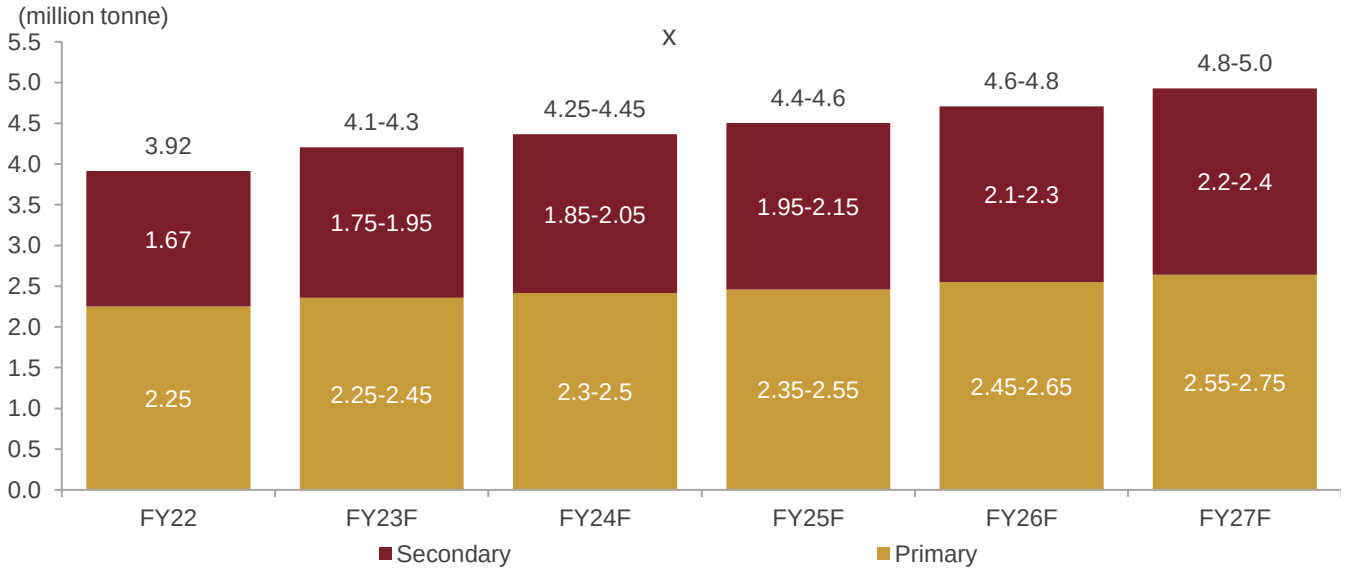
**Construction:** Aluminium is used to make window frames, doors, false ceilings, and industrial roofing. It is costlier than other alternatives, because of which its usage is restricted to premium urban construction projects. Aluminium is also used in various infrastructure projects. During fiscals 2017-2022, various government schemes focused on housing, such as PMAY-Urban, witnessed significant growth. The scheme spearheaded overall aluminium demand from the construction segment.

**Packaging:** Aluminium is used to make foils, beverage cans and industrial metal coated tapes. The segment uses secondary aluminium mostly. During fiscals 2017-2022, metal packaging demand grew 6.6% owing to robust demand from end-use industries such as alcoholic beverages, food products and pharmaceutics.

## Outlook for domestic aluminium consumption

### Demand segregation by primary and secondary aluminium

**Figure 111: Domestic aluminium consumption outlook**




*Source: Industry, CRISIL MI&A Research*

Overall aluminium demand is expected to log 4-5% CAGR between fiscals 2022 and 2027 to 4.8-5.0 MT, driven by healthy growth in the power, construction and automobile segments. Renewable energy investments and deepening EV penetration may also boost the demand significantly.

### Key end-use industries

**Power transmission and distribution:** Over fiscals 2022-2027, the power sector is likely to clock a CAGR of 2,5-3.5% mainly driven by renewable energy grid projects undertaken by PGCIL, supported by state transmission projects. While financial stress on discoms is likely to be a deterrent for demand in the short term, the Rs 3.03 trillion discom reform scheme launched in June 2021 will support demand growth over the long term.

**Transport:** The transport segment is expected to clock 6-8% CAGR during the period. Production of cars and utility vehicles may log 6-8%. Aluminium intensity in various components is also expected to increase as vehicle makers

and consumers seek better fuel efficiency. Production of two-wheelers is expected to log 8-10% CAGR owing to better domestic demand, especially from rural areas and healthy export orders. Production of tractors is expected to remain robust, registering 4-6% CAGR in export orders and 5-7% CAGR in domestic demand owing to better rural income.

**Construction:** Over fiscals 2022-2027, aluminium demand from the construction sector is expected to see a healthy 4-5% CAGR primarily driven by increased intensity of the metal's usage within the sector. The usage pattern — earlier restricted to premium projects — is likely to change with increasing adoption of the metal in other real estate projects as aluminium extrusion is witnessing rising acceptance in tier 2 and 3 cities. However, demand for primary aluminium may be limited due to as usage of secondary aluminium will gain currency.

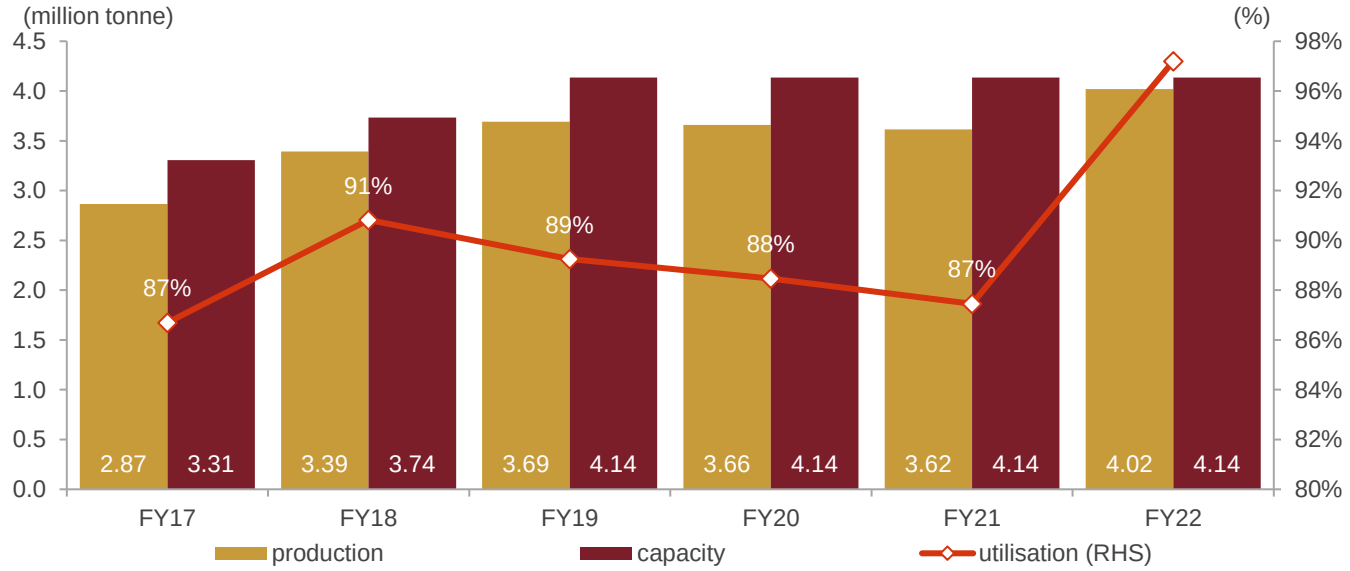
**Packaging:** Over fiscals 2022-2027, the packaging segment is expected to record a 6-8% CAGR owing to robust demand from the beverages, consumer foods and pharmaceuticals segments. The ban on single-use plastic products and increasing awareness about hazards of plastic are expected to boost aluminium usage over the long term.

### *New-age industries*

- **Renewable energy:** This sub-segment in the power segment will be a major factor in aluminium demand growth over the medium term. The metal is used to make solar panels and wind turbines. As of now, India imports most of its solar modules requirement. China has more than 85% share in the imports. However, after the government published the ALMM for the projects approved after April 10, 2021, more than 50% of the module demand has the potential to be met through domestically produced solar modules over the medium term. this will boost overall aluminium demand from the segment. Over fiscals 2023-2027, the country is expected to add 18-20 GW wind energy capacity with over Rs. 1.43 trillion investments. The government also aspires to reach 134 GW wind capacity by fiscal 2032 under its National Electricity Plan (NEP), which will also as a significant factor in boosting aluminium demand
- **Electric vehicles:** This sub-segment in the transport segment will be a paly a major rose in boosting aluminium demand over the medium term. Aluminium usage in EVs is significantly higher than in conventional vehicles as the metal is lighter but is as strong as steel. So, using aluminium will be a crucial factor that improves the overall driving range of EVs. As of fiscal 2021, EV adoption in cars segment stood at 0.2%, in two-wheelers at 0.3%, buses 3% and other commercial vehicles 0%. These are expected to reach 2-4%,11-14%,4-6% and 0-2%, respectively, by fiscal 2027.

## Review of domestic aluminium supply

**Figure 112: Domestic primary aluminium supply trend**




*Source: Industry, CRISIL MI&A Research*

Domestic aluminium capacity logged 4.6% CAGR between fiscals 2017 and 2022 to reach 4.1 MT from 3.3 MT. During the period, Hindalco added 93 KT through debottlenecking to reach a capacity of 1.3 MT. Vedanta added 60 KT in BALCO and 300 KT in Jharsugudha in fiscal 2018. Further, it added another 400 KT at Jharsuguda to reach 2.3 MT in fiscal 2019.

Domestic aluminium production registered 7% CAGR between fiscals 2017 and 2022 from 2.9 MT to 4.02 MT. During the period, Vedanta's aluminium production witnessed a robust 13.3% CAGR from 1.2 MT to 2.3 MT owing to rapid capacity ramp up at Jharsugudha and BALCO.

Despite the capacity expansion, domestic utilisation rate has seen a gradual decline until fiscal 2021 owing to slow ramp-up of Vedanta's Jharsuguda smelter. However, post fiscal 2021, Vedanta has quickly ramped up its output backed by long term coal and bauxite sourcing arrangements as well as rally in global Aluminium prices. Likewise, other players also improved their output amidst elevated metal prices

## Competitor's profile and Adani's positioning

### Vedanta

Vedanta Aluminium, an associate company of Vedanta Resources Plc, was incorporated in 2001. It is a leading producer of metallurgical grade alumina and other aluminium products. It is the largest mining and non-ferrous metals company in India and has mining operations in Australia and Zambia and oil and gas operations in three countries. Its main products are zinc, lead, silver, oil & gas, iron ore, steel, aluminium and power. Vedanta is the largest aluminium producer in India with a capacity of 2.3 million tonnes per annum (mtpa) and holds a 37% market share in terms of capacity. Vedanta Aluminium has an installed capacity of 1.8 mtpa, backed by two smelters — 0.55 mtpa and 1.25 mtpa (SEZ) — and two power plants with a combined capacity of 3615MW. BALCO operates through its plant at Korba in Chhattisgarh with a smelter capacity of 0.57 mtpa and power generation capacity of 2010MW. The alumina refinery at Lanjigarh feeds the aluminium smelters at Jharsuguda and BALCO and forms a

crucial link in the value chain. It is one of the world's largest, single-site integrated alumina refining complexes with a capacity of 2 mtpa that can be ramped up to 6 mtpa. Vedanta produces primary aluminium as ingots and converts majority of primary aluminium into VAPs, such as flat-rolled products, billets, slabs and rods at their Jharsuguda facility.

### Hindalco

Hindalco Industries Ltd was established in 1958 as Hindustan Aluminium Corporation Ltd. The company, which is a subsidiary of Aditya Birla Group, commenced operations in 1962 with a plant at Renukoot, Uttar Pradesh. It was renamed Hindalco Industries in 1989. Subsequent acquisitions and mergers with Indal and Birla Copper strengthened the company's position in the production of primary aluminium, value-added aluminium and copper products. In May 2007, the company acquired Canadian company Novelis for about $6 billion. Following the acquisition, Hindalco figured among the top five global aluminium producers. It is also the largest rolling company in the world. The company is an integrated producer, with alumina and aluminium facilities in India and rolling capacities across the globe. Hindalco produces primary aluminium as ingots and converts ingots into various products such as extrusions, foils and beverage cans.

### NALCO

National Aluminium Co Ltd (Nalco) was incorporated by the central government in 1981 to exploit the large bauxite deposits in Odisha. The company has one of Asia's largest integrated alumina complexes, encompassing bauxite mining, aluminium refining, aluminium smelting and casting, power generation, and rail and port operations. It has one of the largest integrated bauxite-alumina-aluminium-power complex in the country. The company has a 68.25 lakh TPA bauxite mine and 21.00 lakh TPA (normative capacity) alumina refinery located at Damanjodi in the Koraput district of Odisha. It also has a 4.60 lakh TPA aluminium smelter and 1,200 MW captive power plant in Angul, Odisha. Nalco has bulk shipment facilities at Vizag port for export of alumina/aluminium and import of caustic soda and also utilizes the facilities at Kolkata and Paradip ports. The company has registered sales offices in Delhi, Kolkata, Mumbai, Chennai and Bangalore and nine operating stockyards at various locations in the country to facilitate domestic marketing. Nalco is a fully integrated aluminium manufacturer. It produces ingots which are also converted into VAPs such as billets, rolled products.

### Adani Enterprises

The company has received the approval to build a 4 mtpa alumina refinery and captive power plant at Rayagada, Odisha, at an investment of $5.2 billion.

## Risk and challenges

- **Raw material sourcing:** Securing raw materials, such as alumina, bauxite and coal, is a major challenge for the industry. All established players are taking part in bauxite and coal mine auctions. Most of their alumina requirements are met domestically and the balance is met through imports.
- **Carbon emissions:** Aluminium manufacturing process is power-intensive. Most of the power is produced through thermal coal. With the increased focus on climate risk mitigation, governments are formulating various regulations to reduce the usage of fossil fuels.
- **Export competition:** More than ~50% of the aluminium produced in the country is exported. India is among top low-cost aluminium producers. However, it faces intense competition from the Middle East countries.

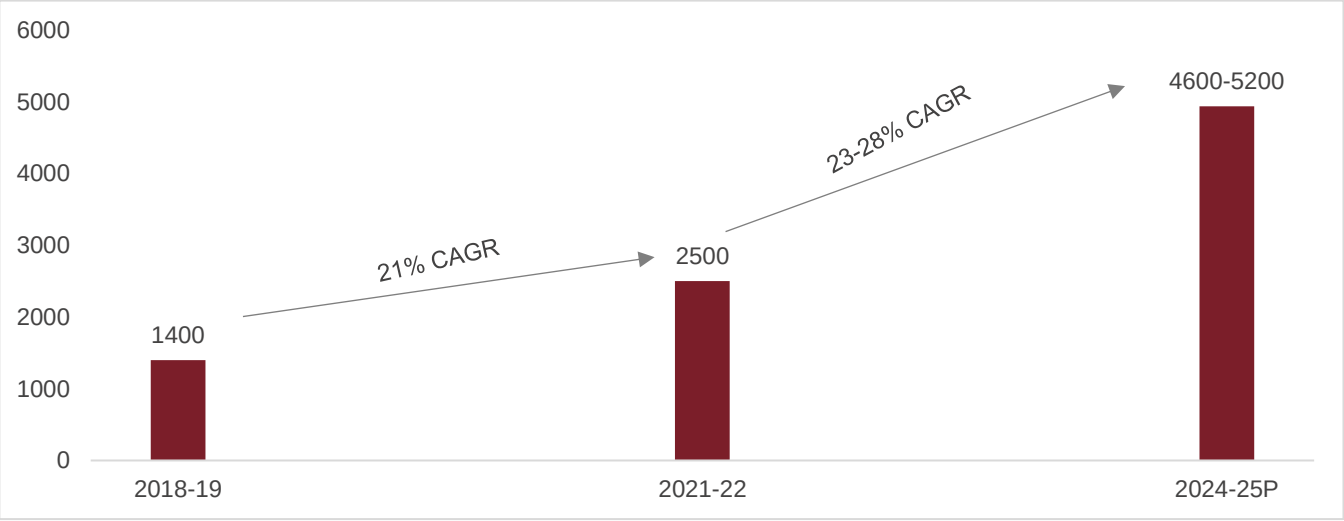
# Digital industry

## Review and outlook of the e-retail industry in India

In India, the e-retail industry, comprising both inventory and marketplace models of operations, gained prominence with the launch of Flipkart.com in 2007. Adding to it, from a deals website in 2010, Snapdeal switched to a marketplace model in 2012 and global e-retail giant Amazon commenced its Indian operations in 2013. Moreover, industry was flush with early stage and venture capital funding that led to growing e-commerce penetration in different retail product segments. Apart from factors such as increasing internet penetration, higher disposable incomes, and rising urbanisation which aided growth, even the user-friendly interface of portals offered by players, ease of shopping, increasing awareness, discounts and easy delivery and innovation, have propelled growth in this sector.

Growth between fiscals 2019 and 2022 was impacted on account of regulatory changes and consumption slowdown due to Covid-19. The Department of Industrial Policy & Promotion's clarification on foreign direct investment (FDI) policy by e-retailers, restricted equity ownership in sellers; capped percentage procurement for sellers from e-marketplaces; and put curbs on marketplaces mandating exclusive partnership with brands or on providing favourable services to a few vendors. With these policy changes initiated to create a level playing field for all sellers, discounts came down, which resulted in slower growth in fiscal 2020. Consumption slowdown following Covid-19 impacted demand in fiscal 2021, with the first quarter facing the brunt on account of ban on sale of non-essentials. The sector performed well during the festive season with demand coming in from Tier 2 and 3 cities apart from metros and Tier I. With the social distancing norms and fear of spread of infection, people preferred buying online. Thus, where most sectors witnessed de-growth during the fiscal, online retail witnessed positive growth. The sector witnessed healthy growth in fiscal 2022 on a low base of previous fiscal. Ban on sale of non-essential goods for most part of the first quarter impacted demand to some extent. However, demand bounced back during the festive season. New launches in electronics during the festive period and easy financing options drove growth. With people leaving their homes after months of lockdown, fashion category too witnessed healthy growth.

**Figure 113: E-retail growth forecast up to fiscal 2025**




Note: P - Projected

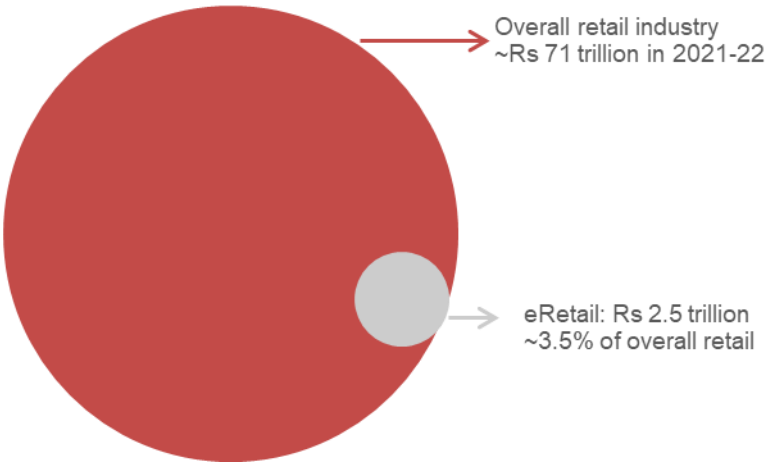
*Source: CRISIL MI&A Research*

Pandemic has brought a change in the buying behaviour with more and more people taking the online route. Going forward, players are expected to focus on customer convenience and their online experience rather than on only discounts. CRISIL MI&A Research projects online retail to clock 23-28% CAGR between fiscals 2022 and 2025.

## Share of e-retail sector in comparison with overall retail industry

The overall retail market in India stood at an estimated Rs 71 trillion in fiscal 2022. The market is dominated by unorganised players. Penetration of e-retail in the overall retail market is significantly low at ~3.5% in fiscal 2022, thereby providing sizeable opportunity in the sector.

**Figure 114: Limited penetration gives room for future growth**

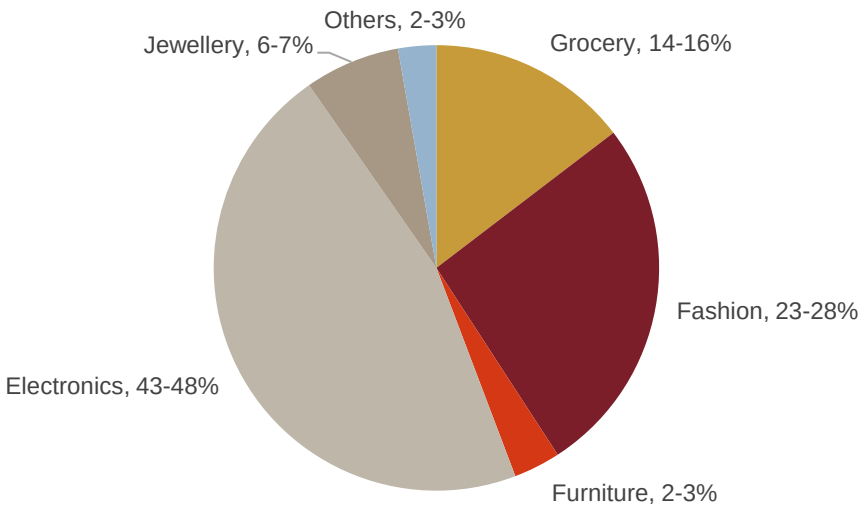



*Source: CRISIL MI&A Research*

## Share of key segments in e-retail industry

Fashion and consumer electronics are segments that found a foothold in the e-commerce space very early and have been growing continuously. They form the bulk of the e-retail pie.

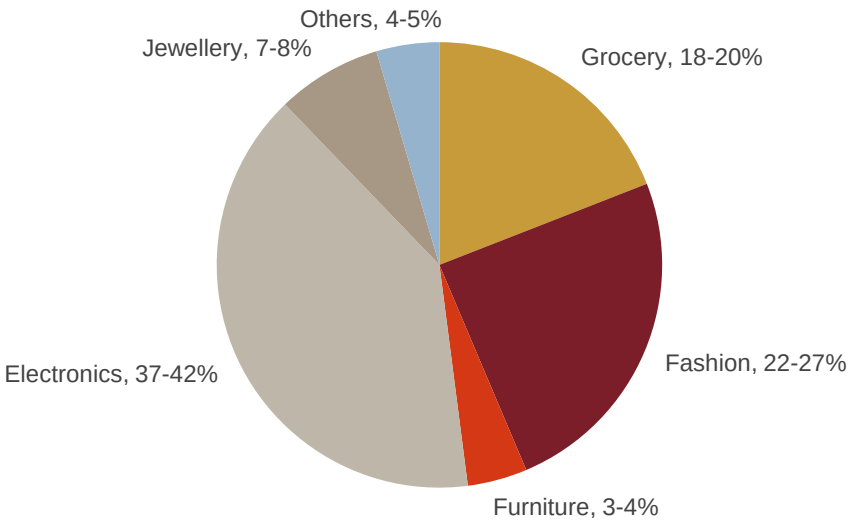
**Figure 115: Share of various segments in e-retail (FY22)**




*Source: CRISIL MI&A Research*

Going forward, while fashion and electronics are expected to form the major proportion, grocery is expected to grow at a much faster pace and increase its share in the overall pie.

**Figure 116: Share of various segments in e-retail (FY25P)**




*Source: CRISIL MI&A Research*

## Key growth drivers and trends for the e-commerce industry in India

### Omni-channel strategy

Over past few years, competition from e-retailers has surged significantly and has eaten into the revenue of brick-and-mortar retailers. With sharp growth in sales volume of e-retailers, brick-and-mortar players have also increased focus on online sales channels. Companies such as Shoppers Stop, Bombay Dyeing, The Mobile Store, Trent and Future Retail have launched online platforms to sell products. Though the share of revenue from online channels has been very small, the focus on these is increasing to combat competition from online counterparts. These brands are fighting the funding-dependent discounts from e-retailers with more sustainable membership benefits in the form of added discounts and loyalty points, to get repeat customers.

Online players too are focusing on expanding in the offline segment. For example, players such as Pepperfry and Urban Ladder have also taken the offline route to increase their connect with customers. They have been investing heavily on offline expansion to boost sales and attract new customers. Showcasing a few products in studios helps customers better visualise designs. Similarly, in the jewellery segment, players such as CaratLane have physical stores, which provide opportunities for customers to touch and feel jewellery.

### Subscription-based models

In a subscription-based model, the customer pays a recurring price at fixed time intervals for access to a product. For example, several micro-delivery platforms such as Milkbasket, DailyNinja and MrNeeds, have emerged in different cities over the past couple of years with a majority of them built around the premise of milk subscription. Apart from milk, subscription-based models have been employed in delivery of other recurring household needs, grooming products, healthcare products and many more. The players get the benefit of frequent orders and customer retention. Customers too are benefitted as they get higher discounts if they are a subscriber.

## Adani's portfolio

Adani Digital Labs (ADL) has been set up by Adani Enterprises with a focus to invest in cutting edge technologies that enhance the future preparedness of conventional businesses on one hand and deepen the relevance of modern technology-driven businesses on the other. Positioned as a strategic catalyst, ADL enhances the visibility, competitiveness and futuristic orientation of every single function across every single market addressing 400 million consumers across Adani group's businesses. ADL is expected to play the role of a potent, dynamic and responsive platform that facilitates consumer engagement and service. The strategic partnership between the Adani Enterprises and Cleartrip Pvt Ltd, an online travel aggregator and part of the Flipkart Group, has put ADL among one of the prominent online travel agencies/ aggregators in the country.

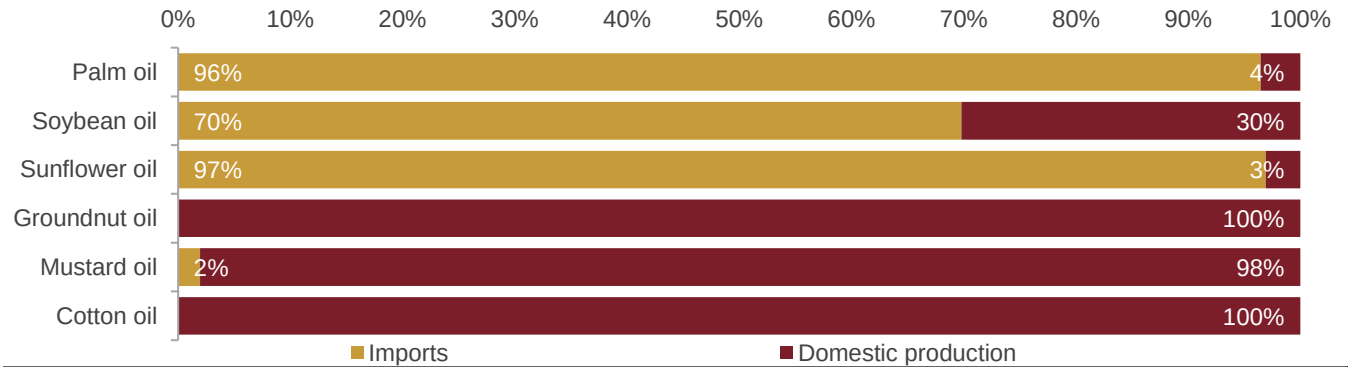
# Consumer Food

## Edible oil

### Overview

The Indian edible oil industry is heavily dependent on imports, which accounts for more than 75% of domestic consumption. The top edible oils which are imported in India are: Palm oil, Soyabean oil and Sunflower oi. On other hand the domestically produced edible oils are: Groundnut oil, Mustard oil, Cottonseed and coconut oil.

**Figure 117: Share of Imports and Domestic Edible oil**




*Source: Solvent Extractor of India, CRISIL MI&A Research*

In India, the usage of edible oil varies across regions. Rapeseed, mustard and rice bran oils are preferred in the eastern and northern regions; soybean oil in the central region; and groundnut, sunflower and cottonseed oils in the southern and western regions. The southern region also uses a significant amount of coconut oil. Palm oil is viewed as a price-competitive alternative, and is primarily used in restaurants, hotels, fast-food centres, and rural/coastal areas.

The edible oil industry comprises crushing units, solvent extraction units and refiners. In India, there are ~15,000 crushing units, 600 solvent extraction units, 600 refiners, and 250 vanaspati-making units.

India edible oil market size increased from ~ INR 1410 billion in OY'2017 to ~INR 2670 billion in FY'2022 registering a five-year CAGR of 14%. The market registered constant increase in demand in terms of volume from 16 million tons to 22 million tons between FY'2012 to FY'2020 before declining to 19-20 million tons in 2021 due to sharp rise in edible oil prices. Revenue generation fluctuated from year to year due to fluctuating prices in the international commodities market. Even though imports dominate the market, production of edible oil domestically has increased over the years from 6.8 MMT in OY 2017 to ~ 8 MMT in OY'2022, registering a five-year CAGR of 3%.

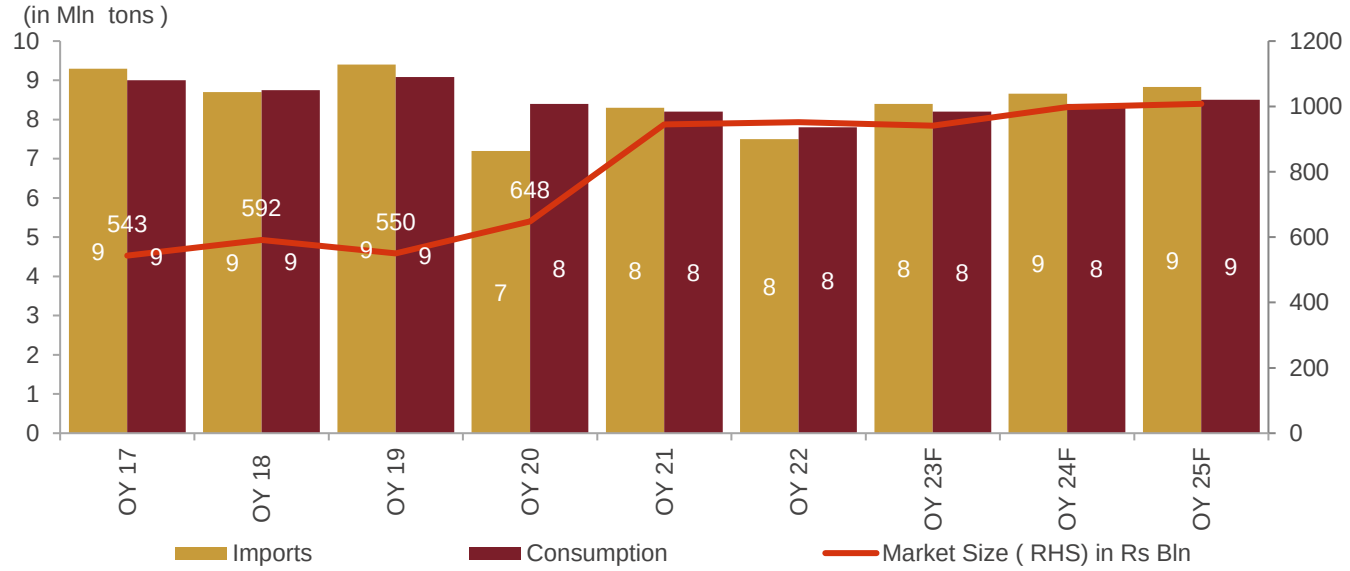
As the edible oil industry is fragmented, small- and mid-sized players focus on segments where they have a strong presence and raw material linkages. In fact, the financial performance of players depends on the ability to procure raw material at the right price, apart from cost management, distribution network, and brands.

#### *Palm oil*

India is the world's largest importer of palm oil, buying over 8 million tons annually, or nearly two-thirds of its total edible oil imports. India imports 96% of its palm oil requirement from the top producing countries such as Indonesia,

Malaysia, Colombia and Thailand. Palm oil is the most consumed edible oil in India having ~40% share in major edible oil consumption basket.

**Figure 118: Palm oil Imports, Consumption and Market Size Trend in India**



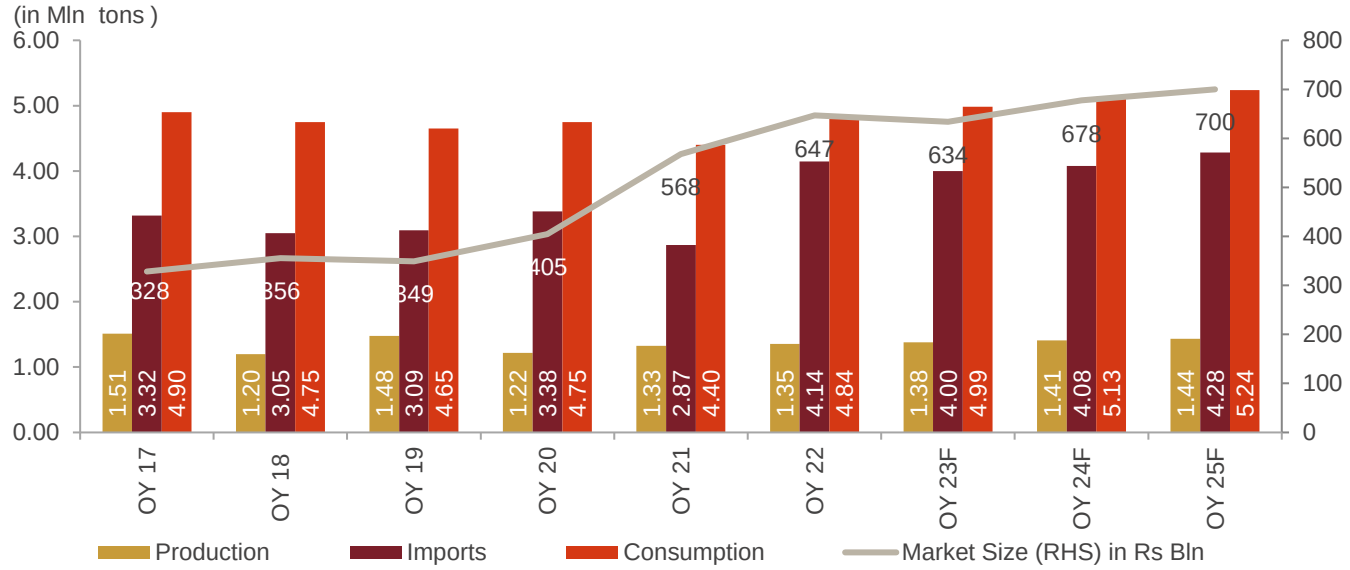

*Source: Solvent Extractor of India, CRISIL MI&A Research, OY-Oil Year Nov-Oct*

Market size increased from INR 540 billion in FY'2017 to INR 950 billion in FY'2022 registering a five-year CAGR of 12%. In OY22, palm oil prices increased by 6-7% on-year despite a very high base of ~60% on-year in OY2. Prevailing geo-political tension between UKR-RUS along with frequent policy changes in Indonesia on palm exports kept the prices significantly higher till Jun'22. Edible oil prices started correcting with negative bias from July'22 onwards and are likely to continue declining trend in coming months.

### *Soybean Oil*

Soybean plays an important role in providing a nutritionally balanced diet. It is the principal source of edible oil and protein in human diets. Soybean oil currently represents the second most consumed edible in India after palm oil. Some of the key factors driving the demand of soybean oil in India includes its large population, rising disposable incomes, growth of the food services sector and increasing demand in non-food applications. Western and Central India currently represent the biggest markets for soybean oil in the country as they also represent the key regions where the domestic soybean crop is grown. Additionally, there is also a strong household demand for soybean oil in Western and Central India. India imports ~75% of its soy oil requirement from the top producing countries such as Argentina and Brazil. Top soybean producing states in India are: Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Telangana and Gujarat.

**Figure 119: Soya oil Production, Imports, Consumption and Market Size in India**



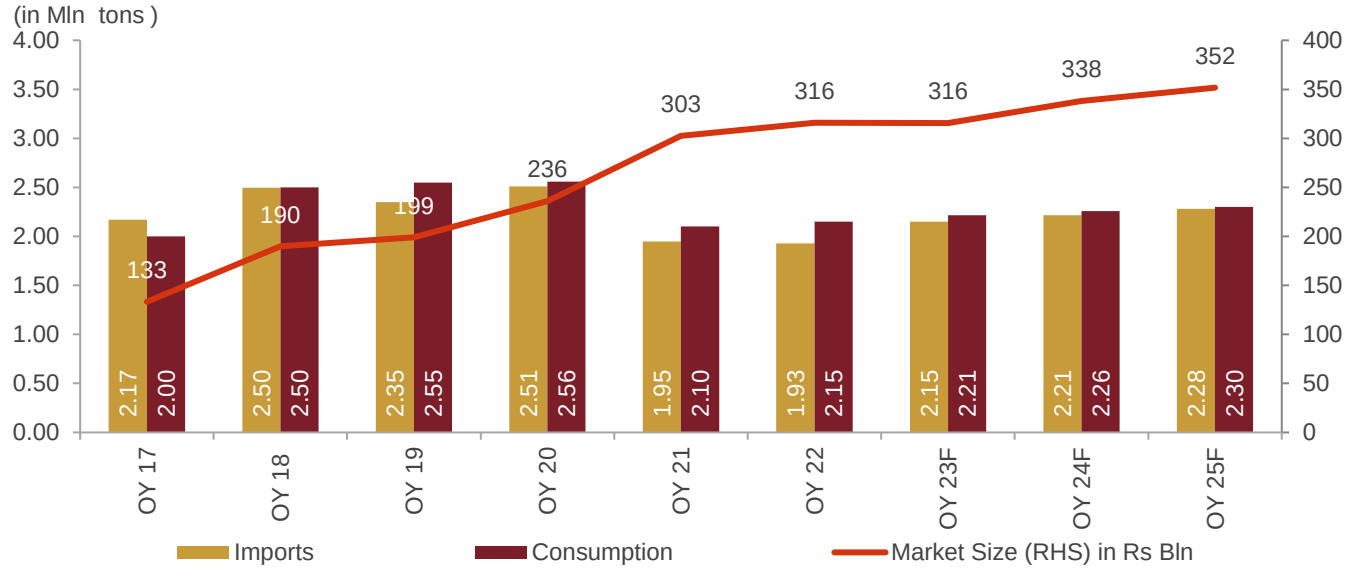

*Source: Solvent Extractor of India, CRISIL MI&A Research, OY-Oil Year Nov-Oct*

Market size for Soybean oil increased from INR ~ 328 billion in FY'2017 to INR ~ 630 billion in FY' 2022 registering a five year CAGR of 15%. In OY 22, soybean oil imports marked a significant improvement and is expected to increase by ~40% to 4.1 million tons. With huge imports, closing stock of soy oil are also expected to increase by ~35-40% in OY22, which will keep market to trade with negative bias in coming months.

### *Sunflower oil*

Sunflower oil is derived from sunflower seeds and currently represents the fourth most consumed edible oil by volume in India after palm oil , soybean oil and sunfllower. Currently, most of the sunflower oil demand comes from the southern states of India. Domestic production of sunflower oil is limited and most of the demand is met by imports. India imports 95% of its requirement from top exporting countries like Ukraine, Russia and Argentina. India imports only crude sunflower oil and further refining is done domestically. Some of the key drivers of the sunflower oil market in India include its large population, rising urbanization rates, increasing health consciousness, and its rising non-food applications. Top sunflower cultivating states in India are Karnataka, Orissa, Haryana and Maharashtra.

**Figure 120: Sun oil Imports, Consumption and Market Size Trend in India**



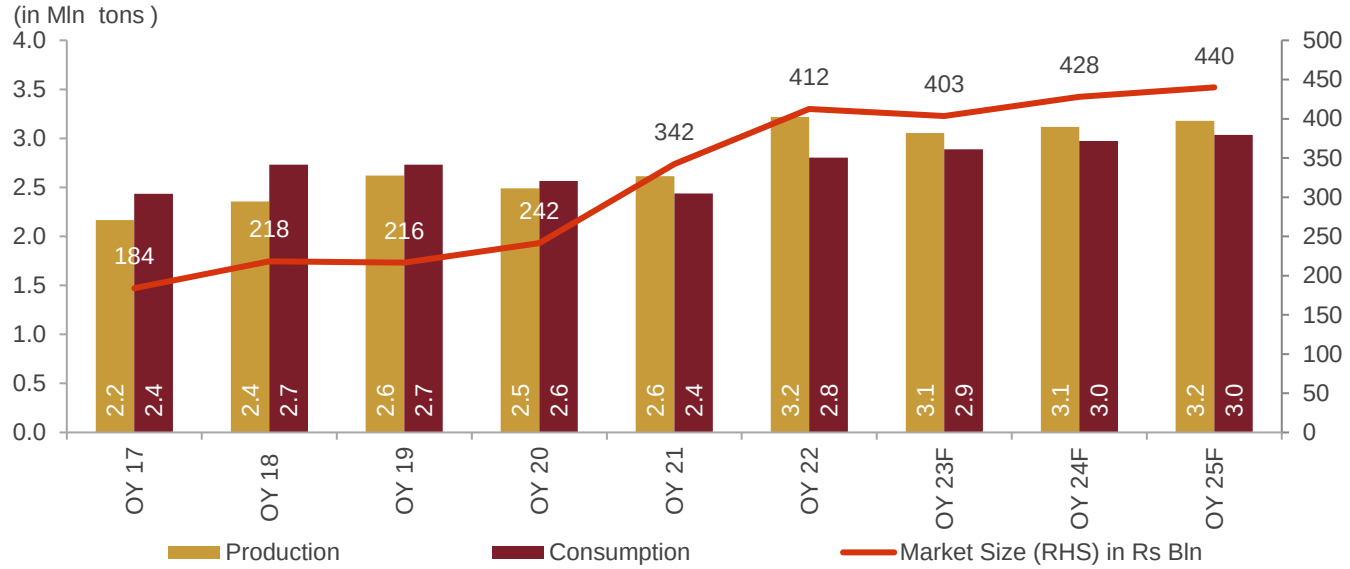

*Source: Solvent Extractor of India, CRISIL MI&A Research, OY-Oil Year Nov-Oct*

Market size increased from INR 190 billion in OY'2017 to INR 316 billion in OY'2022 registering a five-year CAGR of 19%. In OY22, sunflower oil prices likely to remain almost flat with surplus supply from Russia and Argentina during the last quarter of OY22. With steady rise in production , surplus imports and high carryforward stocks, sunflower oil prices are likely to correct with negative bias in OY 23.

### *Mustard Oil*

Mustard oil refers to a type of vegetable oil that is naturally extracted from the seeds of black, brown, and white mustard. In India, it is widely available in different forms, including refined mustard oil, Grade I (Kachchi Ghani) mustard oil, and Grade II (non-edible) mustard oil. Mustard has roughly 38-40% oil and rapeseed has roughly 42% oil. Both the seed and the oil are used as condiments in pickles and to flavor curries and vegetables. The oil is used in cooking and frying for human consumption throughout Northern India. Mustard oil is the third most popular oil in the country and is preferred usually in the east and the southern region. It is observed that the use of mustard oil has been increasing in the country on account of changing dietary preferences and increased health benefits of this oil. The top producing mustard states in India are Rajasthan, Uttar Pradesh, Haryana and Madhya Pradesh.

**Figure 121: Mustard oil Production, Consumption and Market Size trend in India**



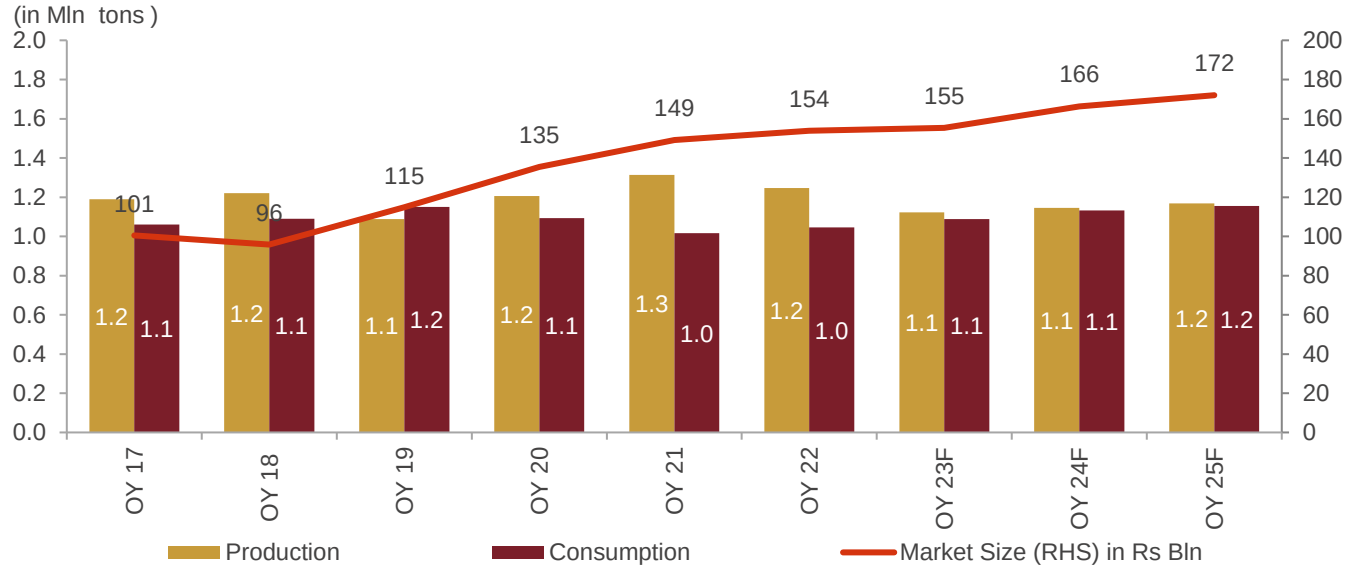

*Source: Solvent Extractor of India, CRISIL MI&A Research, OY-Oil Year Nov-Oct*

Market for Mustard oil increased from INR ~184 billion in OY'2017 to INR ~412 billion in OY' 2022, registering a five year CAGR growth of 18% Its consumption has increased from ~ MMT in FY'2012 to ~ MMT in FY'2017. Domestic production during the same period increased from 2.2 million tons to 3.2 million tons. In OY23 and OY24, assuming normal weather conditions, we expect the production and consumption to rise at a steady pace of 2-3%

### *Groundnut oil*

The cultivation of groundnut takes place in 6 million hectares in India. Gujarat has grabbed the top position in terms of groundnut oil production in India. The other groundnut producing states in India are Maharashtra, Tamil Nadu, Karnataka and Andhra Pradesh. Groundnut seed entails 45-50% of the groundnut oil. It is deemed as one of the best oil seeds to extract oil from. Superior quality groundnut is usually exported, leaving only low-quality groundnut for the Indian population. Since groundnut oil is expensive in the market, it is adulterated and traded by most oil mills. Hence, pure groundnut oil has tremendous demand these days.

**Figure 122: Groundnut oil Production, Consumption and Market Size trend in India**



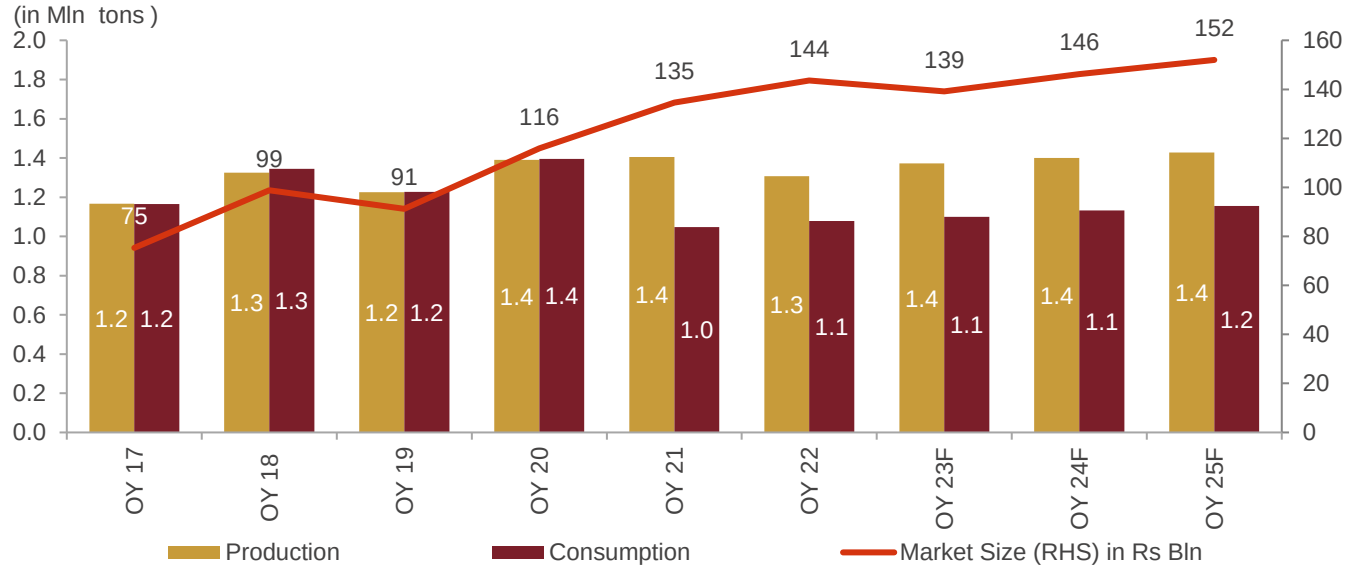

*Source: Solvent Extractor of India, CRISIL MI&A Research, OY-Oil Year Nov-Oct*

Market size for ground nut oil increased from ~ INR 100 billion in OY'2017 to ~ INR 150 billion in OY'2022, registering a five-year CAGR of 9. Production of ground nut oil is almost flattish in last five year at around 1.1 to 1.3 million tons, however rising prices of edible oil have supported growth in market size. Groundnut oil production in OY2022-23 is estimated to drop by ~6-8% on-year with decline in acreage by 8-10% and poor yields due to excess rainfall in western belt of India.

### *Cottonseed oil*

Cotton has been found around ancient times and it has been found that people from 3500 Bc. wave cotton to make cloths. More than 95% of the cotton seed processed in India is through traditional method, where in the seeds are simply crushed through mechanical means without undergoing the pre process formalities of delinting or dehulling. The top cottonseed oil producing in India are Gujarat, Maharashtra, Haryana and Karnataka. In OY23, production of cottonseed oil is likely to increase by ~8% on year on basis. Higher production and declining trend in other domestic edible oil will lead to drop in prices by ~4-5% in OY 23.

**Figure 123: Cottonseed oil Production, Consumption and Market Size trend in India**




*Source: Solvent Extractor of India, CRISIL MI&A Research, OY-Oil Year Nov-Oct*

## Key drivers and risks for the oil industry in India

### *International Factors:*

- Indonesia, Malaysia, Argentina, Ukraine, Russia and Brazil are the major producing and exporting nations of palm soy and sunflower oil to India. Adverse weather conditions in these countries impact the output thus have an effect on the prices. Wide fluctuations in the currencies of these countries also have impact on edible oil prices.
- Government policies related with export tax in these nations have an effect on the prices.

### *Domestic Factors:*

#### *Risks due to change in Government Regulations*

- Import duty on Edible oil
- MSP for oilseeds

#### *Other Domestic Supply-Demand related Factors*

- Volatility in Raw material prices
- Area, Yield Production of domestically grown oilseeds (Eg Groundnnut, Mustard seed, Linseed, Cotton seed)
- Weather conditions in India
- Stock availability in market
- Crushing and Refining Margins
- Consumption pattern- Shift towards economic edible oil, seasonal or festive demand
- Volatility in currency value (Rupee Movement)

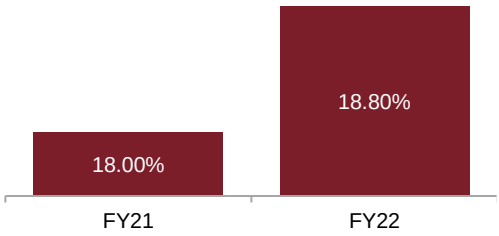
## Adani Positioning

The company's joint venture, Adani Wilmar Limited ("AWL") is among the major packaged food FMCG companies in India offering a range of products under multiple packed food brands. AWL is one of the few large FMCG food companies in India to offer most of the primary kitchen commodities for Indian consumers, including edible oil, wheat flour, rice, pulses and sugar. AWL's products are offered under a diverse range of brands across a broad price spectrum and cater to different customer groups. AWL's flagship product, 'Fortune' is the largest selling

edible oil brand in India. AWL also has a number of masstige brands, including ‘Bullet’, ‘King’s’, ‘Aadhar’, ‘Raag’, ‘Alpha’, ‘Jubilee’, ‘Avsar’, ‘Golden Chef’ and ‘Fryola’.

- No.1 Edible Oil player in India
- Presence across the complete consumption basket of edible oils in India

**Figure 124: Adani positioning in Edible oil segment**




*Source: CRISIL MI&A Research, Industry Reports*

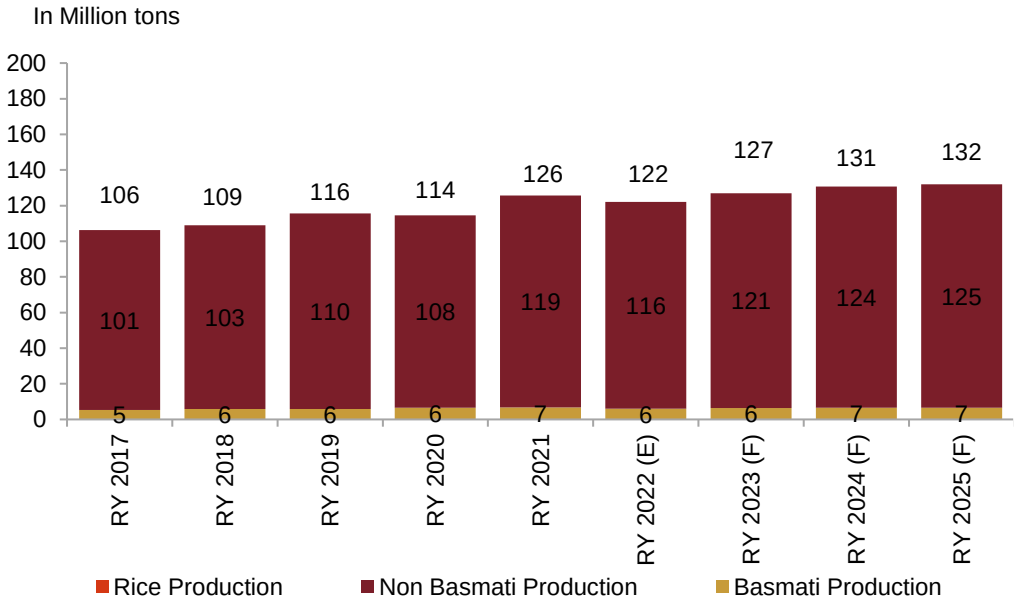
## Rice

### Overview

Rice is the most important cereal food crop of India, occupying one-fourth of the gross cropped area of the country. As the basic food crop, rice is cultivated comfortably in a hot and humid climate. In the country, the crop is mainly grown as a Kharif crop in rainfed areas that receive heavy annual rainfall.

India is one of the top ten rice-producing countries in Asia-Pacific and is largest exporter in world, which is endowed with a wet environment suitable for rice cultivation. Rice-based farming is the main economic activity for hundreds of millions of rural farmers in the region. The major rice varieties grown in India include parboiled rice, broken rice, Sella rice, Swarna rice, and Sona Masoori rice. Basmati rice is known to be one of the best varieties of rice in the world, known for its sleek, slender, tapering grains with unique aroma and taste and its grain elongation quality upon cooking. Other than Iran, major importers of basmati rice are the United Arab Emirates, Kuwait, Saudi Arabia, the United Kingdom, and the United States. The areas of basmati rice production in India are the states of Punjab, Haryana, Himachal Pradesh, Delhi, Uttarakhand, Uttar Pradesh, and Bihar.

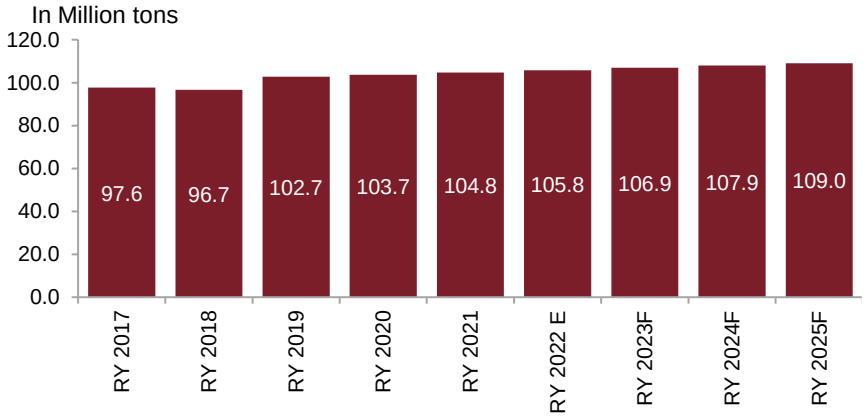
**Figure 125: Rice – Basmati and non-basmati production trend in India**




*Source: FCI, CRISIL MI&A research, RY – Rice year April to March*

Indian rice production dropped is likely to remain low in RY 2022 in the wake of uneven monsoon which impacted yield specially in case of western and southern rice producing belts. For RY 2023, expecting a normal monsoon and reviving of basmati acreages, production is expected to bounce back to the levels of RY 2021.

**Figure 126: Rice – Consumption trend in India**




*Source: FCI, CRISIL MI&A research, RY – Rice year April to March*

For RY 2023, consumption is expected to increase by ~1% and production of milled rice is also expected to improve by 0-1% on year following estimated higher production assuming a normal monsoon. Although the per capita rice consumption in India is lower than Indonesia, Bangladesh and Vietnam, India remains to be the second largest consumer of rice after China on account of its huge population

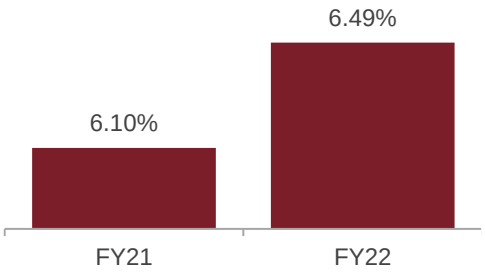
## Key drivers and risks for the rice industry in India

- Acreage, yield and production
- Monsoon progress
- Procurement by government
- Export policy
- Minimum support price (MSP) decided by the government
- Stocks available for milling
- Global supply-demand scenario
- Supply-demand scenario in other exporting nations like Vietnam, Thailand , Pakistan, US and China
- Indian rupee value

## Competitive landscape and Adani positioning

- No. 3 player in India
- Potential market share gain on the back of recent acquisition of Kohinoor brand

**Figure 127: Share of Adani Wilmar in rice segment**




*Source: CRISIL MI&A Research*

# Special Manufacturing – Defence & aerospace

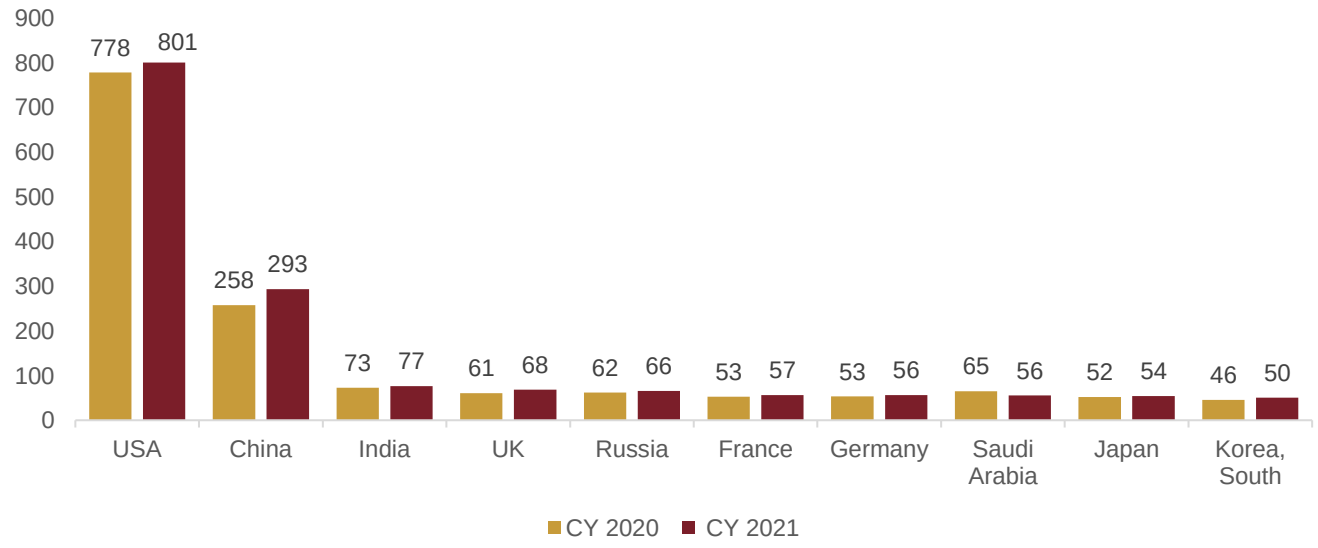
## Overview

Aerospace and defence industry deals with the manufacturing and supply of aircraft, helicopters, missiles, radars, satellites, other defence equipment or components for these equipment. The industry can be classified into Tier 1 and 2 manufacturers. While Tier I manufacturers prepare final products such as aircraft, helicopters and missiles, Tier II manufacturers provide components for these equipment.

The key driving factor for growth in the industry is capital expenditure on defence procurement by the Government of India. Expenditure on defence (both revenue and capex) recorded a 11% CAGR over fiscals 2016 to 2022, rising from Rs 201,000 crore to Rs 340,000 crore. Outlay for fiscal 2023 is budgeted to record 8% on-year increase to Rs 368,000 crore. India is the third largest country in the world based on defence expenditure, behind the US and China.

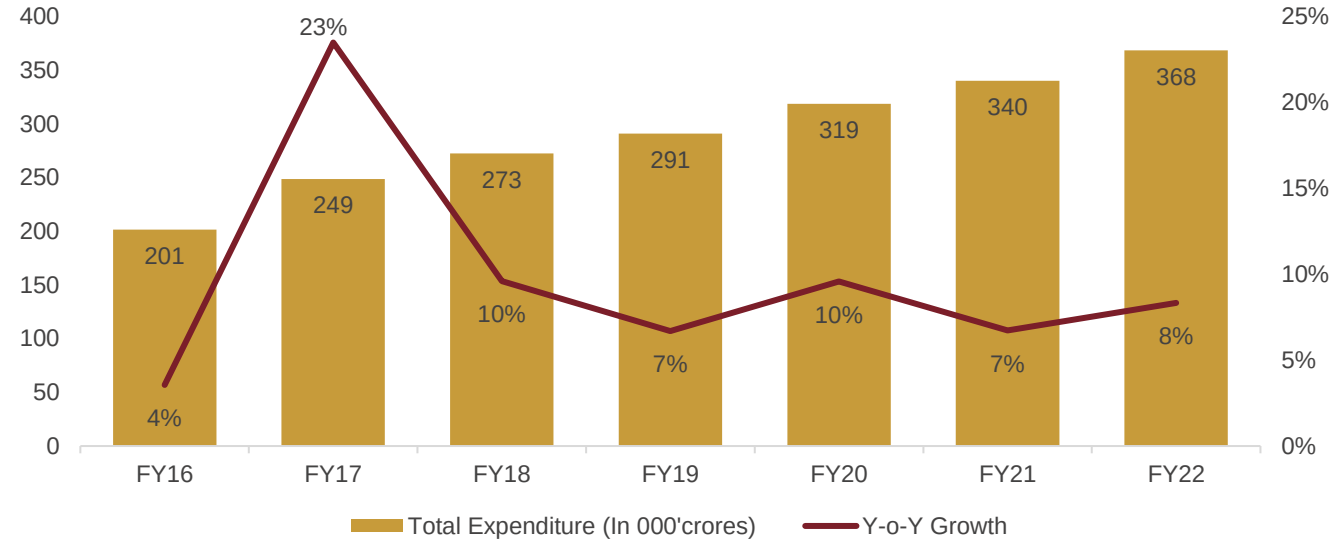
India accounted for 3.7% of global military spending, marking it the world's third highest military spender in 2020 and 2021 in constant USD terms (*source: SIPRI*). As per SIPRI, India's military spending, amounting to $76.6 billion in 2021, grew by 5% from 2020. The capital outlay portion of India's defence has been on a rise, but India's purchase of defence equipment has been dominated by imports. In line with Atmanirbhar Bharat and keeping geopolitical factors in mind, the government has mandated a minimum of 68% of defence purchases to be done from Indian companies fiscal 2022 onwards. Policies have been framed in order to boost the Indian defence manufacturing ecosystem in India.

**Figure 128: Military expenditure by top 10 countries at current price and exchange rate ($ billion)**




*Source: SIPRI, CRISIL MI&A Research*

**Figure 129: Annual defence budget expenditure in value and growth rate in defence expenditure**

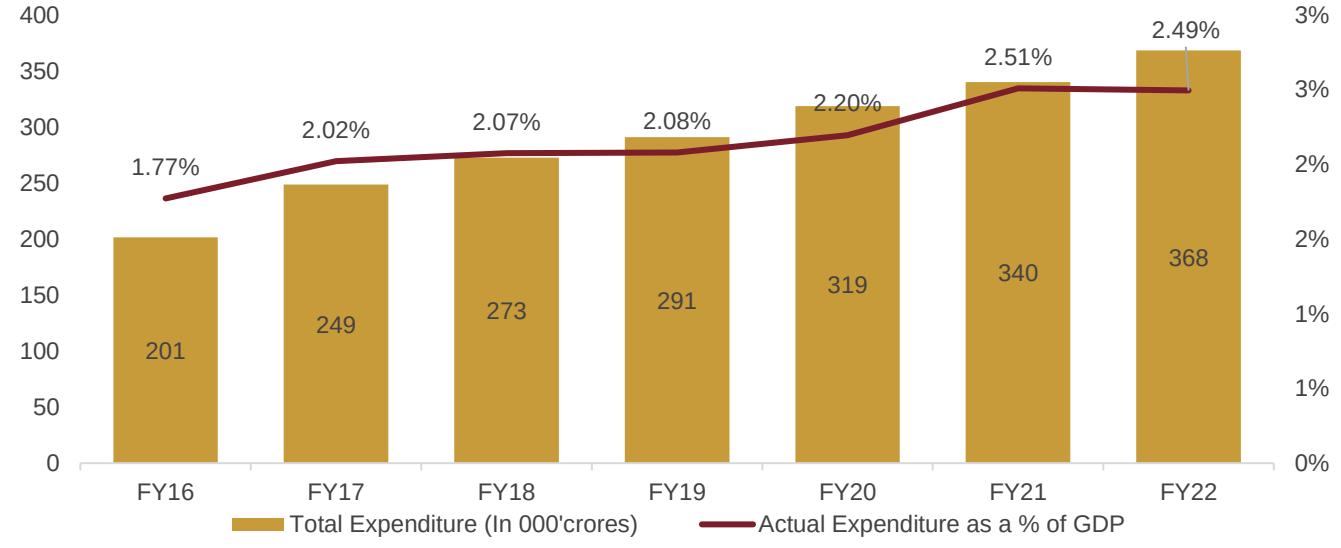



Note: Budget expenditure excluding civil and pension

*Source: Union budget documents, CRISIL MI&A Research*

Defence expenditure as a share of India's GDP is on an upswing as expenditure on defence has outgrown the GDP growth of 4%. The share of defence expenditure increased from 1.77% in fiscal 2016 to 2.49% in fiscal 2022. To be sure, this is excluding the defence expenditure on pension for retired armed forces personnel.

**Figure 130: Annual defence budget expenditure as a percentage of GDP**



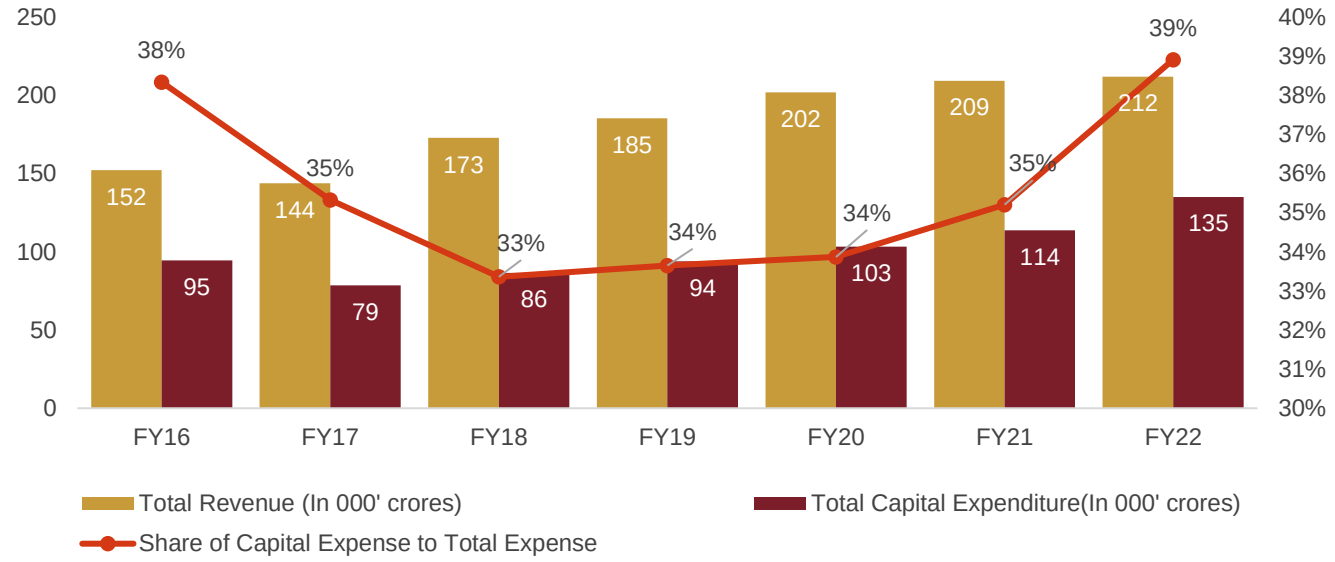

Note: Budget expenditure excluding civil and pension

*Source: MOSPI, Union budget documents, CRISIL MI&A Research*

Capital outlay is the expenditure incurred on purchasing new weapons, aircraft, warships and other military hardware, while revenue expenditure is incurred on payroll, transportation, repairs, spend on stores, etc. Capital expenditure benefits the local manufacturing ecosystem since it involves purchase of equipment and/or ammunition. Capital expenditure as a share of total military expenditure rose to Rs 135,000 crore in fiscal 2022 from

Rs 95,000 crore in fiscal 2016, recording a 6% CAGR, and revenue expenditure also grew at 6%. The share of capital expenditure is on an upswing, reaching 39% of the military expenditure in fiscal 2022.

**Figure 131: Segmentation and details of defence expenditure – Capital and revenue expenditure**




Note: Budget expenditure excluding civil and pension

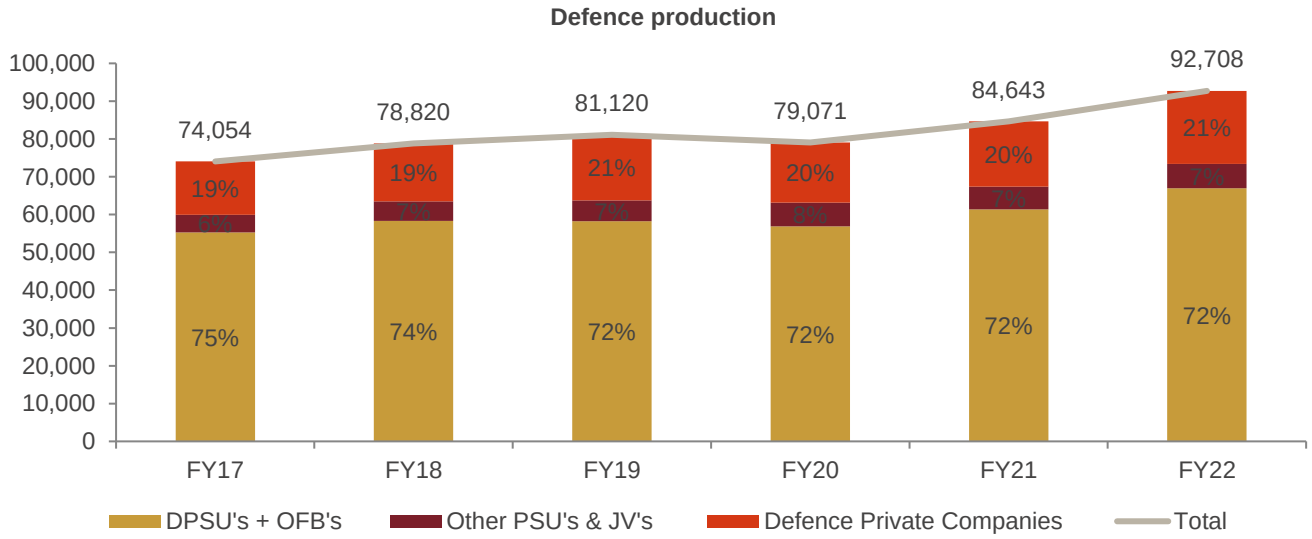
*Source: Union budget documents, CRISIL MI&A Research*

## Review of defence production for FY17-FY22

In May 2001, the Government of India (GoI) opened India's defence sector to 100% participation for Indian private sector. Since then, successive governments have taken efforts to increase the participation of private sector in the defence and aerospace segment. According to the Ministry of Defence data, as of July 2021, 333 private companies were issued a total of 539 industrial licences, and of these, 110 companies reported commencement of production. To aid domestic procurement, the government has earmarked 68% of the total defence budget outlay for domestic procurement. To aid improved domestic manufacturing, the government corporatised 41 Ordnance Factory Boards into seven defence public sector units effective October 1, 2022, to improve cost efficiency, improve expertise across products, and increase competitiveness, functional autonomy, growth potential and innovation in the defence sector.

India's defence manufacturing sector witnessed a glacial CAGR of 3.8% between fiscals 2017 and 2022. Defence manufacturing consists of defence PSUs, joint ventures and private defence companies.

**Figure 132: Share of public vs private sector production**

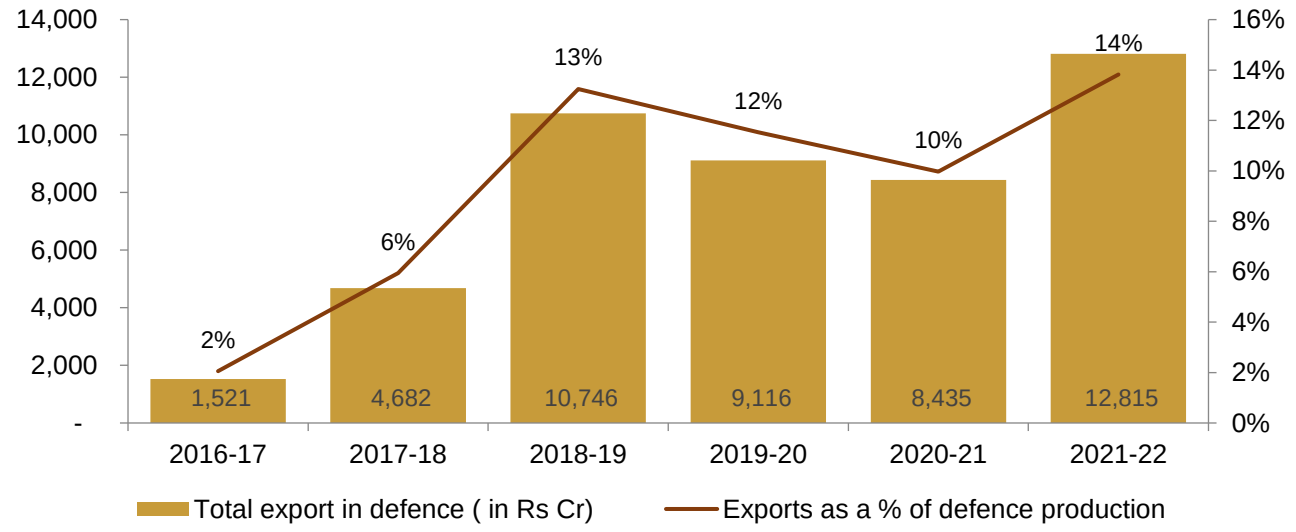



*Source: Ministry of Defence, CRISIL MI&A Research*

DPSUs and OFBs dominate defence production and account for three-fourths of the defence production market. However, with a number of steps taken to boost private participation, private sector contribution is on an uptick.

Although defence manufacturing in India has grown at a glacial pace, defence exports reached the all-time high mark of Rs 12,815 crore in fiscal 2022, at a CAGR of 43% between fiscals 2017 and 2022. In fiscal 2022, India exported defence products to 42 countries.

**Figure 133: Defence exports**




## Defence corridor and investments

The GoI established two defence industrial corridors in the country: Uttar Pradesh Defence Industrial Corridor with six nodes (Aligarh, Agra, Chitrakoot, Jhansi, Kanpur and Lucknow) and Tamil Nadu Defence Industrial Corridor with five nodes (Chennai, Coimbatore, Hosur, Salem and Tiruchirappalli).

The Uttar Pradesh Expressways Industrial Development Authority, the nodal agency for the Uttar Pradesh Defence Industrial Corridor has signed 62 MOUs with industries to attract potential investments of ~Rs 8,638 crore. 25 out of the 62 proposals have been finalised and land has been allotted.

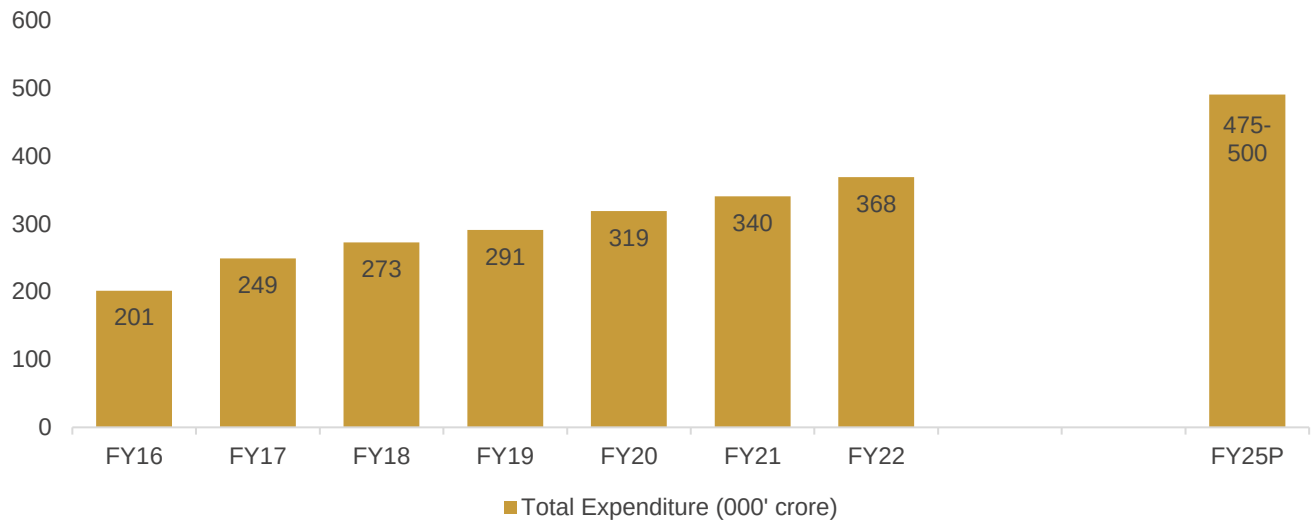
Tamil Nadu Industrial Development Corporation, the nodal agency for Tamil Nadu Defence Industrial Corridor, has signed MOUs with 40 industries to attract potential investments of ~Rs 11,153 crore.

## Outlook on defence production: FY22-FY25

To make the defence sector more self-reliant, the Ministry of Defence has given fresh impetus on indigenisation by signing a number of contracts with domestic players. In Union Budge 2022-23, the government allocated Rs 385,1370 crore to defence (excluding civil and pension), 5% higher than the previous year, which accounts for 2.42% of GDP.

Indian government has set the defence production target at Rs 175,000 crore by 2025. Defence production stood at Rs 92,708 crore in fiscal 2022. With a number of steps taken to boost domestic manufacturing coupled with rising spends by the Indian forces on capital expenditure, CRISIL MI&A Research expects defence expenditure to log 8-12% CAGR over fiscals 2022 to 2025.

**Figure 134: Total expenditure**




## Government policies and regulations

**Defence Acquisition Procedure (DAP) 2020**

The first defence procurement policy was formulated in 2002 to institutionalise, streamline and simplify defence procurement procedure. It was revised in March 2016, to focus on indigenously design, develop and manufacture weapon systems.

In 2020, the Ministry of Defence released the new DAP to simplify the procedure for defence procurement and acquisition in order to modernise the armed forces.

The DAP is aligned with the government's vision of making India a global manufacturing hub. It is designed to boost indigenous defence capability and reduce reliance on imports under the Make in India and Atmanirbhar Bharat initiatives.

The aim of the DAP is to ensure timely procurement of military equipment, systems and platforms as required by the armed forces in terms of performance, capabilities and quality standards, through optimum utilisation of allocated budgetary resources.

Capital acquisition schemes are broadly classified as buy, buy and make, leasing, design and development (D&D), and strategic partnership model (SPM). Under the buy scheme, procurements are categorised as buy (Indian - IDDM), buy (Indian), buy (global - manufacture in India), and buy (global). Under the buy and make scheme, procurements are categorised as buy and make (Indian) and buy and make.

In decreasing order of priority, the categories will be as follows:

(a) Buy (Indian - IDDM)

(b) Buy (Indian)

(c) Buy and make (Indian)

(d) Buy and make

(e) Buy (global - manufacture in India)

(f) Buy (global)

**Buy (Indian - IDDM)** – This category refers to the procurement of products from an Indian vendor, which have been indigenously designed, developed and manufactured with a minimum of 50% indigenous content (IC) on cost basis of the total contract value.

**Buy (Indian) –** This category refers to the procurement of products from an Indian vendor meeting one of the two conditions: products that have been indigenously designed, developed and manufactured with a minimum of 50% IC on cost basis of the total contract value; or products that may not have been designed and developed indigenously, having 60% IC on cost basis of the total contract value.

**Buy and make (Indian) –** This category refers to an initial procurement of equipment in fully formed (FF) state in quantities as considered necessary, from an Indian vendor engaged in a tie-up with a foreign OEM, followed by indigenous production in a phased manner involving transfer of critical technologies as per specified range, depth and scope from the foreign OEM. Under this category, a minimum of 50% IC is required on cost basis of the make portion of the contract.

**Buy and make –** This category refers to an initial procurement of equipment in FF state from a foreign vendor, in quantities as considered necessary, followed by indigenous production through an Indian production agency, in a phased manner, involving transfer of critical technologies as per specified range, depth and scope, to the production agency. With a view to maximise indigenous production in each procurement case, the AoN according authority would approve an appropriate ratio of FF, completely knocked down, semi knocked down and indigenous manufacture kits; and a minimum percentage of 50% IC on cost basis for the make portion of acquisitions under the buy and make category.

**Buy (global - manufacture in India) -** This category refers to an outright purchase of equipment from foreign vendors as approved by the AoN according authority, in quantities as considered necessary, with a minimum of 50% IC on cost basis of the total contract value, which can be achieved in the manufacturing of either the entire equipment or spares/assemblies/sub-assemblies/maintenance.

**Buy (global)** - This category refers to outright purchase of equipment from foreign or Indian vendors. In case of procurement through foreign vendors, the government to government route or inter-government agreement may be adopted, for equipment meeting strategic/long-term requirements

**Leasing** - Leasing is introduced as another category for acquisition in addition to the existing buy and make category as it provides for an innovative technique for financing of equipment. Leasing provides means to possess and operate the asset without owning the asset and is useful to substitute huge initial capital outlays with periodical rental payments. Leasing has two subcategories: lease (Indian), where the lessor is an Indian entity and is the owner of the asset, and lease (global).

**D&D/Innovation -** Acquisitions covered under the D&D/innovation category refer to equipment/system/ subsystem/assembly/sub-assembly, major components, or upgrades thereof, to be designed, developed and manufactured by an Indian vendor/similar D&D projects by DRDO/ processed by the Services through their internal organisations such as base workshop, dockyards or base repair depots, with or without participation of the private industry, as per procedure and norms detailed in Chapter III of the DAP.

**SPM.** Acquisitions under the SPM refer to participation of private Indian firms and foreign OEMs in Make in India in defence and play the role of a system integrator by building an extensive eco-system comprising development partners, specialised vendors and suppliers, in particular those from the MSME sector. Strategic partnerships will seek to enhance indigenous defence manufacturing capabilities through the private sector over and above the existing production base. Detailed norms and procedures for the same are given in Chapter VII of the DAP.

## Strategic partnership model in defence acquisition

To promote ‘Make in India’ in defence, the government introduced the strategic partnership model for acquisitions of aircraft, helicopters, submarines, and armoured fighting vehicles/ main battle tanks. The partnership model aims to incentivise the transfer of niche technology and higher indigenous content to Indian players, and to develop the country as a regional/ global manufacturing hub.

Acquisitions under the strategic partnership model refer to the participation of private Indian firms and foreign OEMs in ‘Make in India’ in defence and play the role of a System Integrator by building an extensive eco-system comprising development partners, specialised vendors and suppliers, particularly from the MSME sector. Strategic partnerships will seek to enhance indigenous defence manufacturing capabilities through the private sector over and above the existing production base. The benefit of this model to the indigenous industry is the development of the Indian defence manufacturing ecosystem.

The policy on strategic partnerships in the defence sector was approved by Defence Acquisition Council (DAC) in May 2017. It was promulgated on May 31, 2017 as Chapter-VII of Defence Procurement Procedure (DPP) – 2016 titled ‘Revitalising Defence Industrial Ecosystem through Strategic Partnerships’. The policy was placed before the Cabinet Committee on Security (CCS). The CCS considered the note on the policy in its meeting held on May 24, 2017 and noted the contents thereof. The chapter was uploaded on the Ministry of Defence website: https://www.mod.nic.in.

The policy is intended to institutionalise a transparent, objective and functional mechanism to encourage broader participation of the private sector, in addition to DPSUs / OFB, in the manufacture of defence platforms and equipment such as aircraft, submarines, helicopters and armoured vehicles. It will serve to enhance competition, increase efficiencies, facilitate faster and more significant absorption of technology, create a tiered industrial ecosystem, ensure development of a wider skill base and trigger innovation, leading to reduction in dependence on imports and greater self-reliance in meeting national security objectives. The following four segments have been identified for acquisition under strategic partnership route:

- Fighter aircraft
- Helicopters
- SubmarinesArmoured fighting vehicles (AFVs)/ main battle tanks (MBTs)

The strategic partnership model is a different category of capital acquisition in addition to the existing categories as mentioned in Chapter-I of DPP-2016, i.e. 'Buy (Indian-IDDM)'; 'Buy (Indian)'; 'Buy & Make (Indian)'; 'Buy & Make' and 'Buy (Global)'.

In a step to boost private sector participation in domestic defence manufacturing, the DAC approved the implementation of strategic partnership\ guidelines to reduce timelines so as to ensure timely delivery of equipment to the armed forces.

The DAC has also approved platform-specific guidelines for procurement of naval utility helicopters.

## Offset policy

The objective of the defence offset policy is to partially compensate for the significant outflow in defence contracts. These contracts are big ticket size and government wants either a part of it to benefit local economy or transfer to technology.

Offset policy is applicable to 'Buy & Make' and 'Buy (Global)' categories of procurement.

Offset dilution: In order to reduce the cost of defence deals the government decided to remove offset clause for contacts between two governments or ab initio single vendor. All other international deals that are competitive, and have multiple vendors, will continue to have a 30% offset clause on contract value greater than Rs 300 crore.

## Defence Testing Infrastructure Scheme (DTIS)

On May 8, 2020, the Ministry of Defence launched DTIS to domestic defence and aerospace manufacturing. This will help MSMEs and startups to get easy access to defence testing infrastructure. The scheme has an outlay of Rs 400 crore for creating state-of-the-art testing infrastructure over five years.

The government aims to set up 6-8 greenfield defence testing infrastructure facilities by providing up to 75% government funding, while the remaining 25% will be borne by a special purpose vehicle (SPV) backed by Indian private players and state governments.

## Innovations for Defence Excellence (iDEX)

In April 2018, iDEX was launched with the aim to achieve self-reliance through innovation and technology development in defence and aerospace. The objective is to partner with MSMEs, startups, individual innovators, research and development (R&D) institutes and academia to provide funding and other support for R&D.

iDEX is set up as an executive arm of Defence Innovation Organisation (DIO) to facilitate promote, empower and fund the participants, while DIO will provide high level policy guidance.

In fiscal 2022, the Ministry of Defence set aside Rs 1,000 crore for the procurement of defence equipment developed by Indian startups. On March 22, 2022, DAC cleared the procurement of 14 items worth Rs 380.43 crore from iDEX startups/MSMEs.

## Geopolitics

India is surrounded by countries with whom it does not share the friendliest of relations and witnessed military clashes in the past. The current geopolitical situation necessitates strengthening the country's aerospace and defence capabilities through self-reliance and modernisation.

The requirement of modern aircraft, weapons and defence equipment's for Indian armed forces coupled with Make in India and Atmanirbhar Bharat initiatives will boost the country's defence and aerospace sectors.

## Adani's positioning

The company has set up India's first small arms manufacturing facility, PLR Systems Ltd (PLR), a joint venture between Adani Enterprises and Israel Weapon Industries (IWI). Adani Defence and Aerospace and Israel-based Elbit Systems have also set up an unmanned aerial vehicles (UAV) manufacturing facility in Hyderabad. The facility is touted to be the first private UAV manufacturing unit in India and the first one outside Israel to make UAVs (Source: company reports, press release and CRISIL MI&A Research).

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