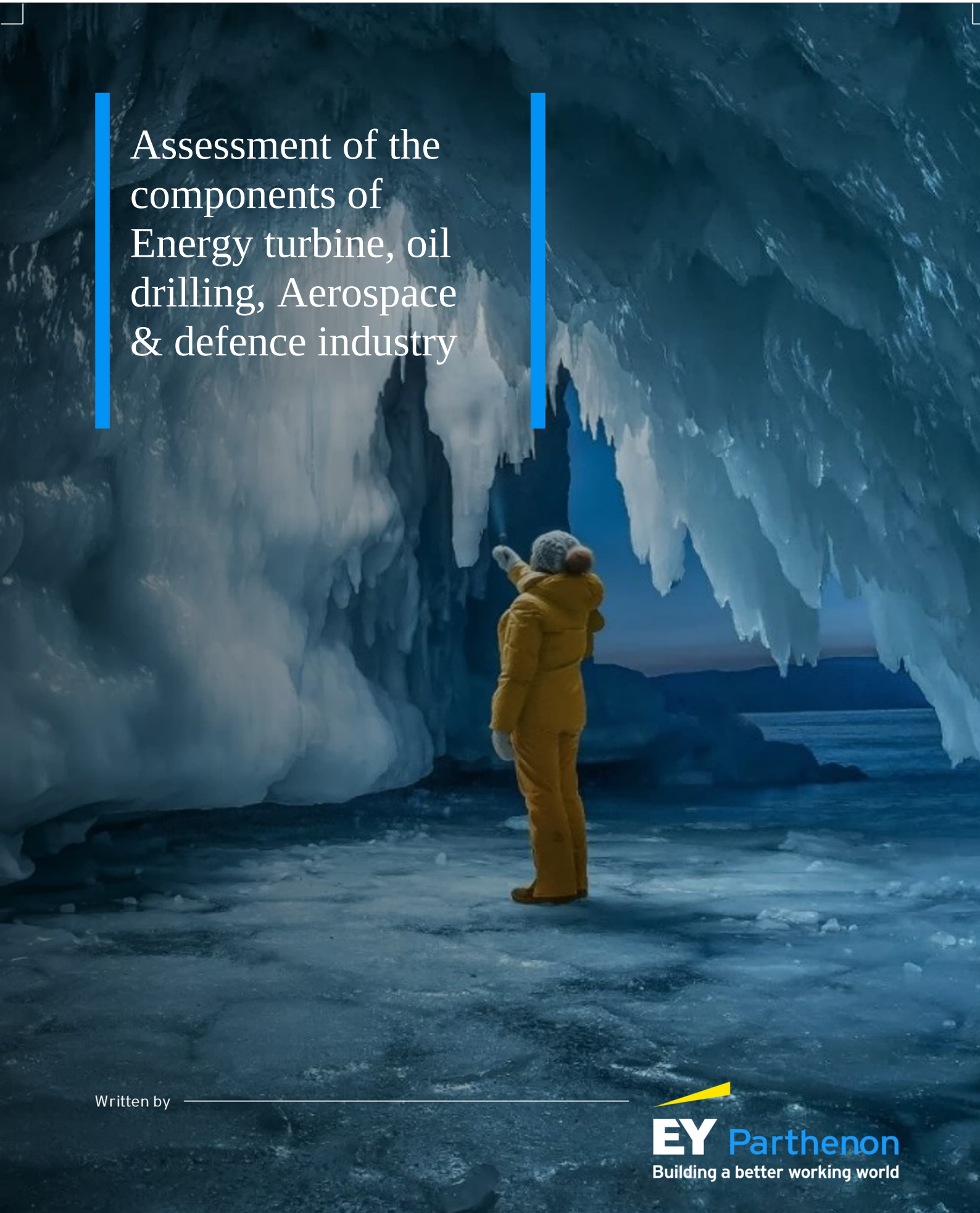
Appendix A

Assessment of the components of Energy turbine, oil drilling, Aerospace & defence industry



Written by

EY Parthenon

Disclaimer to be used in the Offer Documents

"EY Report was prepared by EY LLP for the Company based on information available in public domain and discussion with industry participants for the purpose of providing industry assessment report on the industry which the Company operates and will be used as a reference report in the "Our Industry" and other sections, as may be applicable, of the Company's Offer Documents. In preparing the EY Report we did not, and could not, take into account any specific requirements that any third party may have. Therefore, to the extent that such requirements differ from your specific requirements, please note that they were not required to be dealt with in the EY Report. The EY Report includes judgmental estimates and assumptions, about circumstances and events. Accordingly, we cannot provide any assurance that the projected market estimates will be attained in this ever-changing dynamic market environment.

EY LLP has taken due care and caution in preparing this "EY Report" based on the information obtained by EY LLP from sources which it considers reliable ("Data"). EY has relied on Company representation for all data provided by the Company, and used by EY for the purpose of Industry section in DRHP. This EY Report is not a recommendation to invest / disinvest in any entity/industry covered in the EY Report and no part of this Report should be construed as an expert advice or investment advice or any form of investment banking within the meaning of any law or regulation. Without limiting the generality of the foregoing, nothing in the EY Report is to be construed as EY providing or intending to provide any services in jurisdictions where EY does not have the necessary permission and/or registration to carry out its business activities in this regard. The Company will be responsible for ensuring compliances and consequences of non-compliances for use of the EY Report or part thereof outside India."

TABLE OF CONTENTS

SUMMARY

Azad Engineering Ltd. is one of the key manufacturers of qualified product lines supplying to global original equipment manufacturers (OEMs) in the energy, aerospace & defence and oil & gas industries. The company manufactures complex and highly engineered precision forged and machined components that are mission and life-critical and hence, some of these products have a “zero parts per million” defects requirement. The components have been supplied to countries such as USA, China, Europe, Middle East, and Japan since its inception. And hence, the company is a key link in the global supply chain for OEMs / customers.

The company’s manufacturing infrastructure comprises four facilities in India, at Hyderabad with a total manufacturing area of ~20,000 sq. meters. Within the energy turbine industry, airfoils contribute to majority of the sales for the company. Other than this, the company also supplies other special machined components for energy turbines. Azad Engineering Ltd.'s aerospace and defence products are largely utilized in commercial and defence aircraft to provide propulsion, actuation, hydraulics, and flight control. At an overall level, the company has delivered 3.09 million units between FY09 to FY23.

The demand for these precision forged and machined components is driven by requirements relating to energy turbines (industrial, gas, nuclear and coal), aircrafts (commercial and military) amongst others.

The global energy consumption has increased from 406 EJ in 2017 to 449 EJ in 2022 with annualized growth rate of 2% from 2017-2022. In the energy turbine market, market for both turbines used for power generation and turbines used in industries for applications other than power generation have been included in the report. The industrial turbines are used in industries such as oil and gas, chemicals, marine applications etc. The industrial energy consumption has increased from 143 GW in 2010 to 167 GW in 2021. Out of this industrial energy consumption, more than three-fourths of the market is consumed for non-power end use applications. Global electricity consumption increased from 77 EJ in 2017 to 92 EJ in 2022. Global capacity for power generation stood at 8,185 GW in 2021. Out of this, the global capacity for gas power generation was 1,850 GW, 390 GW capacity for nuclear power generation and 2,184 GW capacity for coal power generation in 2021.

For gas turbines, the total number of orders were 461 units in 2021. Out of 274 orders of gas turbines in H1 2022, GE Power, Siemens Energy and Mitsubishi Power Ltd. are the key manufacturers for gas turbines globally. Similar for steam turbines (which includes multiple fuel types such as fossil, biomass, nuclear etc.), the total number of orders were 610 units in 2021. Out of 323 orders of steam turbines in H1 2022, Siemens Energy & Triveni Turbines Ltd have a combined market share of 37% (based on technology ownership and number of units). Azad Engineering Ltd. supplies components to some of the key manufacturers of energy turbines. In FY23, the company has supplied to the customers which control approximately 70% of the gas turbine market (based on technology ownership and number of units ordered in H1 2022) globally.

Revenue Passenger Kilometer (RPK) for the commercial aircraft industry is expected to increase to 9.5 Bn by 2027, growing at a CAGR of 12% in the period 2022-27. This industry has recovered in 2022 and 2023 after facing headwinds post the Covid-19 pandemic. The Boeing Company & Airbus SE dominate the commercial aircraft industry with over 90% market share. The 2 companies have an order backlog of ~12,000 units as of December 2022. Nearly 87% of these backlog orders were for narrow body aircrafts like Airbus A220, A320 and Boeing 737. In defence segment as well, the world spent US$ 2,148 bn in military expenditure in 2022 which is about 2.1% of global GDP. Azad Engineering Ltd. supplies components to OEMs as well as Tier 1 manufacturers in the aerospace & defence segment. The company has supplied critical components for aircraft platforms such as B737, B737 Max, B747, B777, B777X, A320, A350, A355, A350 XWB, Gulfstream G550, and is in discussions for supply of components for new engine platforms during the preparation of this industry report.

In the oilfield industry, the company supplies components like drill bits, reamers that are used in the drilling equipment and are part of the exploration and production phase. In this segment, it has supplied

to one of the global manufacturers of drilling equipment.

Among the addressable markets for the company, there is a high variation in expected CAGR between gas, nuclear and coal turbines with highest CAGR expected for components of nuclear turbines (+8% CAGR by 2027) followed by gas turbine (+1% CAGR by 2027). The market for aerospace and defence components is the largest at INR 99k Cr in 2022 and also expected to have the highest CAGR of +9% by 2027. The overall addressable market across energy turbine, aerospace and defence components for the company is expected to grow at +7% CAGR from INR 128k Cr in 2022 to INR 181k Cr in 2027. Additionally, there is addressable market for oilfield drilling components which is expected to grow at +4% CAGR by 2027.

Addressable market size for the company (2022-27) (INR'000 Cr)

Market size	2022	2027	CAGR (2022-27)
Energy turbine components	28	28	0%
Power generation			
Gas turbine blades	4.9	5.1	1%
Gas turbine non-blades	15.8	16.6	1%
Nuclear turbine blades	0.4	0.5	8%
Nuclear turbine diaphragm	0.6	0.9	8%
Coal turbine blades	5.5	4.0	-6%
Industrial gas turbine blades	1.16	1.22	1%
Aerospace & Defence components	99	153	9%
Total addressable market	128	181	7%

Source: Company annual reports, IEA World Energy outlook dated October 2022, Global energy monitor January 2023, Global energy monitor February 2023, World Nuclear Association accessed July 2023, IAEA reports, IEF, S&P Global Upstream Oil and Gas Investment Outlook, dated February 2023, Schlumberger, Ltd. corporate overview
Note: 1. For A&D components market, the market includes the market for five key players: Eaton Corporation Plc, The Boeing Company, Honeywell International Inc., GE Aerospace & HAL
2. The market forecast for energy turbine (coal power, gas power & industrial gas) components is based on the STEPS scenario of IEA.
3. There is an additional addressable market for oilfield drilling equipment market (INR 28k Cr in 2022 for drill bits and INR 32k Cr in 2022 for downhole drilling tools which is expected to increase by +4% CAGR to INR 34k Cr in 2027 for drill bits and INR 39k Cr in 2027 for downhole drilling tools). These market numbers also include overall drill bits & downhole drilling tools market which is supplied by large OFSE players such as Schlumberger, Ltd., Baker Hughes etc. and doesn't specifically take into account the outsourcing share in this market.

Azad Engineering Ltd. increased their revenue from INR 124 Cr in FY20 to INR 262 Cr in FY23 (CAGR of 28.4% between FY20 – 23) with an EBITDA margin of 31.4% in FY23. The company is one of the fastest growing manufacturers (in terms of revenue growth for the period between FY20 – 23) with one of the highest EBITDA margins among the key players mentioned in the report for machined components for the key industries serviced by the company.

The energy turbine, aerospace & defence industry have a significant entry barrier due to a lengthy qualification process for the components driven by criticality of their usage. Some of these components are life critical and mission critical and hence, have zero parts per million defect requirements. Superior manufacturing demands a unique blend of expertise, innovation, quality, and advanced safety controls in the industry which cannot be obtained by only installing CNC machines. The vendors must go through separate qualification process for each component that they supply. The qualification process for a new vendor is stringent and includes multiple steps (such as assessment & audit of technical capabilities of the vendor, vendor registration, evaluation & test of the product qualifications). This entire process is time intensive and often takes more than 15 months to qualify as a supplier during which the vendor is evaluated by the OEM. The vendors also need to institute quality and tracking procedures for all products that are supplied which demands a higher order quality control.

Once a contract is awarded by an OEM to a supplier for a critical component, the OEM and the supplier typically spend significant amount of time and capital on design, manufacturing, first article inspection,

testing & certifications for product specific equipment such as tooling. Any new supplier will need to undergo the same process. OEMs are reluctant to switch suppliers as there are high switching costs unless the current suppliers are unable to meet the requirements on quality, cost, or delivery.

Other than high quality requirement, OEM's vendor selection decision is primarily driven by the potential for cost saving. Hence, the vendors in these industries have to optimize labour cost while maintaining highly skilled labour. There is a preference of OEMs for suppliers which are capable of scaling over time and hence, aim for consolidation in the supplier base with a reasonable share diverted towards each supplier. Hence, Indian players who are able to pass the stringent qualification process have an edge. Additionally, to ensure consistent supply by the vendors, OEMs also closely monitor geo-political risks associated with supplier locations. Locations with low geopolitical risk are preferred for developing a supplier base, and India is increasingly being considered a strategic procurement destination by OEMs.

MACROECONOMIC OVERVIEW

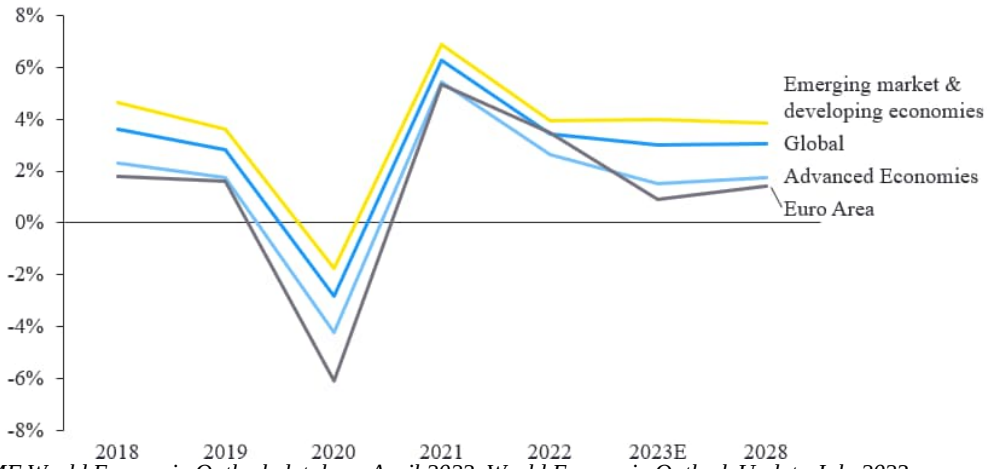
OVERVIEW OF GLOBAL GDP

The global economy expanded at a compounded annual growth rate of 3.1% from 2010 to 2019. The Covid-19 pandemic crisis of 2020 impacted the growth and the global economy contracted by ~3.3% and entered recession. The pandemic forced the economy to a standstill for almost the entirety of 2020 and some part of 2021. While the pandemic subsided, recovery was hindered further by the Russia-Ukraine war, a downturn in the United States, and challenges in the global supply chain. The world has begun to recover from the economic shocks of the last several years.

The global economy is expected to witness a growth rate of 3.0% in 2023. According to IMF, the global slowdown bottomed out in 2022 and the world would likely see a modest growth of ~3% per annum till 2028.

Global growth will be led by emerging markets and developing economies, with established economies, particularly the United Kingdom and the Eurozone, expected to increase only at 0.4% and 0.9% in 2023, respectively. Because of its proximity to the war zone and greater sensitivity to swings in energy costs, the Eurozone is projected to suffer the greatest impact on growth. When compared to global GDP growth, emerging markets, and developing economies are predicted to grow at a rate of 4.0% in 2023.

GDP growth across key aggregates of countries (2018-28)



Source: IMF World Economic Outlook database April 2023, World Economic Outlook Update July 2023

GDP growth across key economies (2018-28)

Country	2018	2019	2020	2021	2022	2023E	2028P
United States	3.0%	2.3%	-2.8%	6.0%	2.1%	1.8%	2.1%

United Kingdom	1.7%	1.6%	-11.0%	7.6%	4.1%	0.4%	1.5%
China	6.8%	6.0%	2.2%	8.5%	3.0%	5.2%	3.4%
India	6.5%	3.9%	-5.8%	9.1%	6.8%	6.1%	6.0%
Russia	2.8%	2.2%	-2.7%	5.6%	-2.1%	1.5%	0.7%
Japan	0.6%	-0.4%	-4.3%	2.2%	1.1%	1.4%	0.4%
Brazil	1.8%	1.2%	-3.3%	5.0%	2.9%	2.1%	2.0%

Source: IMF World Economic Outlook database April 2023, World Economic Outlook Update July 2023
Note: Annual percentages are year-on-year changes of constant price GDP reported in the country local currency; the base year is country-specific

GROWTH OUTLOOK OF KEY ECONOMIES

Outlook on key advanced economies

- USA is facing an estimated growth rate of 1.8% in 2023 over the previous year which witnessed a 2.1% growth. The economy is witnessing a resilience in consumer demands and industrial production which drives the expansion of the economy. The country is slowly easing out of inflation, which peaked to ~8% in 2022. The inflation has been steadily falling ever since, with the country witnessing lower CPI% at 4.5%, a first post pandemic. CPI eased majorly due to fall in energy prices, but other goods in the CPI basket appear to be impacted as well. But this is still higher than the Federal committees' target of 2% inflation over the long term. The US Federal Open Market Committee meeting of July 2023 indicated a below trend GDP growth and softening of labor markets are required to balance supply and demand and to ease inflation. This indicates possible continuing of the rate hike trend. However, the hiking of rates from 2022 also led to added stress on the country's financial systems, indicated by the recent collapse of Silicon Valley Bank. So, the economy is on a delicate balance between increasing rates to rein in inflation, while ensuring absorbable stress on the banking sector.
- UK is facing slower growth rates and the country's growth is projected to witness a marginal growth of 0.4% in the current year. While the economy appeared to be on a path of recovery after a growth of 4.1% in 2022, the high inflation level of 9% in 2022 forced the Bank of England to tighten the policy measures by increasing interest rates. While the market also witnesses higher wages, the pressure it exerts on inflation is gradually expected to come down with loosening of labor markets.
- Japan is projected to grow at 1.4% driven by domestic demand and retail demand due to pick-up of tourism post pandemic. The country is witnessing reduction in exports due to weak global demand and hence the lower than global growth rate.

Outlook on key emerging markets

- China's economy is facing a slowdown post the pandemic recovery, primarily due to slowing of manufacturing output and decreased domestic demand. Potential for increased exports from the country will also be limited due to slow down in advanced economies such as USA and UK. According to IMF, the country is expected to remain as one of the fastest growing economies in the Asia region in the current year, contributing to ~35% of global growth. However, the economy is expected to slow down in the future due to inherent demographic characteristics and a drag in productivity.
- Russian economy faced contraction in 2022 due to wartime sanctions and higher focus on military spends. While EU has stopped the import of oil from Russia, the country has diverted production to other economies. Despite oil revenues, growth will slow down due to continuing global sanctions.
- Brazil has had faster-than-expected GDP growth due to agricultural expansion, despite a

slowdown in the services sector, which accounts for 70% of GDP, and underperformance in the industrial sector. The Central Bank of Brazil has been raising interest rates to control inflation, which has so far had no effect on consumer spending due to a solid labour market. However, the job market's continuous expansion is not projected to continue, which will have an influence on consumer spending, and growth rates are expected to decline.

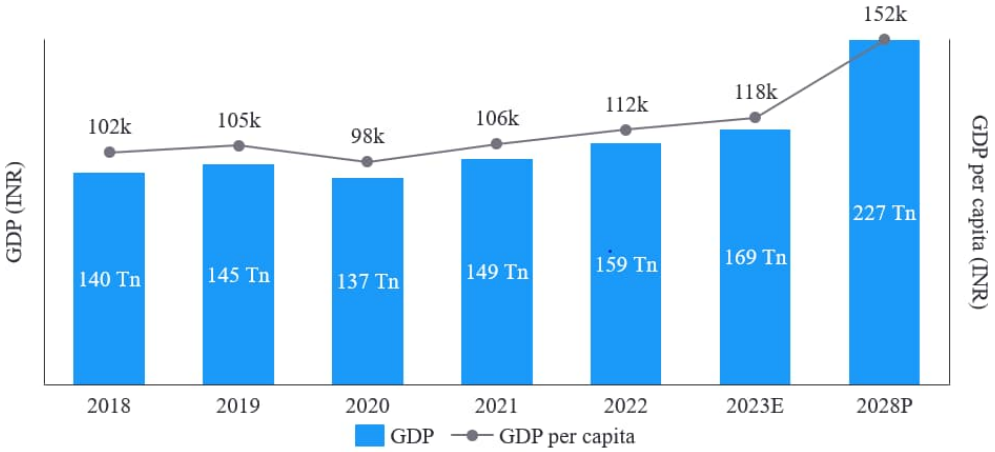
MACROECONOMIC OVERVIEW OF INDIA

GDP GROWTH FOR INDIA

Indian economy had a steady growth over the last few years with the GDP witnessing a compounded annual growth rate of 6.6% from 2010 to 2019. The global pandemic in 2020 led to a 5.8% contraction in the economy. India has recovered from the slump from the pandemic period, with ~7% growth in 2022 and an estimated growth of 6.1% in 2023. In 2022, the Indian economy overtook the UK economy to become the 5th largest in the world. The economic growth is driven by strength of services exports from India. Structural reforms of the government including higher FDI limits, focus on disinvestment have also supported the economy in the recovery post slowdown due to the pandemic.

India has been a major driver of global growth in the recent years, especially due to higher inflation and economic slowdown in major economies. With global supply chains getting back to the pre-pandemic order, International Monetary Fund (IMF) predicts that Asia will account for about 70% growth in the world in 2023 and India & China together will contribute towards 50% of global growth.

India GDP and GDP growth (2018-28)



Source: IMF World Economic Outlook database April 2023, World Economic Outlook Update July 2023
Note: GDP at constant prices (Base year: 2011-12)

The outlook for the next few years is also positive for Indian economy with projected GDP growth of 6%. Various initiatives by the government including Atma Nirbhar Bharat, PLI schemes and higher government spending on infrastructure are driving economic growth.

INDIAN MANUFACTURING SECTOR

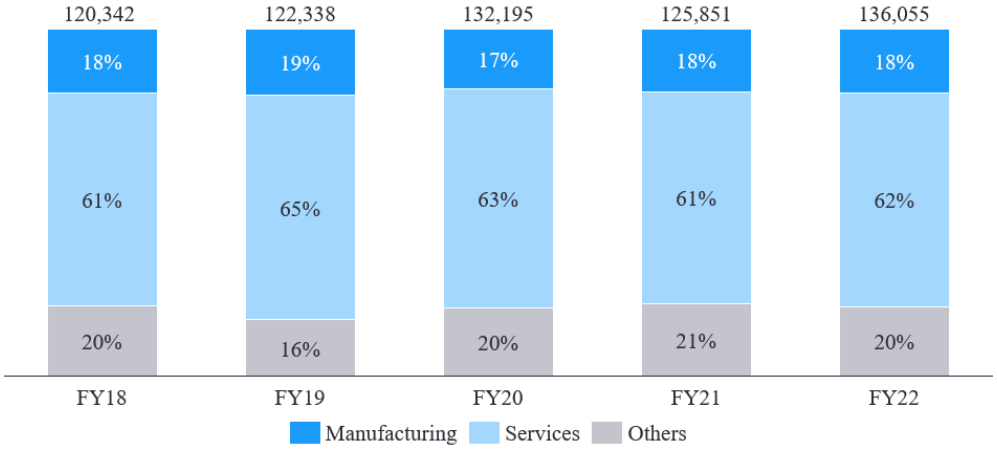
India has the potential to become one of the largest manufacturing hubs in the world. It has a large population base with growing income, considerably younger proportion of workforce and business friendly sector policies which provide the opportunity to become a global manufacturer. The World Economic Forum in 2021, identified that India's manufacturing sector can contribute to over US$ 500 billion to the economy in 2030.

Due to the COVID-19 pandemic, the country's overall economic activity decreased in 2020. Industrial activity reduced and project completion dates were pushed back. Because of the re-opening and resilience of the domestic manufacturing sector, industrial production recovered strength and returned

to a positive trajectory in 2021 after the country emerged from multiple lockdowns.

The country's manufacturing sector reportedly employs over 27 million people and the overall contribution of manufacturing to GVA is about 18%. The contribution of manufacturing to GVA has been broadly constant in the past few years, but the absolute GVA from manufacturing has been growing at a CAGR of 2.3% from FY18-FY22.

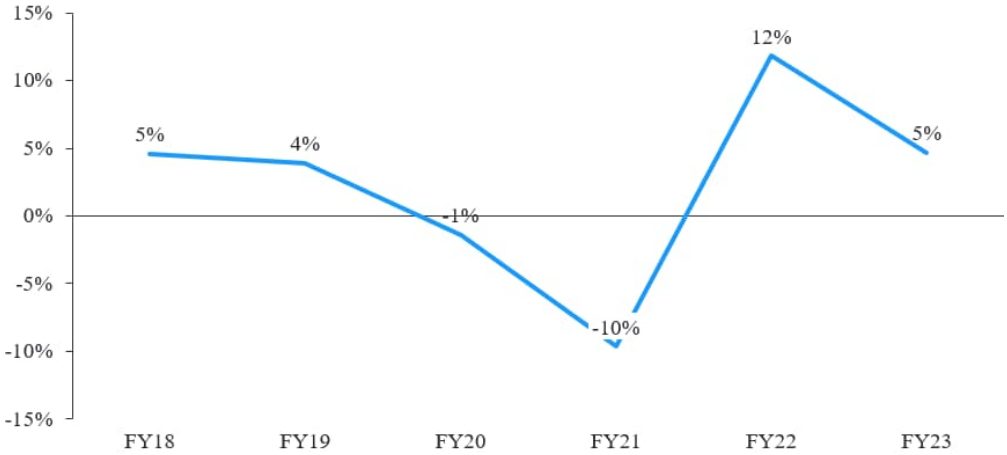
Contribution of manufacturing towards Gross Value Added (INR Bn) (FY18-22)



Source: RBI Handbook of Statistics on Indian Economy
Note: GVA at constant prices (Base year: 2011-12)

Index of Industrial Production (IIP) which is an indicator of mining, manufacturing and electricity production has gotten back to pre-pandemic levels. IIP witnessed an accelerated growth in FY22, mainly due to the lower base effect and recovery from FY21 pandemic levels. The manufacturing sector contributes to more than 75% of the IIP in India.

Growth rate of manufacturing IIP over the years (FY18-23)



Source: Ministry of Statistics and Programme Implementation (MOSPI), India accessed July 2023

For Indian manufacturing sector to pick up pace, the country must shift towards developing competency in niche manufacturing segments and move beyond pure-play cost-advantage. The sector also requires capital investments and strong government policies to attract global manufacturing companies to manufacture in India.

ENABLING FACTORS FOR INDIAN MANUFACTURING SECTOR GROWTH

Large corporations throughout the world are working on implementing a "China plus one" strategy, in

which they explore possibilities for suppliers outside of China to diversify their supply chains and avoid disruptions caused by the COVID-19 outbreak or geopolitical conflicts. As a result, India now has the opportunity to exploit its industrial strengths and become a global manufacturing hub. India's recent success in the service sector, as well as repeating that success in the manufacturing sector, is critical for the country to create more employment and achieve balanced and sustainable growth.

The Government has recognized the need to promote domestic manufacturing and has been taking multiple initiatives to attract manufacturing investments and promote existing manufacturing capabilities.

India's new foreign trade policy 2023

Indian government has released a dynamic Foreign Trade Policy in 2023, with provisions for adaptable revisions and investor-friendly guidelines. The policy aims to be responsive and incorporate continuous feedbacks from the industry on necessary changes and upgrades. The new policy will focus on:

1. Incentives, tax breaks and remissions
2. Better trade through use of technology
3. Promotion of exports through collaboration of multiple stakeholders at exporter, districts, and state levels
4. Increased thrust for emerging areas such as e-commerce exports, developing export hubs across districts and streamlining the policy for SCOMET category of products. SCOMET stands for Special Chemicals, Organisms, Materials, Equipment and Technologies and refers to nine categories of products and technologies which have civil as well military applications such as nuclear materials, biological organisms, material processing equipment, aerospace systems etc.

In terms of policy support, the policy envisages enabling completely paperless authorization processes, automating approvals, and bringing down the processing time for approvals from about a month to under one day, reducing user charges, promoting the use of e-certificates, provisions for electronic data exchange with partner countries etc.

In terms of infrastructure and access, there are efforts to promote internationalization of Indian Rupee and improving manufacturing infrastructure by creating additional 'Towns of Export Excellence,' with export promotion benefits. The government also plans to extend initiatives under 'Vivaad se Vishwaas' to reduce potential for litigations and promote trust among foreign investors.

Make in India

Indian government launched the 'Make in India' initiative in 2014 to boost local manufacturing and to make India a global manufacturing hub. The scheme involved focused investments to increase innovation and intellectual property, develop best-in-class manufacturing infrastructure and promote favorable policy initiatives. The scheme currently focuses on improving twenty-seven key sectors, fifteen of which are manufacturing sectors with tailored 'Action Plans'. The Department for Promotion of Industry & Internal Trade (DPIIT), which also manages 'Invest India' to facilitate foreign investments into the country, has chosen twenty-four sub-sectors (including automobile, chemicals, medical devices, auto-components, defence manufacturing, electronic systems etc.) to boost local manufacturing based on local competency, potential for import substitution, opportunities for export and potential for increased employment opportunities.

Atma Nirbhar Bharat Abhiyan

In the midst of the COVID-19 epidemic, the Government of India announced the Atma Nirbhar Bharat Abhiyan (or 'Self-reliant India') in May 2020. The campaign's principal goal was to recover from the economic impact of the pandemic and become self-sufficient on five key pillars: economy, technology-

driven infrastructure, infrastructure, demand, and demographics. The Indian government unveiled a combined economic package worth INR 20 trillion (approximately 10% of India's GDP) to support a variety of projects aimed at benefiting enterprises, MSMEs, farmers, and the agriculture sector.

Reducing import dependence and promoting the growth of domestic manufacturing industry was one of the key emphases of the government in this scheme. Under Atma Nirbhar Bharat, the government also plans to introduce parameters for better quality of output to meet international standards so that Indian products can compete in the global market.

Production Linked Incentive (PLI) scheme

India introduced the PLI scheme in 2020 to promote domestic production through subsidies and encourage exports while cutting down on cheap imports. The scheme is available across fourteen key manufacturing sectors including specialty steel, telecom, auto components, drone components etc. It is designed to provide incentives which are linked to investment and turnover size. The government sanctioned over INR 1.9 lakh crore to be periodically utilized for the scheme.

The country expects that PLI sectors will attract more FDI inflows due to added incentives especially in food processing, pharmaceuticals, and electronics segments. The government is analyzing the effect of the scheme and depending on the success, it is likely that the scheme will be extended across other manufacturing segments.

Ease of doing business

India ranks 63rd in the 'Ease of Doing Business' ranking by World Bank. This is a massive improvement over its position just a decade back, when it stood at 142nd rank in 2014. The improvement in ranking is driven by simplification of the business ecosystem through government initiatives such as 'Make in India', 'National Single Window System (NSWS)' etc.

Among its South Asian peers, India ranked better in terms of trading across borders ranking including both 'Border compliance' and 'Documentary compliance' that improves cost to export; the country lagged behind China in-terms of time and cost to import and ranked the lowest in terms of time to export.

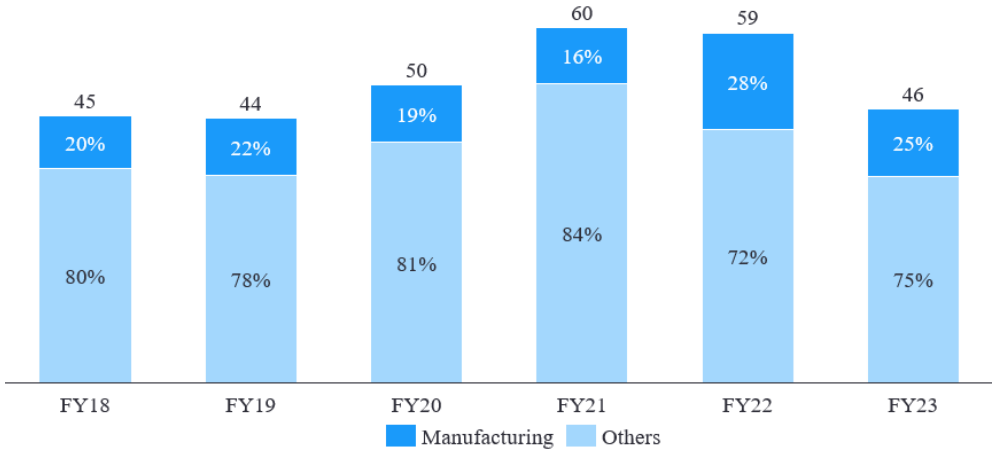
The government has been focusing on initiatives to empower India as an export destination and capitalizing on the opportunities arising out of global China plus one strategy. Thus, improving the overall ease of doing business in the country is a major milestone on the path towards manufacturing success.

FDI INTO THE MANUFACTURING SECTOR

India is among the top 10 FDI destinations in the world. FDI flows across the world witnessed a degrowth of 12% in 2022 due to global economic conditions and this also reflected in the reduction in FDI inflows into India in FY22 and FY23. Indian manufacturing sector has been consistently accounting for about 20% of total FDI flows into India. In terms of relevant industrial segments, the renewable energy sector attracted US$ 11 Bn worth of FDI in the last 9 years. The defense sector attracted US$ 62 Mn worth of investment since the policy liberalization in 2020, as per InvestIndia website accessed in August 2023. Indian government allows for up to 100% FDI through automatic route in the manufacturing sector.

The country has been witnessing a stimulus in new manufacturing investments and UNCTAD's World Investment Report 2023 mentions that India announced 1,008 greenfield investment projects in 2021 and 2022. Some of the large projects announced in 2022 include 'Ayana Karnataka wind and solar hybrid project' with an estimated investment of US$ 1.5 Bn. India is among the top destinations for wind energy component manufacturing. India, UK, USA, Turkey, and China accounted for over 45% of total projects in the sector from 2016-2022.

Trends in FDI inflows into India (US$ Bn) (FY18-23)



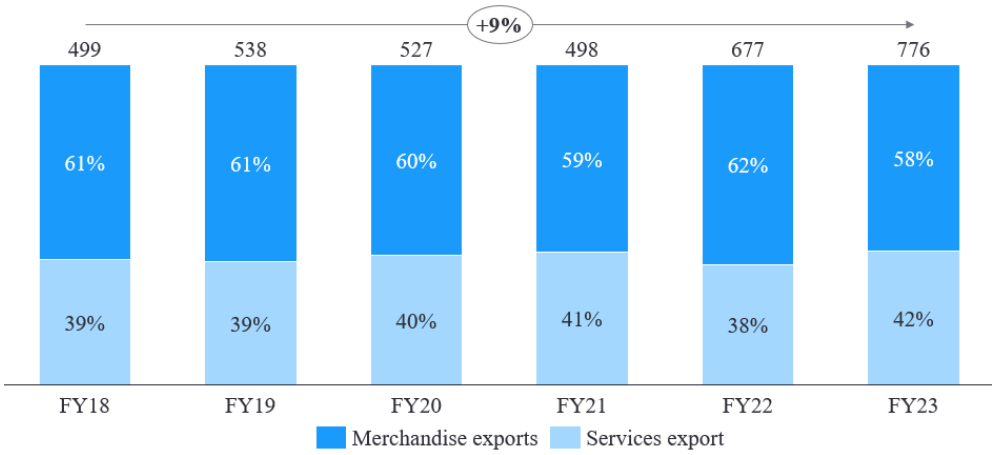
Source: Reserve Bank of India Annual Report dated May 2022

Supply chain disruptions caused by the global pandemic have driven countries to seek new investment venues and diversify their supply chains. With its large skill pool, low-cost operations, and investor-friendly environment, India is well-placed to attract these global investments. Geopolitical constraints, high commodity prices and higher inflation and slower growth rates in advanced economies, on the other hand, will impact the performance of India's manufacturing sector.

TRENDS IN INDIA'S MANUFACTURING SECTOR FOREIGN TRADE

India has traditionally been a foreign trade deficit nation. The country is a net exporter of services, but it is a net importer of global goods. The total exports from India have grown at a CAGR of 9% in the last 5 years.

Export statistics for India (US$ Bn) (FY18-23)

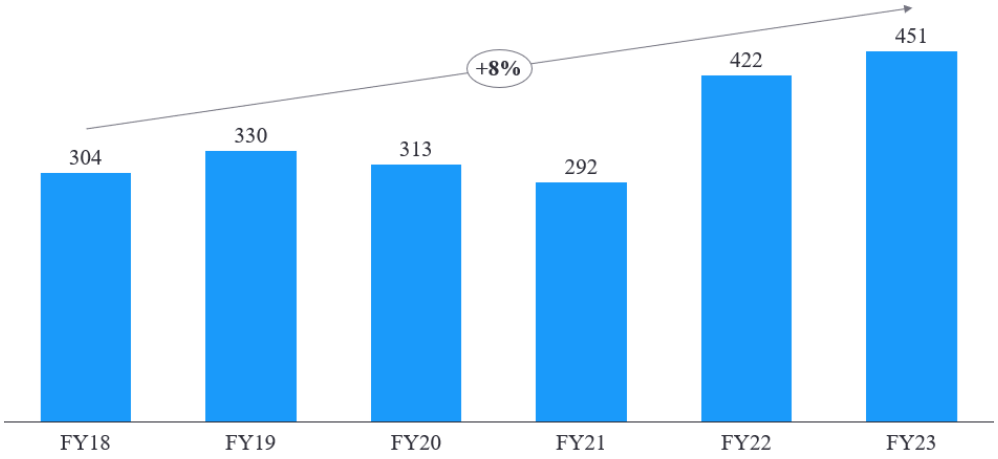


Source: Ministry of Commerce and Industry

India's merchandise exports

The growth in manufacturing sector in India due to various government policies and trade agreements have had a positive impact on the merchandise exports from India. Merchandise exports from India have grown at a CAGR of 8% from FY18 to FY23.

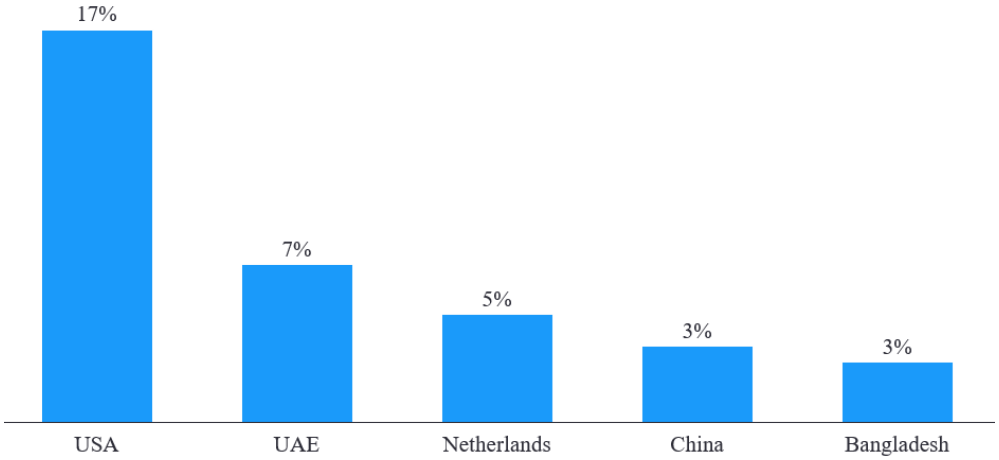
India's merchandise exports (US$ Bn) (FY18-23)



Source: Ministry of Commerce and Industry, Dept. of Commerce dashboard accessed July 2023

In terms of demand for Indian goods, USA is the major export destination and accounts for 17% of exports from India in FY23, followed by UAE, Netherlands, China, and Bangladesh.

Top five destinations for Indian merchandise exports in FY23



Source: Ministry of Commerce and Industry, Dept. of Commerce dashboard accessed July 2023

Of the top five commodities exported from India at an HS Code level, petroleum products such as mineral fuels, oils, mineral waxes, and bituminous substances that fall under the HS code 27 constitute the largest share of exports from India and accounted for about 22% of total exports in FY23. Electrical machinery and equipment, nuclear reactors, boilers and parts and organic chemicals accounted for the other major product categories in the top five.

Electrical machinery and equipment replaced iron and steel components in the top five as compared to FY22. While export of precious or semiprecious stones and pearls along with organic chemicals have reduced compared to previous years, exports of electrical machinery and equipment have witnessed a growth of ~42% in FY23.

Value share of top five export commodities in FY23 and change from FY22

Commodity definition*	Share of total trade in FY22	Share of total trade in FY23	% Growth in FY23
Mineral fuels, mineral oils, and products of their distillation; bituminous substances; mineral waxes.	16.5%	22.4%	45.4%
Natural or cultured pearls, precious or semiprecious stones, pre-metals, clad with pre-metal and articles	9.3%	8.5%	-2.9%

thereof imit. jewelry; coin.			
Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts.	4.8%	6.3%	41.8%
Nuclear reactors, boilers, machinery, and mechanical appliances; parts thereof.	6.02%	6.09%	8.1%
Organic chemicals	5.2%	4.7%	-3.1%

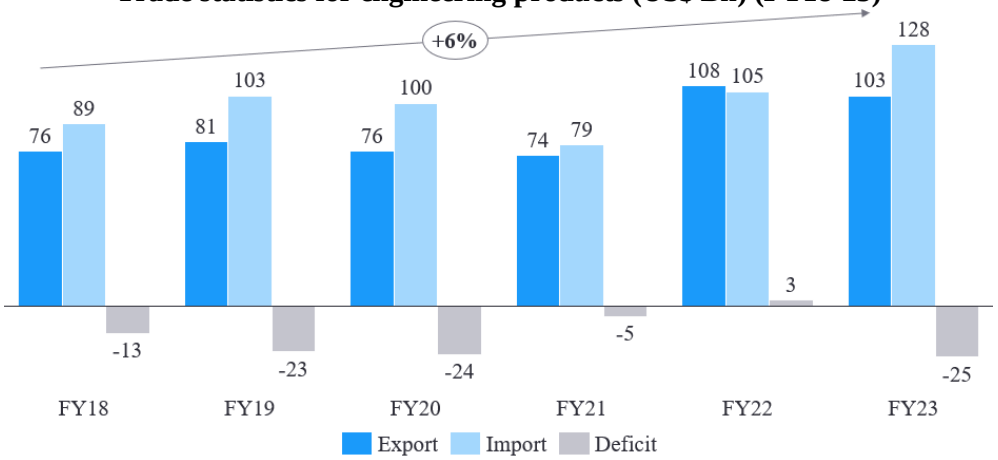
Source: Ministry of Commerce and Industry, Dept. of Commerce dashboard accessed July 2023
Note: Definitions as per Ministry of Commerce and Industry, Dept. of Commerce

Trends in engineering products export

India has historically had a trade deficit in the engineering products segment with high value goods traditionally being imported. While exports witnessed a boost due to recovery post the pandemic in FY22, high inflation and elevated commodity prices led to higher value of imports and widening of deficits again in FY23.

Engineering products (across multiple HS codes) account for 23% of total merchandise exports from India and the exports in this segment have grown at a CAGR of 6.3% between FY18 to FY23.

Trade statistics for engineering products (US$ Bn) (FY18-23)

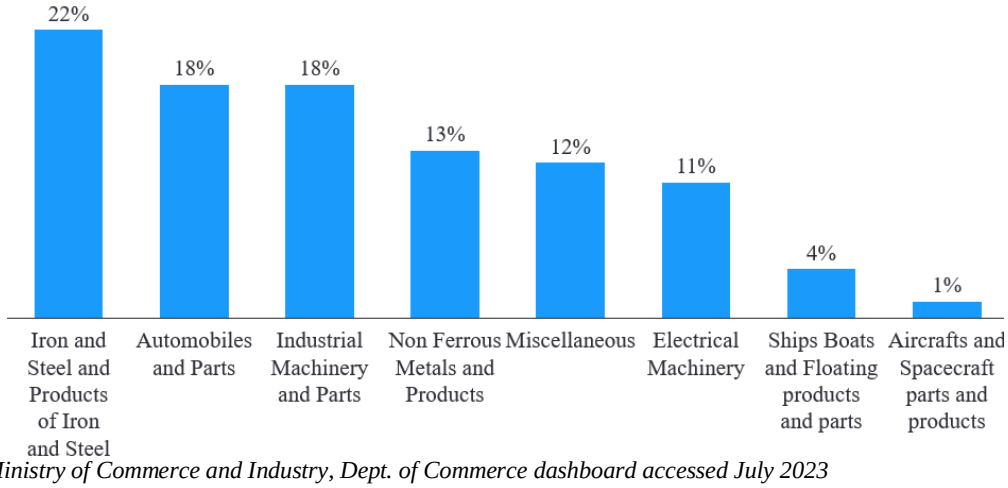


Source: Ministry of Commerce and Industry, Dept. of Commerce dashboard accessed July 2023

United States, UAE, Italy, Germany, and Singapore were the top five top export destinations for India for engineering products. Looking at imports in India for engineering products in FY23, majority of the imports have originated from China, USA, Germany, Korea, and Japan.

Iron and steel-based products form the highest share of engineering product exports from India, followed by automobile parts and industrial machinery parts. Absolute value of exports of iron and steel products and non-ferrous metals has fallen by ~27% and 13% in FY23 compared to FY22, while the value of aircraft components exported has grown by 25% in FY23 over FY22.

Sub-category wise value share break-up of engineering product exports from India (FY23)



Source: Ministry of Commerce and Industry, Dept. of Commerce dashboard accessed July 2023
Note: Sub-category definitions as per Ministry of Commerce and Industry, Dept. of Commerce

ENERGY INDUSTRY

PRESENCE OF AZAD ENGINEERING LTD. IN THE ENERGY INDUSTRY

Azad Engineering Ltd.'s key customers are in the power and industrial turbine industry. The company supplies precision, forged and machined components for energy turbines (which are used in industries & power plants with different fuel types such as gas, nuclear and coal). The company provides precision, forged and machined airfoils and other special machined parts (SMP) and hence is a key link in the global supply chain for customers in the industry. These components are high precision components and are mission critical & hence, have a "zero parts per million" defects requirement.

The company has developed manufacturing capability to deliver solutions which have helped clients and has supplied to both Indian and global OEMs many of which are leaders in their respective sectors. In FY23, the company has supplied to the customers which control approximately 70% of the gas turbine market (based on 2022H1 orders) globally. Airfoils contribute to majority of the sales for the company. Other than this, the company also supplies other special machined components for energy turbines. Azad Engineering Ltd. has witnessed an increase in its market share for airfoils in the period 2017-22. The company has over 15 years of experience as a Tier I supplier of high precision components for energy industry. The demand for these products is driven by the orders for these components in either new energy turbines (industrial & gas, nuclear and coal power plants), or the service market. The demand for both in turn is driven by energy consumption and growth in energy demand.

This section of the report covers the assessment of energy industry (including coal, gas, and nuclear power) along with an overview of the energy turbine market.

ASSESSMENT OF ENERGY INDUSTRY

Global energy consumption review and outlook

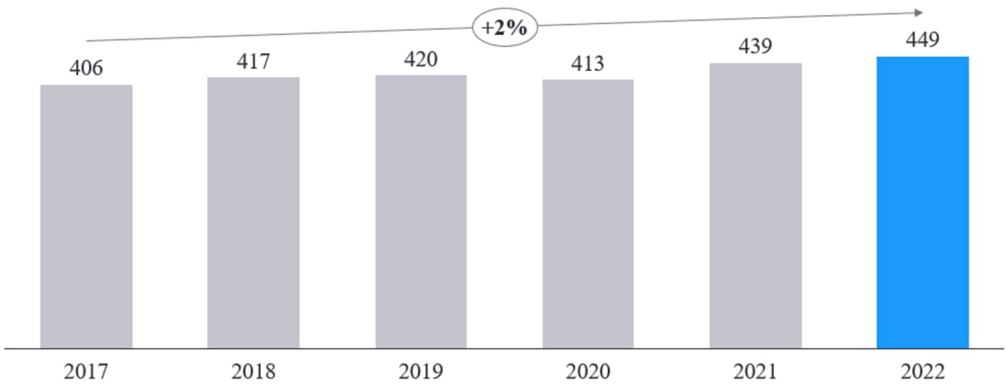
Overview of global energy consumption

There has been a steady increase in energy consumption, which is rebounding from setback due to COVID-19 pandemic.

Over the last 5 years, the global energy consumption has witnessed a steady upward trend with annualized growth rate of ~1.8% from 2017-2022, driven by macroeconomic factors such as increase in income levels, urbanization, and industrialization. Even though energy consumption growth slowed down in 2022 (about 2%) as compared to 2021 (about 7%), that was primarily a result of lower base in

2020 due to temporary reduction resulting from the COVID-19 pandemic.

Global total energy consumption (EJ), (2017-22)



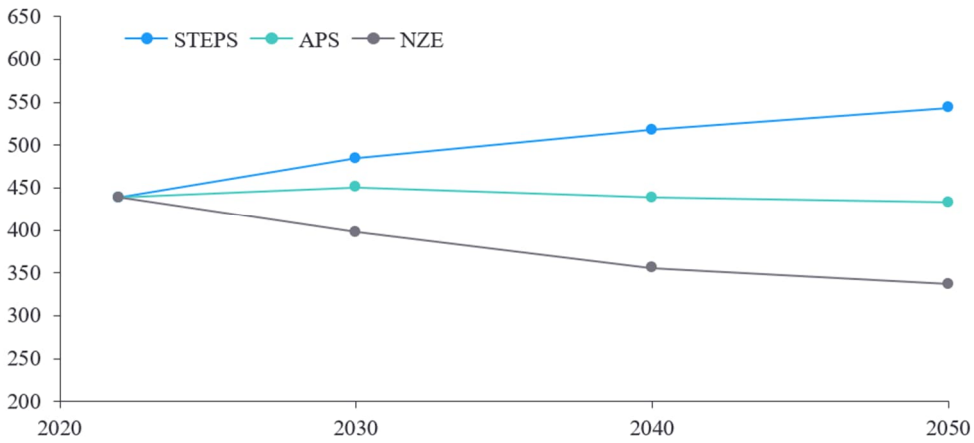
Source: IEA World energy outlook, dated October 2022, Enerdata, accessed August 2023

Global energy demand outlook

International Energy Agency ("IEA") has created three scenarios for the energy demand outlook based on the policies and actions of the governments. These scenarios estimate the outlook assuming different possible cases. The primary difference is the overall mix of energy and share of renewables within the final energy consumption mix. The scenarios are described below:

1. ***States policies scenario (STEPS):*** It projects the outlook based on current policies of the government and is the most conservative scenario (when compared with the other two cases). It takes into consideration the existing policies as well as the policies already under progress.
2. ***Announced Pledges scenario (APS):*** This is the base case where the countries meet all the targets set by the government for long term (2050) and well as 2030. All the commitments will be met fully as per the assumptions in this case.
3. ***Net Zero emissions by 2050 scenario (NZE):*** The most optimistic scenario is net zero case. The projections set by this case are challenging but will have the highest impact on net carbon emissions moving forward and target zero emissions by 2050.

Global energy demand forecast scenarios (EJ)



Source: IEA World energy outlook, dated October 2022

In the STEPS scenario, it is estimated that the energy consumption will reduce by roughly 0.5% each year in the developed countries. However, in the developing countries, there will be a slight increase in

energy demand by around 1% annually.

In the Announced Pledges, consumption of fossil fuel will be roughly 80% of the consumption under the STEPS scenario by 2030. In APS scenario, renewable power demand is projected to rise faster. NZE scenario takes a more conservative outlook of total energy consumption however renewable energy will account for the maximum share of power within the total mix.

Global energy consumption scenarios by fuel (EJ), (2030-50)

Fuel	2030			2040			2050		
	STEPS	APS	NZE	STEPS	APS	NZE	STEPS	APS	NZE
Oil	183	165	134	185	129	72	185	101	39
Power	107	108	110	130	140	149	151	169	176
Natural gas	77	67	54	81	55	32	81	45	16
Coal	52	44	35	49	30	17	46	19	6
Bioenergy	39	32	26	40	32	26	41	34	28
Others	27	35	39	33	53	60	40	65	72
Total	485	451	398	518	439	356	544	433	337

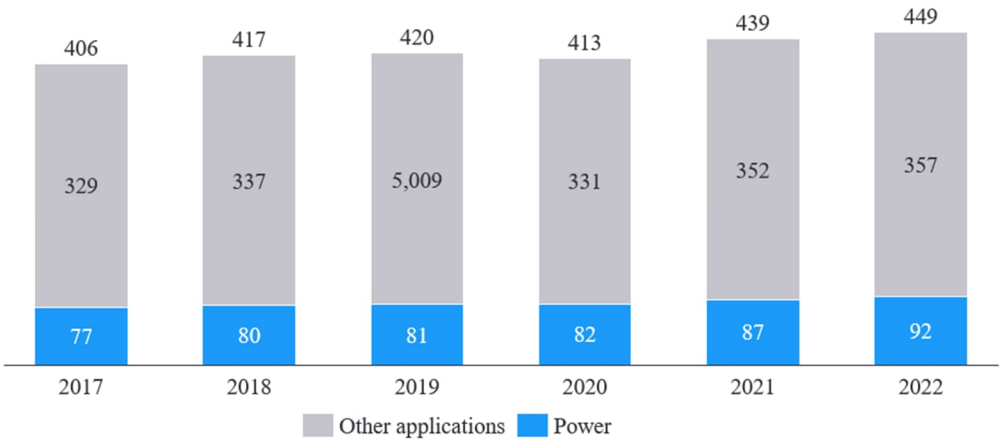
Source: IEA World energy outlook, dated October 2022

Global power consumption review and outlook

Historical power consumption trends

Electricity makes up for about a fifth of the global total final energy consumption. Global electricity consumption was roughly 92 EJ in 2022 with an increase of around 5% (relatively lower than the 6% growth in power consumption in 2021). Increase in power consumption in 2021 was the highest since 2010 majorly driven by COVID-19 pandemic recovery of many economies.

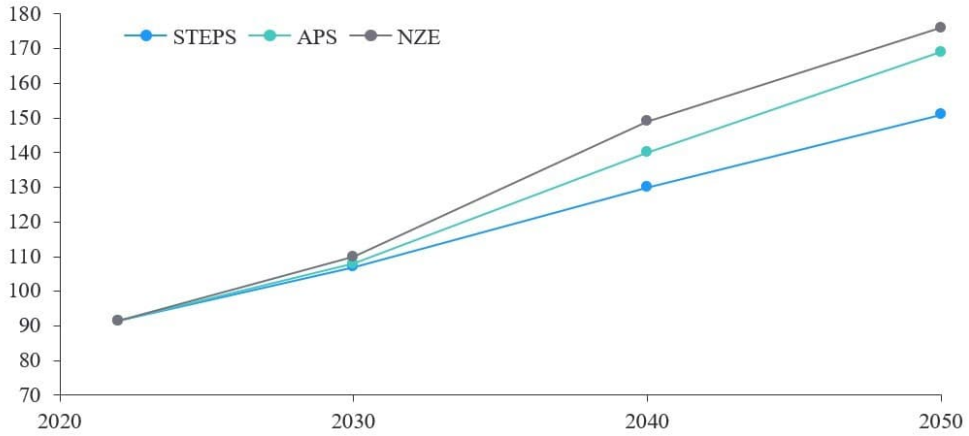
Global power share within overall energy consumption (EJ), (2017-22)



Source: IEA World energy outlook, dated October 2022, Enerdata, accessed August 2023

Share of power out of the total energy consumption is expected to increase. In STEPS scenario, the demand will rise to about 107 EJ by the end of the decade and then reach around 150 EJ by 2050. The final consumption for 2030 remains similar in APS as well but the demand rises to 169 EJ by 2030, making up around 39% of total energy consumption. The net zero case estimates the power consumption to rise significantly as a proportion of total energy mix, making up 42% in 2030.

Global power consumption outlook scenarios (EJ)



Source: IEA World energy outlook, dated October 2022

Global power generation and capacity overview

The share of unabated fossil fuels in electricity production fell from about 65% in 2017 to 62% in 2022. The share of renewables has been on a consistent rise in overall mix of power generation, specifically share for solar and wind power. This increase is majorly due to the present market conditions and challenges faced globally. After the lifting of restrictions due to COVID-19, markets experienced a sudden rise in demand which provided an upward boost to price of energy. There was further rise in prices due to Russia – Ukraine war. Due to this, some countries returned to coal power generation, however this return is expected to be short term. Additionally, few countries have initiated and shown rapid progress in their targets to reach net zero emissions by reducing the dependency on power generation from fossil fuels.

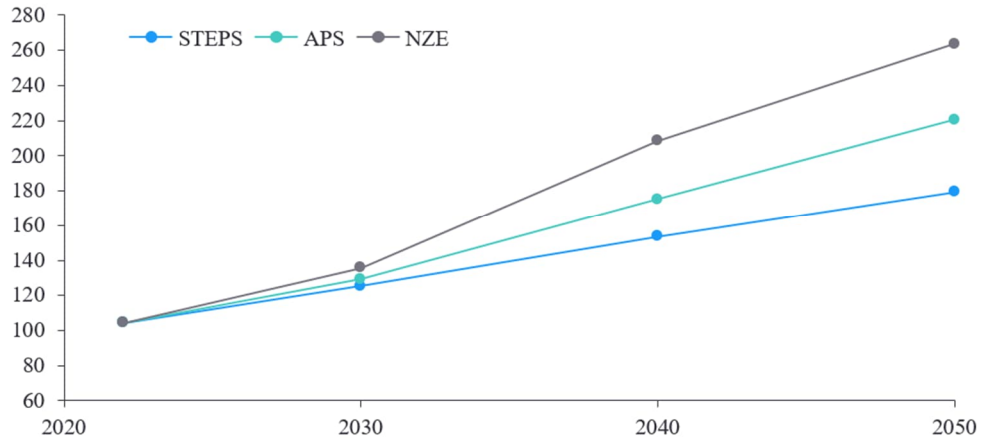
Global power generation (EJ), (2017-22)

Fuel	2017	2018	2019	2020	2021	2022
Coal	35.5	36.4	35.5	34.1	36.7	37.4
Renewable	22.9	24.5	25.8	27.8	29.0	30.8
Natural gas	21.1	22.0	22.7	22.5	23.6	23.5
Nuclear	9.5	9.8	10.0	9.7	10.0	10.4
Others	3.5	3.0	3.0	2.7	2.7	2.2
Total	92.4	95.8	97.0	96.3	102.0	104.4

Source: IEA World energy outlook, dated October 2022

Similar to the trends in power consumption, it is expected that there will be rise in electricity generation across all the three cases of IEA. However, the mix of energy used for this generation is highly dependent on the policies and decisions of the policy makers. Additionally, overall geographic conditions and global events are also expected to impact this energy mix. As per the NZE case of IEA, power generation is projected to increase by more than 150% by 2050.

Global power generation outlook scenarios



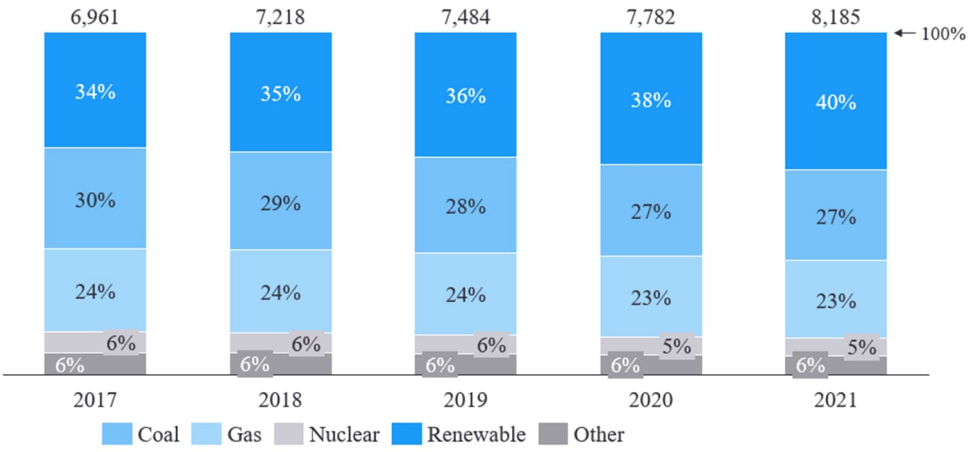
Source: IEA World energy outlook, dated October 2022

Dependency on fossil fuels for power generation is expected to reduce. There is a significant variation in the usage of renewable energy for power generation across different IEA scenarios (STEPS, APS and NZE). However, the share of nuclear is expected to remain constant at 10% in all the three cases.

1. ***STEPS*** – The share of renewables is projected to rise to about 43% by 2030 and power generation using fossil fuel generation will fall to 47%.
2. ***APS*** – Power generation using renewable energy is projected to make up almost 50% of the power in 2030 with power generation using fossil fuels expected to fall to roughly 40%.
3. ***NZE*** – The biggest jump in renewables is projected in NZE where renewables and nuclear make up for about three quarter of the total power generated by 2030 and fossil fuel-based power generation falls to 26%.

The global capacity for power generation stood at 8,185 GW in 2021, a growth of 5% over 2020. The current capacity is dominated by fossil fuel-based power plants with share of renewables being about 40%. The principal factor however is how this capacity mix has been evolving. The share of coal and oil combined has declined from 54% in 2017 to about 50% in 2021 while the share of renewables has increased from 34% to 40%. As per IEA, there are about 175 GW worth of coal-fired power plants that are currently under construction.

Global power generation capacity (GW), (2017-21)

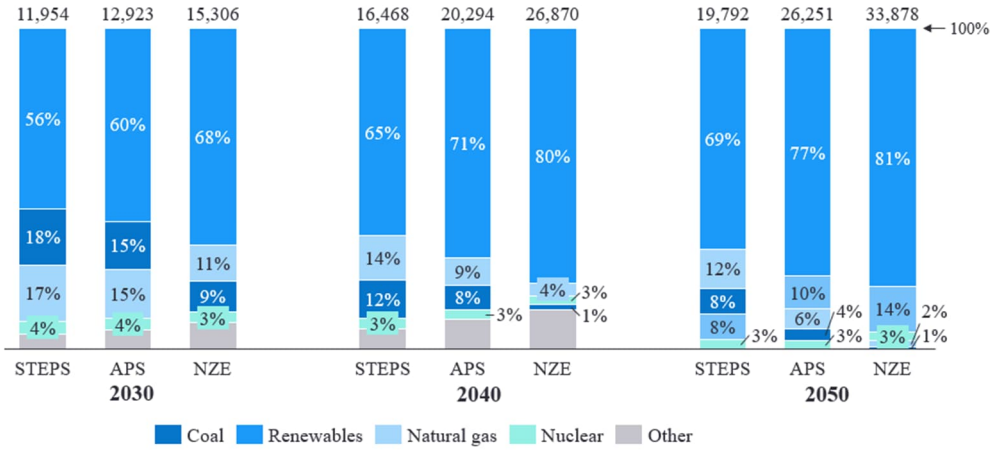


Source: IEA World energy outlook, dated October 2022

The projections for total capacity as well as capacity mix varies considerably across the three scenarios:

1. ***STEPS*** – Capacity for coal-based power generation (which is under development at present) is expected to continue growing in the near future and reach its highest by 2025, after that, it will start to decline. Share of coal within the power generation capacity is expected to fall to 8% by 2050.
2. ***APS*** – APS projects the share of coal to decline to 15% by 2030 and further reduce to less than 5% by 2050. Capacity for natural gas power plants is also projected to fall to about 6% by 2050 with renewables accounting for 77% by 2050. IEA estimates there will be an average addition of 18 GW each year in the nuclear power generation capacity by 2050.
3. ***NZE*** – Net zero takes the renewable capacity all the way up to 60% by the end of this decade and 81% by 2050. The capacity for gas and coal combined falls to less than 5% by 2050. NZE projects an average of 24 GW capacity addition for nuclear plants per year leading up to 2050.

Global power generation capacity outlook scenarios - split by fuel (GW)

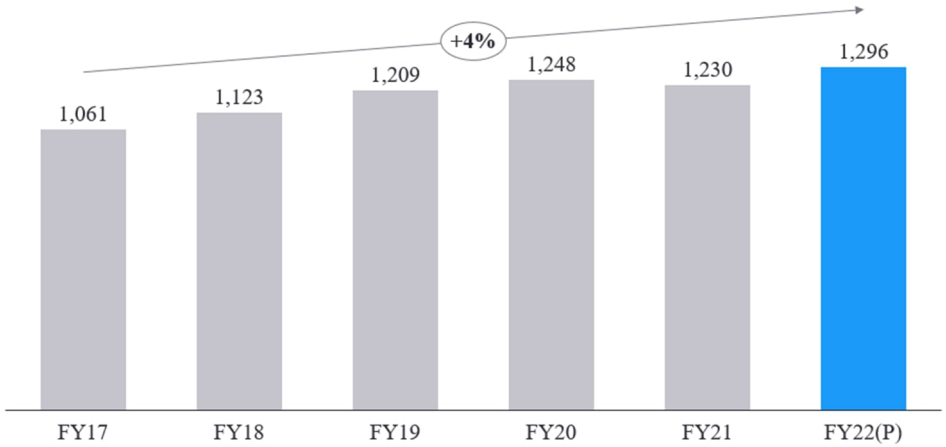


Source: IEA World energy outlook, dated October 2022

India's power consumption and demand outlook

Presently, the Indian electricity consumption is about 1,296 TWh, a 4% compounded annual growth from FY17. This growth rate is almost two times of the global consumption growth. There was a decline in demand in 2021 owing to COVID-19 pandemic. The rate of consumption of power is increasing, with India ranking third globally. Nearly 3/4th of the demand is still dependent on the conventional sources of fuel.

India's power consumption (TWh), (FY17-22)



Source: CEA, MOSPI Energy statistics India, dated March 2023

Per-capita consumption in India is 1.3 MWh in FY22 as per CEA which a significant increase from about 0.63 MWh per capita in 2005. There is a huge opportunity to further increase this consumption as the global per capita consumption was 3.2 MWh in 2021.

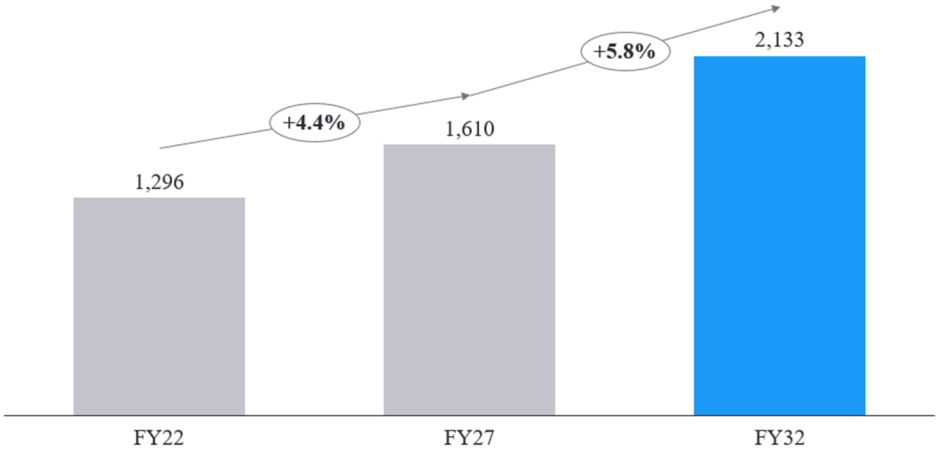
India's per capita power consumption (MWh) trend, (FY18-22)

Source: CEA National electricity plan, dated March 2023, IEA World energy outlook, dated October 2022

India's demand forecast and growth drivers

India has been an economy where services sector has contributed to majority of GDP, but services sector consumes comparatively lesser power. Moving ahead with the developing industrial sector, growth in population and increasing urbanization, India's power demands will go up. The potential to push demand is high led by infrastructural development that India's future beholds. The consumption according to CEA estimates would reach 1,610 TWh in the next 5 years & reach 2,133 MWh by FY32. The growth rate over the next 5 years would be 4.4% & further from 2027-2032 the CAGR is expected to be 6%, a growth rate thrice the global average.

India's power consumption outlook (TWh), (FY22-32)



Source: CEA Electric power survey India, dated November 2022

Rural development would lead to shift in consumption of solid biomass which will be replaced with electricity by 2040. All these factors will push the residential sector share of demand to three times. However, based on IEA, traditional fuels like solid biomass, firewood and others would be in usage over a medium time frame by 2030, especially in the rural & sub-urban areas.

Following the footsteps of developed nations, while attaining net-zero emissions is a goal for the Indian government, they are pushing towards lesser usage of fossil fuels. However, the government also wants to ensure that there is sufficient power across the country. Hence, it is projected that there would be major changes in demand as well as in the mix of energy which will be utilized in India.

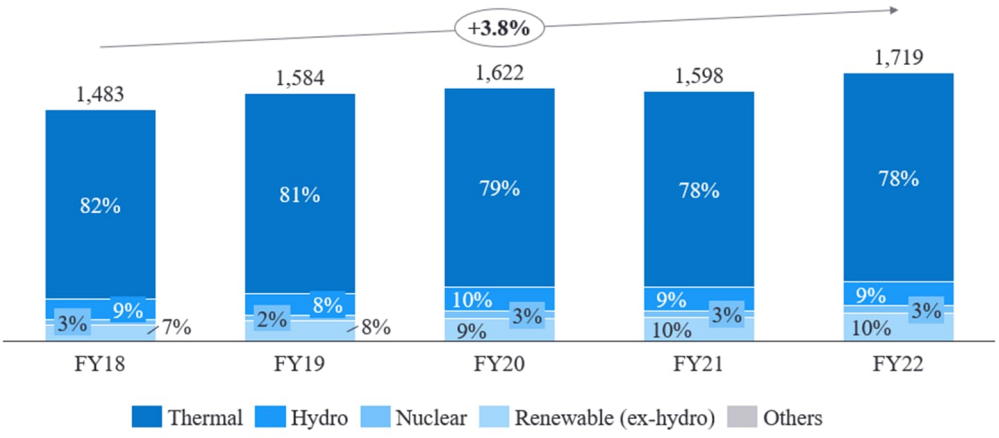
India's power generation review and outlook

Power generation in India

As per CEA, India's current power generation stands at about 1,719 TWh, growing at about 3.8% CAGR from FY18 to FY22. The generation growth is in line with the fast-growing demand. Ministry of power has taken significant initiatives to drive power generation in India and move India to a power surplus nation. Significant strides have been made by the government to connect the whole country onto one grid and to boost electrification in Indian households.

Majority of the generation is still driven by thermal power plants using coal as a fuel source; however, the share of thermal has been declining slowly over the years.

India's power generation (TWh) – split by fuel, (FY18-22)



Source: CEA, MOSPI Energy statistics India, dated March 2023

Coal-fired power generation has been on a decline in terms of share within the overall mix. The share of thermal in India's power mix has reduced from 82% in FY18 to about 78% in FY22(P) as per CEA. Power generation from renewable energy sources has increased to 306 TWh during FY21 registering a CAGR of 6.8%. Share of generation from renewable sources (including hydro) in total generation has increased to about 20% during FY21.

Share of generation from non-fossil fuel (renewable energy and nuclear) in total power generation has increased to 22% in FY21, with nuclear power accounting for just about 3%.

As per ministry of power, India presently has about 40 GW capacity under construction for thermal and hydro-based power plants out of which 28 GW is for thermal, and 12 GW is for Hydro based power plants. The total renewable installed capacity is now over 152 GW and further India has about 78 GW of renewable capacity currently under installation process.

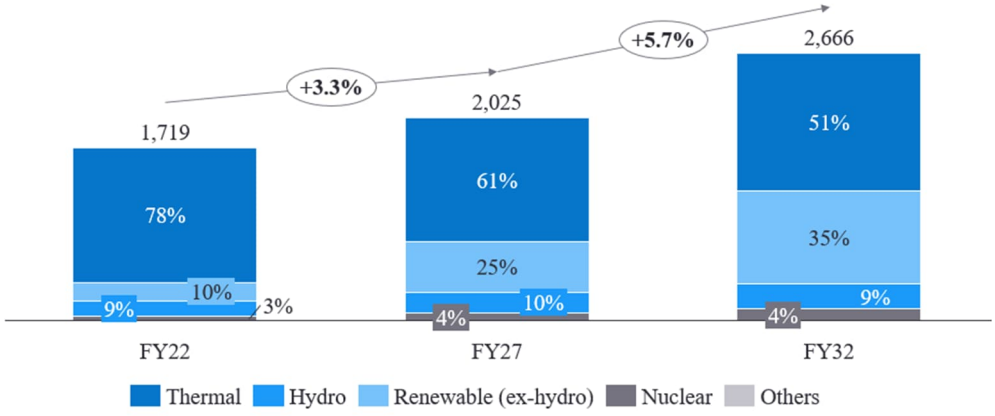
India's power generation outlook

The generation capacity has been dominated by usage of fossil fuels, although there is a constant awareness & push towards renewable sources. And, despite India being a developing nation, it has made strides towards clean energy transition and net zero emission.

Post the commissioning of the ongoing coal-power based projects, it is expected that the demand for coal will slow down. As per IEA, the share of coal in overall generation of power would go down once it reaches its peak in 2040.

According to IEA, the share of coal in India's energy mix would decline from 44% in 2019 to 34% in 2040, despite this coal-fired power will form most of the power generation (75% in FY22 as per CEA) in the country. In absolute terms, given that the entire rising demand of power cannot be met by renewable sources, coal-based power generation would slightly pick up. Although according to CEA, the share of thermal power plants would become 50% by FY32.

India's power generation outlook (TWh) – split by fuel, (FY22-32)



Source: CEA, National electricity plan, dated March 2023

Aiming to transition to renewable sources for power generation, India faces two key challenges:

1. Maintaining the affordability of renewable energy along with the financial stability for the distribution company, considering the cost of battery storage systems.
2. Timely infrastructure required for evacuation of renewable power.

The country is planning to expand its renewables-based power generation capacity from 152 GW (as of Jan 2023) to 450 GW in the next 10 years. The states within India which have a greater share of renewable energy have been facing challenges from Variable Renewable Energy (VRE), these states have expressed concerns over the capacity expansion leading to the same. This issue can be curbed by

either cutting down the established thermal power plants or by supplying the excess capacity to states with lesser capacity.

The battery energy storage system (BESS) that stores renewable energy for future usage poses some challenges. These have performance issues along with high upfront, maintenance & monitoring costs. This makes it challenging to shift to renewables sources of energy.

India's power generation captive capacity

The industries that have captive capacity keep it for times when there are power failures & emergency situations to ensure a steady power supply. These industries usually are electricity intensive like manufacturing plants for chemical and fertilizers, steel, and iron plants as well as sugar mills.

The share of companies that have captive power generation is 15% of total (in FY21), this is higher when compared to global numbers of 7%. These companies (with capacity above & equal to 1 MW) have 78.5 GW of capacity & have a prominent place in the overall power generation industry in India. There are two reasons of companies having captive capacities:

1. It provides an alternative source against unreliable supply from the grid, and
2. Consumers (especially large industrial plants) benefit at times from cheaper power than that supplied by the grid.

There is a higher growth rate witnessed in captive capacity (~11%) vs the growth of overall capacity increase in FY21 vs FY20 of 3.2%. According to CEA, the total installed capacity in India including captive power plant (with industries having capacity of more than 1 MW) increased to 461 GW by FY21 as compared to 446 GW in FY20.

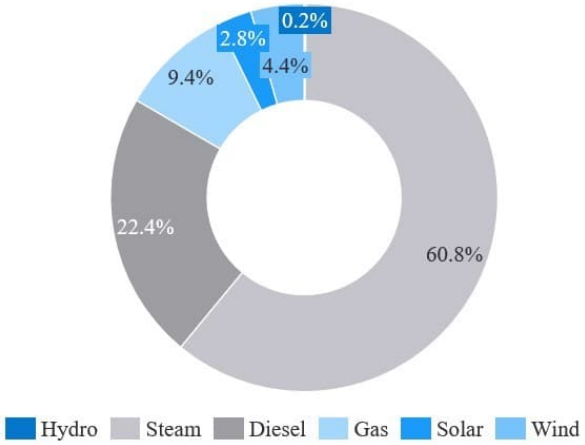
Power generation captive capacity - India (GW), (FY17-21)

Source: CEA, General review, dated May 2022

The power generation by the captive plants witnessed a decline in FY21 vs FY20 reaching from 239 MW to 224 MW. Basis the analysis of CEA, 8,556 captive power generation units were identified & analyzed with capacity greater than 1 MW.

Currently, more than 50% of India's 78.5 GW of installed captive capacity (for units with capacity above & equal to 1 MW) is coal-fired, followed by diesel generators with about 22% share. The share of gas in captive power is ~10%, whereas almost 25% of total gas-fired generation in FY21 was from captive power units. Fertilizer plants and petrochemical were the main users of coal-based power. Share of renewables in captive capacity is only 8%.

Power generation captive capacity – Split by fuel (FY21)



Source: CEA, General review, dated May 2022

ASSESSMENT OF GAS ENERGY INDUSTRY

Overview of global gas energy industry

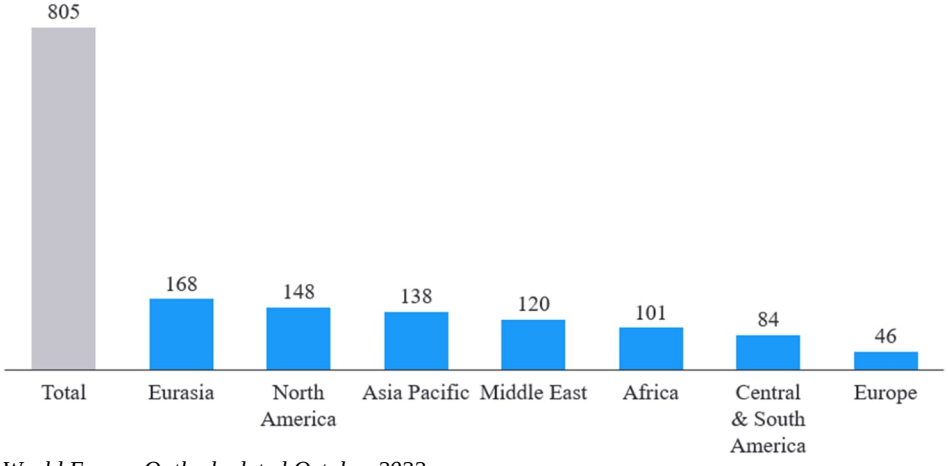
Globally, the demand for gas was higher when compared to other fossil fuels during the pandemic. During the year 2021, it went up to 5% that is double the growth rate over the last 10 years. The invasion of Ukraine by Russia pushed the gas supply market with issues like lack of newer projects and increasing demand due to the weather conditions. European nations demand of LNG pushed up the spot prices of LNG. This led to shift of balance in imports, with countries like India & China reducing their LNG imports.

This situation has led the world into re-thinking the global gas supply & led to shift of long-lasting contracts between supplying & importing nations. While the demand-supply dynamics are shifting, natural gas is emerging to be a fuel of importance given that it emits lesser carbon & the flexibility of power generation in tandem with the renewable sources such as hydrogen.

Gas reserves

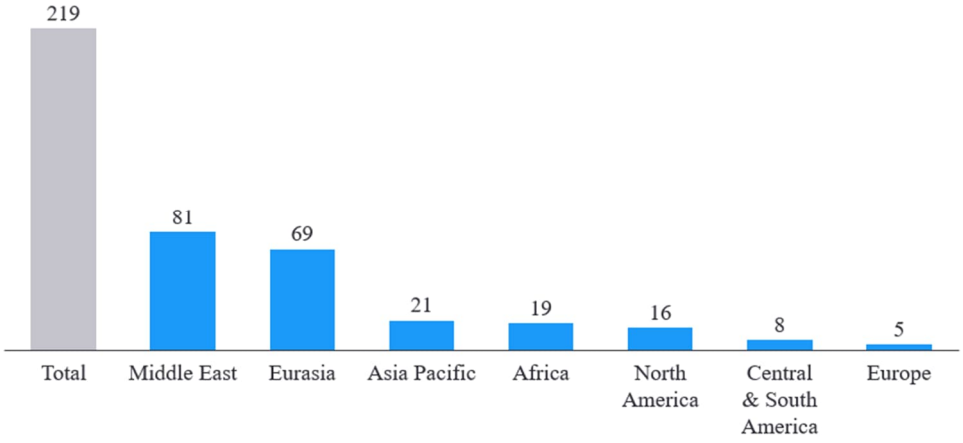
According to International Energy Agency, there is an estimated total gas reserves of 805 trillion cubic meters globally with proven resources of 219 trillion cubic meters. Middle East, Eurasia, Asia Pacific, and Africa region account for more than 85% of the proved natural gas resources globally.

Global total natural gas reserves (2021), trillion cubic meters



Source: IEA World Energy Outlook, dated October 2022

Global proved natural gas reserves (2021), trillion cubic meters



Source: IEA World Energy Outlook, dated October 2022

The world's natural gas reserves are spread across the globe, but not evenly, Middle East has the world's most proven natural gas reserves.

Global gas production

The global gas production in 2021 was 4,149 bcm, up by 5% vs the 2017 production, mainly led by Middle East & Eurasia. Based on the STEPS scenario of IEA, the production of natural gas will become 4,372 bcm by 2030, a growth of 5% vs 2021 production figures.

Production of natural gas by continent 2017-30, bcm

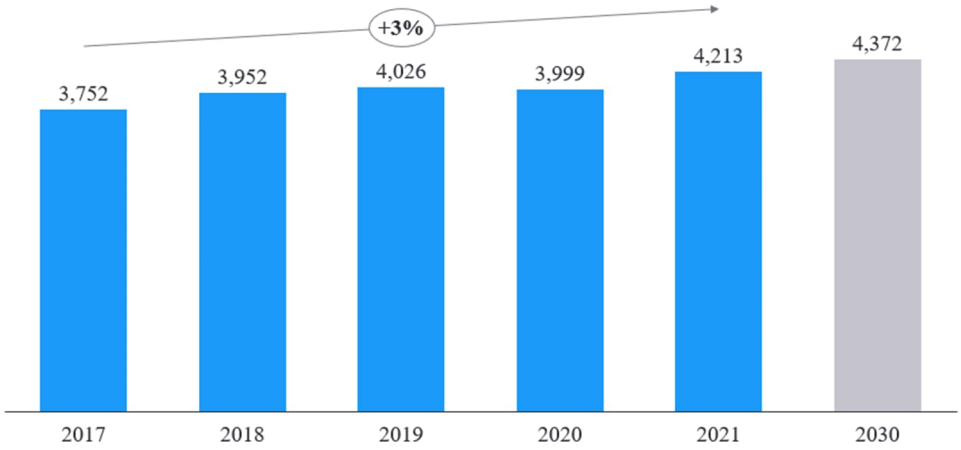
Continents	Natural gas production (in bcm)					
	2017	2018	2019	2020	2021	2030
Asia Pacific	775	598	636	643	648	648
Africa	145	240	250	244	265	265
Central & South America	174	177	174	151	151	151
Eurasia	575	918	959	926	998	998
Europe	613	277	260	241	239	239
Middle East	501	645	653	645	660	660
North America	969	1,083	1,159	1,165	1,189	1,283
World	3,274	3,938	4,091	4,015	4,149	4,372

Source: IEA World Energy Outlook dated October 2022
Note: Estimated production of Natural gas for 2030 is basis Stated Policies Scenario of IEA

Global gas demand

Global gas demand in 2021 was 4,213 billion cubic meters growing at a rate of 3% vs 2017. By 2030 based on the STEPS scenario of IEA, the demand is expected to reach 4,372 billion cubic meters.

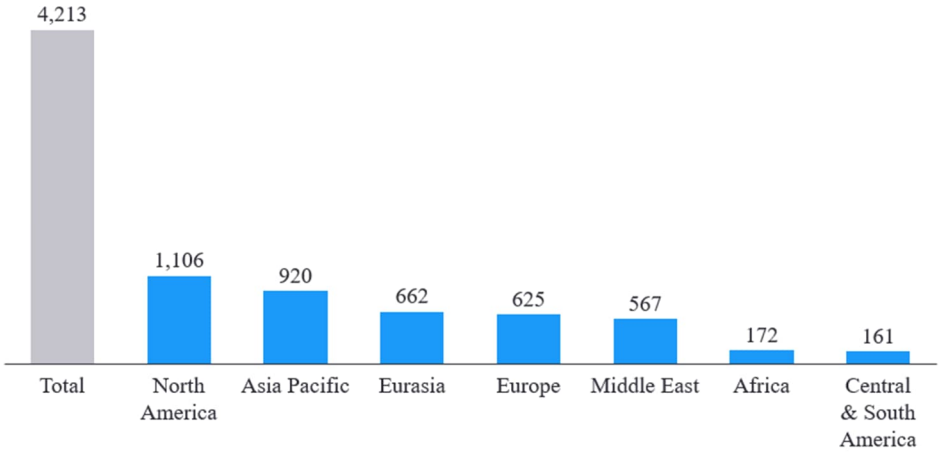
Global total natural gas demand 2017-30, billion cubic meters



Source: IEA World Energy Outlook dated, October 2022

The demand split for 2021 reveals that more than 50% of the demand comes from America & Asia Pacific combined. Apart from these Europe, Eurasia & Middle East also contribute to the demand of gas.

Split of global total natural gas demand (2021), billion cubic meters

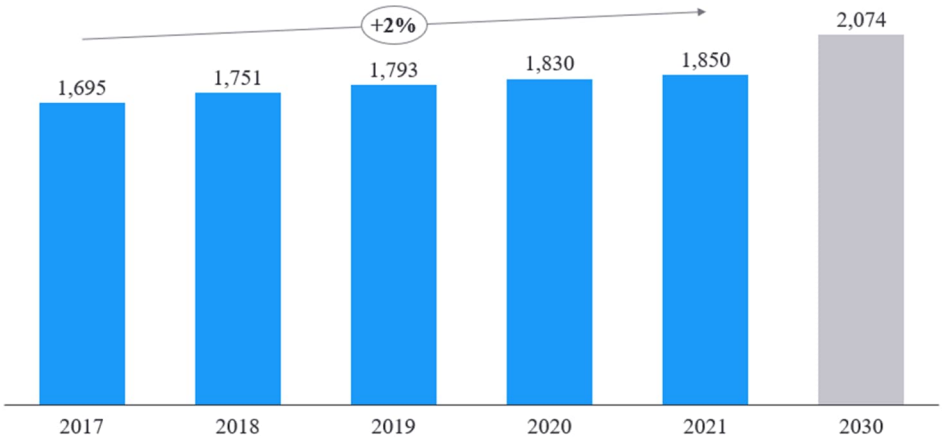


Source: IEA World Energy Outlook, dated October 2022

Global gas power plant capacity & expected capacity additions

Global gas production capacity in 2021 was 1,830 GW growing at a rate of 2% vs 2017. By 2030 based on the STEPS scenario of IEA, the capacity is expected to reach 2,074 GW.

Global gas power generation capacity 2017-30, GW



Source: IEA World Energy Outlook, dated October 2022
Note: Estimated capacity of Natural gas for 2030 is basis Stated Policies Scenario of IEA

IEA predicts that by 2030, the demand of gas will increase by 2% over 2020, majority of this demand would be driven by the rising requirement of electricity in emerging economies. Further the relevance of gas power stations in advanced economies is already going up given lower cost factor & lower carbon emissions.

Key global trends in gas power

1. ***Natural Gas as a bridging fuel***: Natural gas is referred as a transitional or bridging fuel to reduce carbon-di-oxide emissions. Being a fossil fuel, it produces lesser emissions when compared to oil or coal. This has led to the belief that it can be used as a replacement fuel to the other fossil fuels & nations can continue using fossil fuels for long.
2. ***Usage of advanced technologies****:* The utilization of natural gas can contribute to CO_2 emission reduction by substituting more carbon-intensive fuels in power generation and industrial processes. Gas powered power stations offer a method for more cleaner, efficient & flexible way to generate power and can also be combined with renewable fuels such as Hydrogen. Multiple studies have also pointed out to the fact that natural gas like all fossil fuels emits greenhouse gases & can still harm the environment, but it can serve as a transition bridge to move towards other renewable fuels. While the world stands divided on the issue with one group wanting a direct transition to cleaner fuels, other group seeks to use advanced technologies like carbon capture & hydrogen to further mitigate the emissions from natural gas.
3. ***Realignment of Supply Contracts***: The supply chain disruptions made European Union enter discussions with Qatar for long term supply contracts, with Germany entering a 15-year long contract with QE (Qatar Energy) to supply LNG, 2 Mn Tons of LNG annually starting from 2026. It is noteworthy that Germany is EU's largest gas market. This deal comes post Qatar Energy signed five deals for the North Field Expansion project that aims at expanding Qatar's liquefication capacity from 77 Mn Tons to 126 Mn Tons.

Overview of India's gas energy industry

India's power needs are ever increasing as more development activities are being undertaken. Within the energy landscape of the country, its gas power capacity is crucial, it includes both natural gas and LNG based power plants. These plants utilize natural gas as a primary fuel, and they have various environment benefits over coal & oil such as lower emissions & higher efficiency. These gas-based power plants fit well in the country with peak load demands & the renewable mix for fulfilling the power demands.

India's gas reserves

India has very small reserves of gas and there has not been any large find in the last 5 years which can segment local supply of gas.

Gas Reserves in India (2017-22)

Gas Reserve	Gas reserves in India (in billion cubic meters)				
	2017-18	2018-19	2019-20	2020-21	2021-22
	1,340	1,380	1,371	1,373	1,139

Source: Indian Petroleum & Natural Gas Statistics 2021-2022 dated October 2022

India's gas production

Gross production for natural gas was 34.02 bcm in 2022, an increase from 2021 with 28.67 bcm production. Though currently the share of gas-based power plants is low, and the import dependency continues to remain high.

Natural gas production in India (2017-22)

Details	Natural gas in India (in million cubic meters)				
Year	2017-18	2018-19	2019-20	2020-21	2021-22
Gross Production	32,649	32,875	31,184	28,672	34,024
Net Production (exc. Flare gas & loss)	31,731	32,058	30,257	27,784	33,131
LNG Import	26,328	28,740	33,887	33,198	31,028
Total Consumption (inc. internal cons.)	58,059	60,798	64,143	60,982	64,159
Total Consumption (in billion cubic meters)	58.1	60.8	64.1	61	64.2
Import Dependency based on consumption	45.3%	47.3%	52.8%	54.4%	48.4%

Source: Indian Petroleum & Natural Gas Statistics 2021-2022 dated October 2022

LNG terminals and plans for gas production

LNG is crucial to India's energy mix with the ever-increasing demand of the country & need to reduce carbon emissions. Plan of developing LNG terminals in India along with formulation of plans for gas production has been in the forefront with increased need to diversify energy sources & promotion of sustainability.

India has made considerable progress in establishing LNG terminals along its coastline, facilitating the import and distribution of LNG across the country. Some notable LNG terminals in India include:

LNG infrastructure operational

Location	Promoters	Capacity	Capacity utilization
Dahej	Petronet LNG Ltd	17.5 MMTPA	77.8%
Dabhol	Konkan LNG Ltd	*5 MMTPA	36.5%
Ennore	Indian Oil LNG	5 MMTPA	13%
Hazira	Shell Energy India	5.2 MMTPA	36.2%
Kochi	Petronet LNG Ltd	5 MMTPA	18.4%
Mundra	GSPC LNG Ltd	5 MMTPA	16.7%
Total capacity		42.7 MMTPA	

Source: Indian Petroleum & Natural Gas Statistics 2021-2022 dated October 2022
Note: Data for 2022-2023, Capacity as on 01.04.2023 & Capacity utilization for Apr-Feb 2023

LNG infrastructure under construction

Location	Promoters	Proposed capacity
Chhara	HPCL Shapoorji Energy	5 MMTPA
Jaigarh	H-Energy Gateway	6 MMTPA
Jafrabad	Swan Energy	5 MMTPA
Mundra	APSEZ	5 MMTPA

Total proposed capacity	21 MMTPA

Source: Global Energy Monitor accessed June 2023

To bolster the natural gas production, Hydrocarbon Vision has laid out great emphasis on building infrastructure to facilitate the distribution of natural gas, either via building gas pipeline infrastructure or LNG terminals. Currently, India has 14,449 km of gas pipeline infrastructure operational with capacity of 332 MMSCMD, that is further going to expand by 12,002 kms.

India's gas power generation capacity

In recent years, India has witnessed a surge in gas power capacity additions with existing gas-based power plants being modernized and new projects being initiated to enhance the country's energy infrastructure. Notable projects include the expansion of existing LNG terminals, the establishment of new regasification facilities, and the introduction of advanced gas turbine technology for improved efficiency.

Current gas-based power plants capacity in MW

Region	Sector	Capacity in MW
All India	State	7,087
	Private	10,574
	Central	7,237
	Sub Total	24,899

Source: CEA Installed Capacity Report
Note: Data as of 30.04.2022

ASSESSMENT OF NUCLEAR ENERGY INDUSTRY

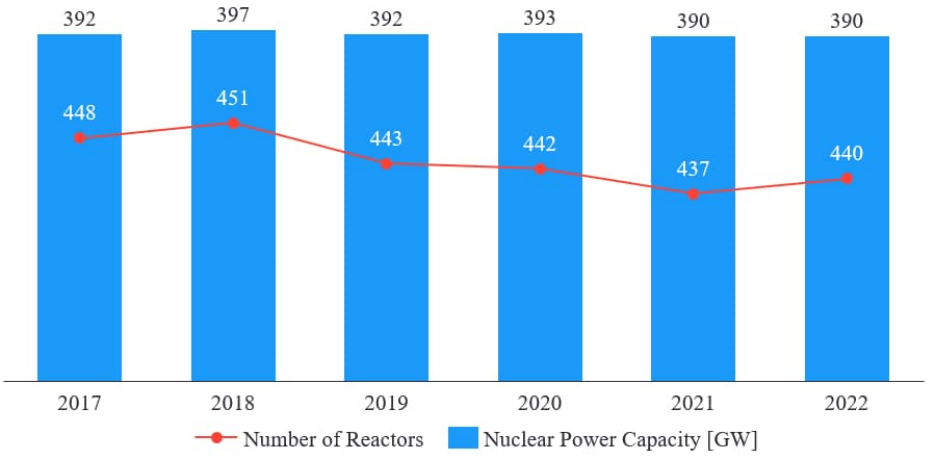
Global nuclear power generation capacity and expected additions

Nuclear power generation capacity

In 2022, the global nuclear power generation capacity was 390 GW. For the last 5-6 years, capacity has stayed nearly flat. This is mostly owing to the higher capital expenditure necessary to construct them, as well as the significant costs associated with the storage and disposal of hazardous radioactive waste.

The number of reactors has likewise been decreasing, from 448 in 2017 to 440 in 2022. Because of increased competition from more cost-effective renewable energy sources, the future of nuclear power with the currently used large reactors is in doubt though it is a cleaner form of generation when compared to fossil fuels.

Nuclear power generation capacity (GW) and Number of nuclear reactors (2017-22)

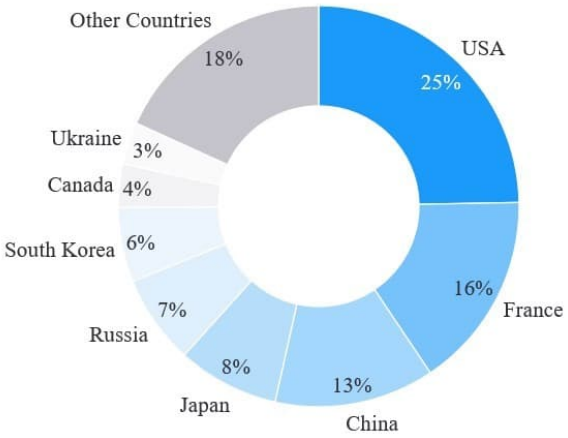


Source – IAEA reports

Global nuclear power generation capacity by country

The United States has the highest installed capacity that amounts to 25% of the global nuclear capacity, followed by France and China at 16% and 13% respectively.

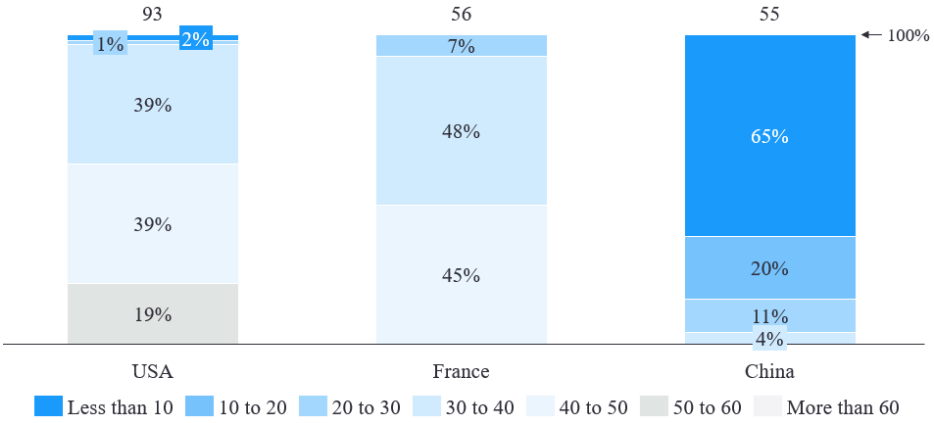
Nuclear power generation capacity by country (%)



Source – IAEA Report, 2022 Edition

Among the top three countries by nuclear power generation capacity, China has the largest number of young power plants that are currently operating. Nearly 2/3rd of its total operational reactors were connected to the grid less than 10 years ago. Meanwhile, in both US and France, majority of the operational reactors are nearing end of their useful life.

Age distribution of operable reactors (years)

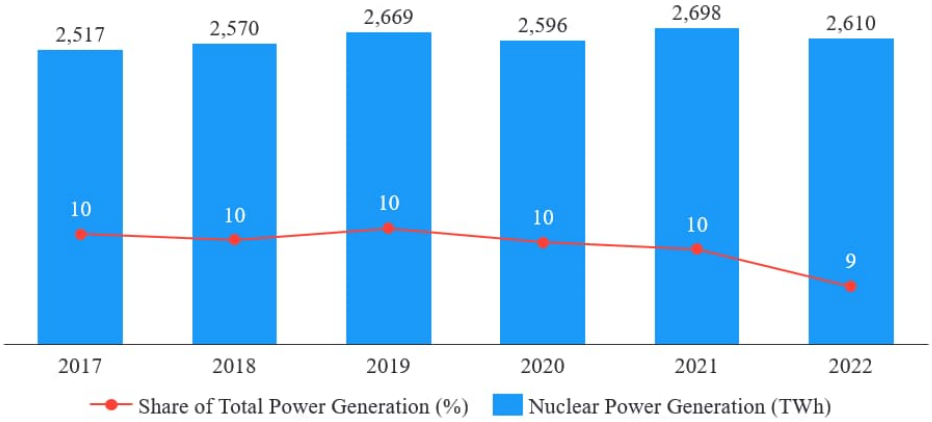


Source – PRIS – IAEA accessed July 2023

Power generation from nuclear plants globally

Despite a steady increase in nuclear power generation over the past decade, its proportion in the global energy mix has experienced a gradual decline. In 2022, nuclear power supplied 2,610TWh, accounting for 9% of the total power generation. Meanwhile, non-hydroelectric renewable sources, such as solar, wind, and biofuel, have witnessed substantial growth, with their share doubling in recent years.

Nuclear power generation (TWh) and its share in overall power generation (%) (2017-22)

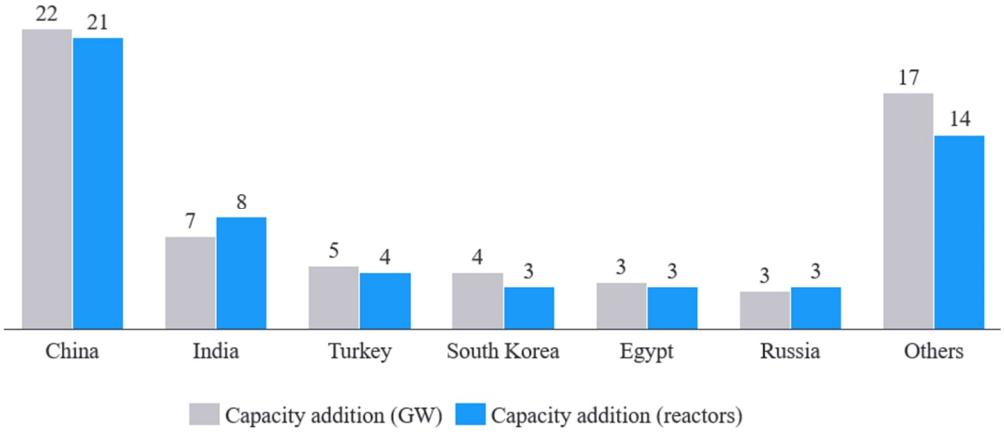


Source – EIA accessed July 2023

Reactors under construction

Across sixteen countries, there is an expected total capacity addition of 59 GW, facilitated by the installation of fifty-seven new reactors. Leading the way is China, with an approximate addition of 22 GW, while India and Turkey closely trail behind, targeting new reactor capacities of 6.6 GW and 4.5 GW, respectively.

Capacity addition currently under development by countries (GW)



Source – IAEA accessed July 2023

Approximately one hundred nuclear plants are currently in the planning stages across fifteen countries, set to provide a total capacity of 102 GW. Notably, China accounts for 45% of this overall addition, planning to increase its capacity by 49 GW. Following closely, Russia and India have 25 and 12 reactors, respectively, in the pipeline.

Capacity planned by countries

Country	No. of reactors	Capacity (MW)
China	45	49,810
Russia	25	23,525
India	12	8,400
USA	3	2,550
Hungary	2	2,400
Romania	2	1,440
United Kingdom	2	3,340

Uzbekistan	2	2,400
Others	7	8,162
World	100	1,02,027

Source – world-nuclear.org accessed July 2023
Note- Others include – Argentina, Bulgaria, Czech, Egypt, Iran, Japan and Pakistan, each planning 1 reactor.

Decommissioning of reactors in France

France has a nuclear fleet of fifty-six reactors with an installed capacity of 61 GW. All its nuclear reactors are managed and operated by Électricité de France (EDF). There are fourteen reactors which have been permanently shut down (oldest one being in 1970s) in France. EDF takes the full responsibility for the decommissioning phases for these reactors.

Decommissioning occurs in three stages:

- Phase 1 involves shutting down the power plant, unloading fuel, and emptying circuits.
- In Phase 2, there includes take down of the equipment and buildings, except for the reactor building. Additionally, monitoring procedures are introduced.
- Phase 3 includes complete shutdown, where the reactor building, along with any remaining radioactive materials and equipment, is disassembled.

The first two phases take 10 years after the power generation stops and the third takes another 10 years. Of the fourteen reactors, only one has been fully dismantled. For some of them, the process has been delayed due to non-availability of sites to dispose the intermediate waste.

Meanwhile, most of EDF's fleet in UK has already crossed the original end of generation date and extension was sought for each of them. By 2028, 7 out of eight reactors operated by EDF would be decommissioned after the extension period ends.

India's nuclear power generation capacity and expected additions

Currently, India operates twenty-two nuclear reactors with a combined capacity of 6.8 GW, translating to roughly 2% of the global capacity.

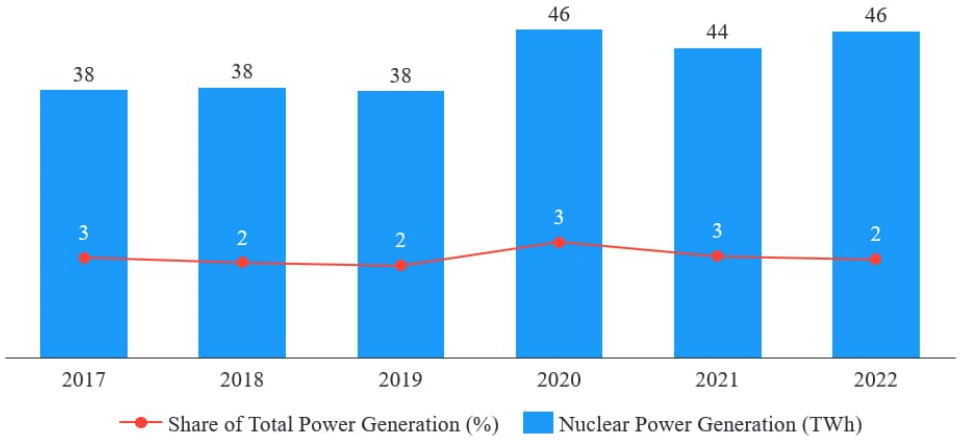
Operational nuclear power plants in India

Plant name	Number of reactors	Gross power (MW)	Type
Kaiga Power Plant, Karnataka	4	220MW x 4	PHWR
Kakrapar Power Plant, Gujarat	2	220MW x 2	PHWR
Kudankulam Power Plant, TN	2	1000MW x 2	PWR
Madras Atomic Power Plant, TN	2	220MW x 2	PHWR
Narora Atomic Power Plant, UP	2	220MW x 2	PHWR
Rajasthan Atomic Power Plant, RJ	6	1,180MW	PHWR
Tarapur Atomic Power Plant, MH	4	1,400MW	PHWR & BWR

Source – Atomic Energy Regulatory Board India

There has been a YoY increase in the amount of power generated which stood at 46 TWh in 2022. The share of total power generated hasn't changed much which hovers around 2.5%. Dependency on fossil fuel has remained mostly same contributing majority of the overall power generation in the country. However, energy from renewable sources like solar and wind has increased in the last couple of years.

Nuclear power generation (TWh) and its share in overall power generation (%) (2017-22)



Source- EIA accessed July 2023

Eight reactors with an installed capacity of 6,600 MW are currently under development. Five of these reactors are located in Tamil Nadu alone.

Reactors under construction

State	Reactor name	Capacity (MW)	Start of construction
Tamil Nadu	PFBR	500	Oct, 2004
Gujarat	Kakrapar 4	700	Nov, 2010
Rajasthan	Rajasthan 7	700	July, 2011
Rajasthan	Rajasthan 8	700	Sept, 2011
Tamil Nadu	Kundakulam 3	1000	June, 2017
Tamil Nadu	Kundakulam 4	1000	Oct, 2017
Tamil Nadu	Kundakulam 5	1000	June, 2021
Tamil Nadu	Kundakulam 6	1000	Dec, 2021
		6,600	

Source- world-nuclear.org accessed July 2023

Reactors planned in India by type

Reactors planned

State	Reactor name	Capacity (MW) each	Construction planned
Haryana	Gorakhpur 1 & 2	700	2023
Haryana	Gorakhpur 3 & 4	700	By 2031
Madhya Pradesh	Chutka 1 & 2	700	
Rajasthan	Mahi Banswara 1 &2	700	
Rajasthan	Mahi Banswara 3 & 4	700	
Karnataka	Kaiga 5 & 6	700	

Source- world-nuclear.org accessed July 2023

Nuclear reactor technology and advancements

Nuclear reactor technology can be classified into two main categories: large reactors and small modular reactors (SMRs). Large reactors are currently available for commercial use, while SMRs are largely still in the development phase.

1. Large reactors have evolved over time, with standard designs ranging from approximately 700 MW to 1,800 MW. These reactors have proven technologies and achieve capacity factors exceeding ninety percent with a lifespan of at least 60 years.
2. SMRs, with modern designs producing up to 300MW of electrical output. They differ from

earlier small nuclear reactors due to innovative safety features and advanced production techniques (e.g., enhanced factory construction and standardization). They are intended for markets where large reactors may be unsuitable. More than 70 SMR designs are currently under development, each at various stages of technology readiness.

SMRs have received widespread attention due to their ability to provide varied power generation, serving as both flexible power sources and base-load solutions for a variety of applications. Furthermore, they offer the possibility for reusing ageing or defunct fossil-fuel-based power facilities. Because of their intrinsic and passive safety features, their improved safety performance is a significant advantage.

Furthermore, because SMRs are well-suited for cogeneration and non-electric applications, they can be used in distant places with inadequate infrastructure. They also offer the possibility of developing synergetic hybrid energy systems that integrate nuclear power with alternative energy sources such as renewables. This capability opens up new avenues for more resilient and sustainable energy solutions.

SMR development by countries

Reactor type	Canada	China	Japan	S Korea	Russia	UK	USA	Other	Total
Land-based water-cooled SMRs	1	5	1	2	5	1	6	4	25
Marine based water cooled SMRs		2		1	5				8
High temperature gas cooled SMRs	1	2	2		3	1	4	3	16
Liquid metal-cooled fast neutron spectrum SMRs	1		1	1	2		1	2	8
Molten Salt Reactor SMRs	2	1	1			1	5	3	13
Microreactors			1		2	2	5	2	12
Total	5	10	6	4	17	5	21	14	82

Source - Advances in Small Modular Reactor Technology Developments, 2022 - IAEA

Interest in SMR has grown widely with several developed nations working on developing new designs related to SMR technology. US leads with twenty-one projects, followed by Russia and China with 17 and 10 initiatives, respectively. In the US, the Department of Energy will invest around $3 billion over 7 years, with equal funds from industry partners to develop SMRs.

In 2021, China successfully connected a demonstration plant with two high temperature gas cooled reactors connected to the grid. Each reactor powered a 210 MW turbine, using helium gas as the primary coolant, and reaching high temperatures. Additionally, China has announced several other projects in this field.

Russia achieved a significant milestone in May 2020 when the world's first floating nuclear power plant became operational comprising two 35 MW SMRs. Furthermore, Russia's first onshore SMR power plant is currently being planned which will be equipped with a 55 MW capacity, likely to be completed by 2028.

SMR development in India

India is actively pursuing the development of Small Modular Reactors (SMRs) with a capacity of 300 MW as part of its clean energy transition commitment. India is already working with the US to set up six nuclear reactors in Andhra Pradesh under the Kovvada nuclear project. Additionally, both countries are in talks to jointly develop next-generation small-modular reactor technologies for domestic and potential export purposes.

A developing nation like India which is already heavily dependent on fossil fuel-based power generation, this technology will help the country to accelerate its progress towards the net zero target. Their modular design also allows meeting power demands in remote areas of the country.

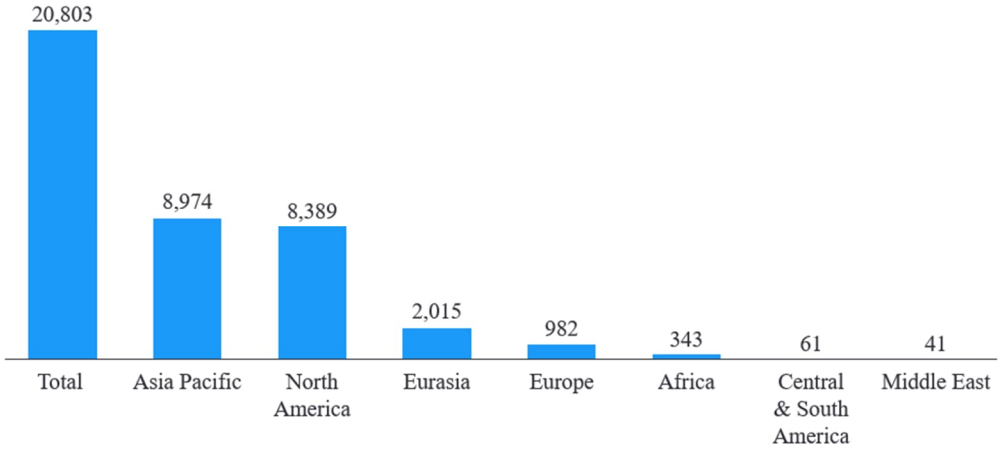
ASSESSMENT OF COAL ENERGY INDUSTRY

Overview of global coal energy industry

Global coal reserves

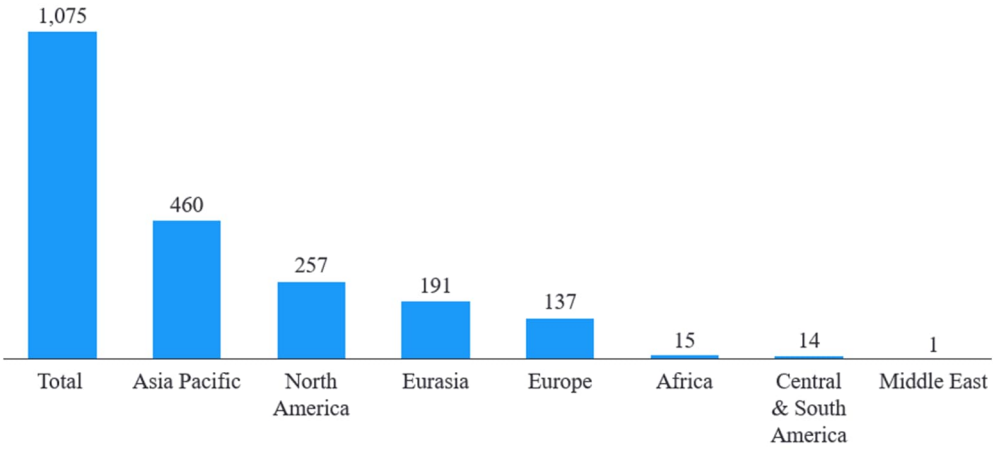
According to International Energy Agency (IEA), there is an estimated total coal reserves of 20,804 billion tons globally with proven resources of 1,075 billion tons. Asia Pacific, North America, and Eurasia region account for more than 80% of the proved coal resources globally.

Global total coal reserves (2021), Bn tons



Source: IEA World energy outlook, dated October 2022
Note: Eurasia region includes Russia, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan

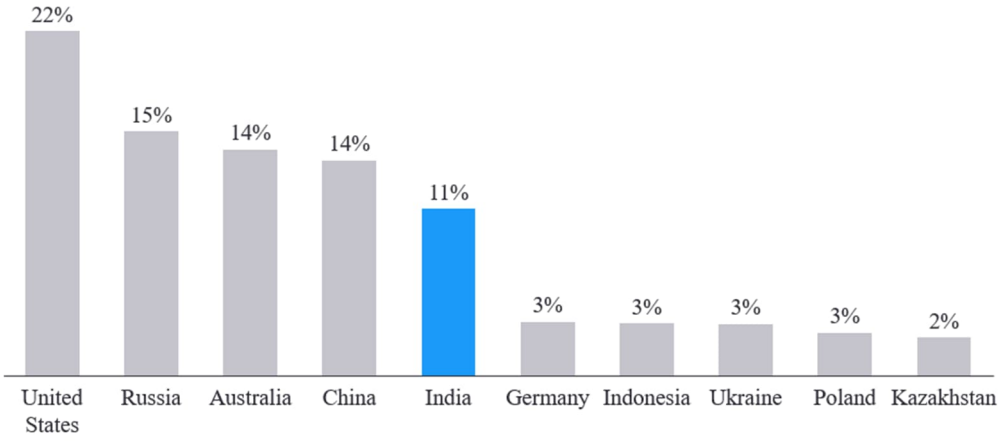
Global proven coal reserves (2021), Bn tons



Source: IEA World energy outlook, dated October 2022
Note: Eurasia region includes Russia, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan.

Five countries namely United States, Russia, Australia, China, and India account for roughly 75% of the total coal reserves in 2021.

Coal reserves by country (2021), %



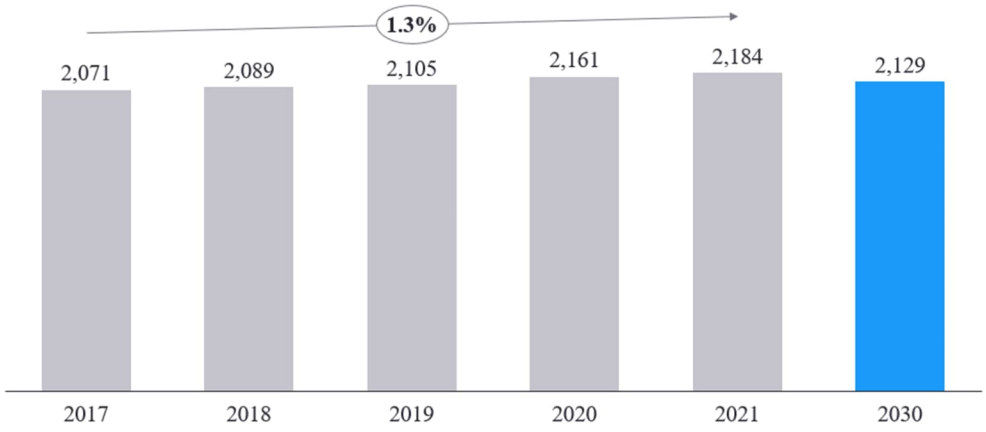
Source: US Energy Information Administration (EIA) accessed July 2023

Global coal power generation capacity and expected additions

Global coal power generation capacity

The global coal-fired power capacity stands at 2,184 GW in 2021 and this capacity has grown by 1.3% from 2,071 GW in 2017. As per the STEPS scenario of IEA, the capacity for coal-fired power plants is expected to have a small decline and reach 2,129 GW by 2030. This change in capacity will be majorly driven by phasing out of coal power plants due to emerging laws in Europe and New Energy Policy Direction in some Asian countries.

Global coal-fired power capacity 2017-30, GW

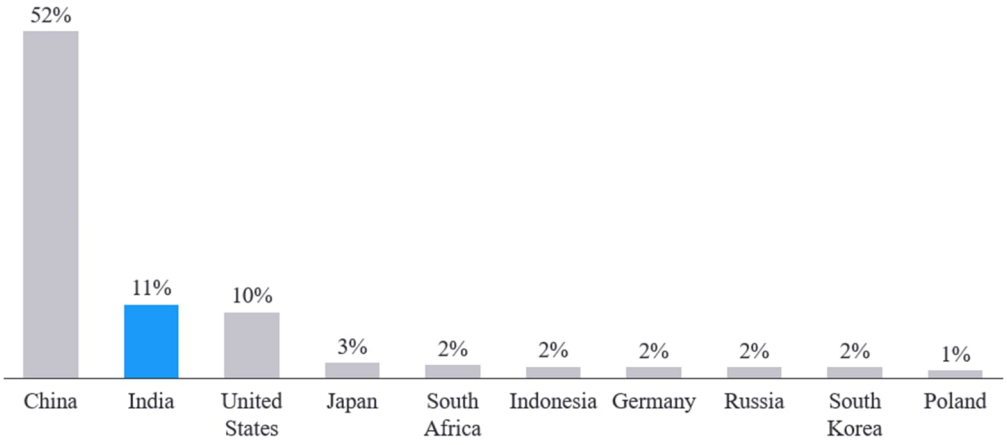


Source: IEA World Energy Outlook, dated October 2022
Note: Estimated capacity for 2030 is basis Stated Policies Scenario of IEA

Global coal power generation capacity by country

Top three countries namely, China, India, and United States account for more than 70% of the coal power generation capacity globally.

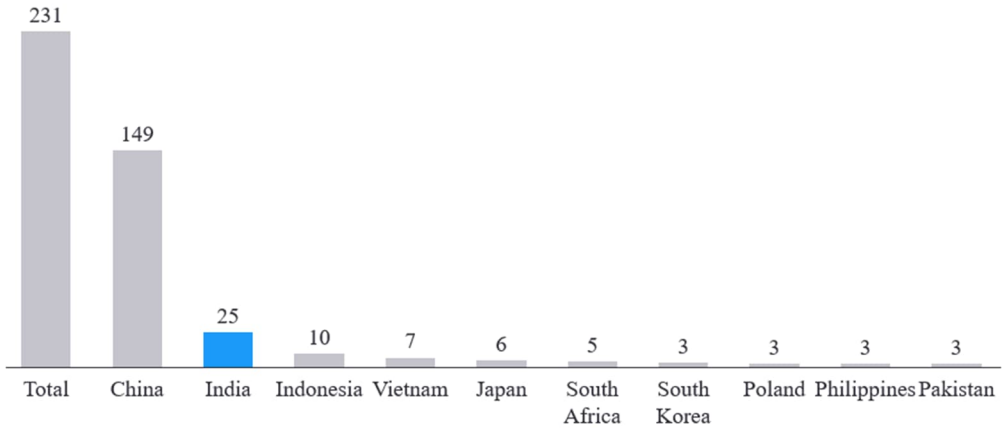
Global coal-fired power capacity by country, %



Source: Global energy monitor, dated January 2023
Note: Share of country includes both operating and mothballed capacity

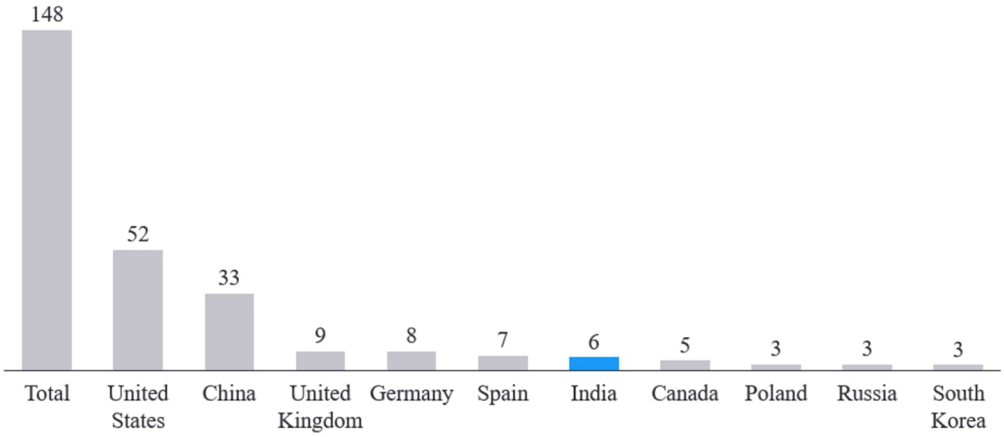
Looking at the capacity additions for coal-fired power generation, China and India contribute to roughly 75% of the capacity additions between 2018 – 21. For the retired coal-fired power generation capacity, top ten countries (including United States, China, United Kingdom, Germany etc.) account for more than 85% between 2018 – 21.

Global additions in coal-fired power capacity for top ten countries, GW (2018-21)



Source: Global Energy Monitor, dated January 2023

Global retired coal-fired power capacity for top ten countries, GW (2018-21)

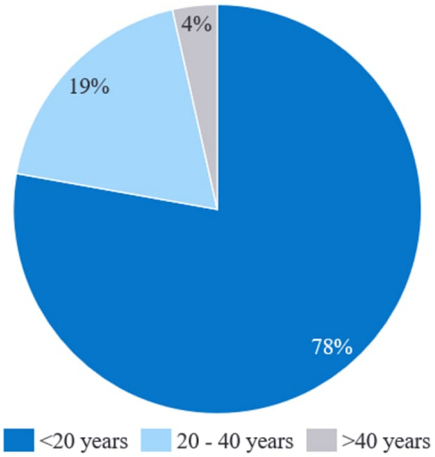


Source: Global Energy Monitor, dated January 2023

Age of coal power generation capacity in India

Similar to China, over 75% of the coal power generation capacity in India is within 20 years age group with roughly 20% of the capacity between 20 to 40 years age group.

Coal power generation capacity in India, by age (as of Jan 2023)

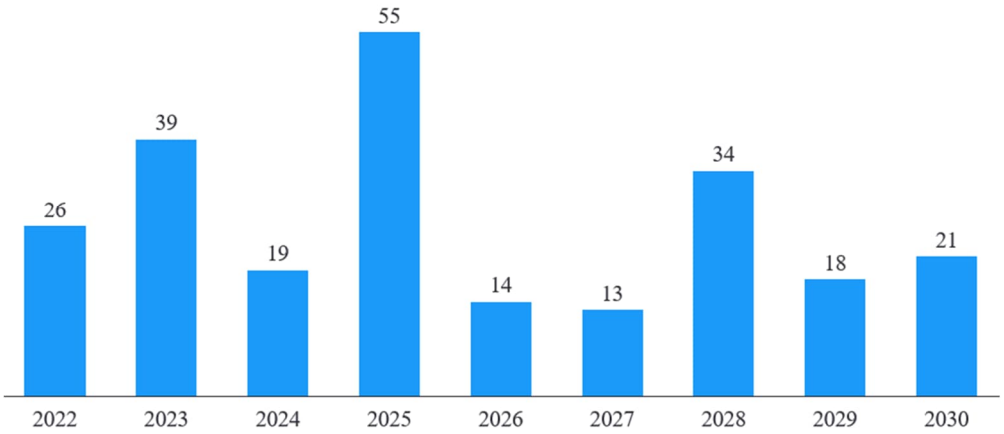


Source: Global energy monitor, dated January 2023

Expected additions in coal power generation capacity

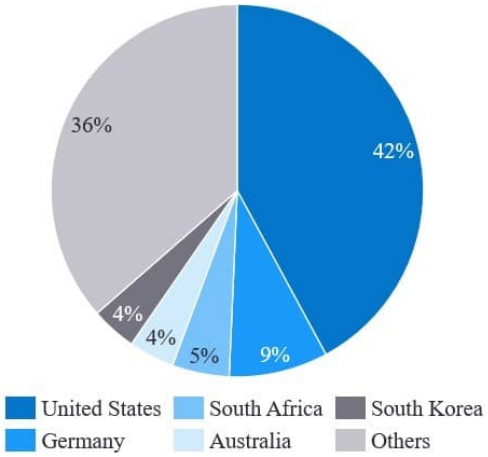
Total retirement for coal power generation capacity between 2021 – 30 are projected to be 241 GW globally, with United States, Germany, and South Africa accounting for more than 55% of the planned retirements for coal power generation capacity between 2021 – 30.

Retirements for coal power generation capacity, 2022 – 30 (GW)



Source: Global energy monitor, dated January 2023

Country-wise total retirements for coal power generation capacity, 2022 – 30 (%)



Source: Global energy monitor, dated January 2023

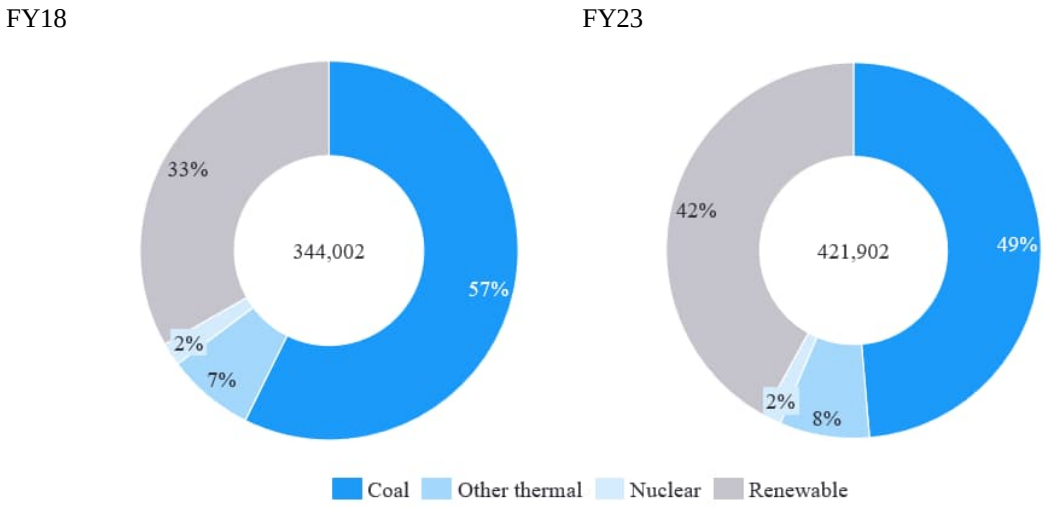
Based on the planned retirements for coal power generation capacity and overall projected capacity, there is an expected capacity addition in coal power general by roughly 185 GW between 2022 – 2030.

India's coal power generation capacity and expected additions

Coal-based power generation capacity

India's power generation is highly dependent on coal-based thermal power plants, and they account for about 49% of total installed power capacity (MW) in India. Although high, the share of coal in power generation has sharply fallen, compared to half a decade back when in FY18, it accounted for 57% of total installed capacity. The county has gradually invested in renewable sources of power generation such as wind and solar power to reduce the dependence on coal-based power generation and this is indicated by increase in share of renewable sources of power from 33% in FY18 to 42% in FY23.

Share of coal-based power plants in total installed capacity (MW) (FY18-23)



Source: CEA, MOSPI Energy statistics India - 2023

Expected capacity addition

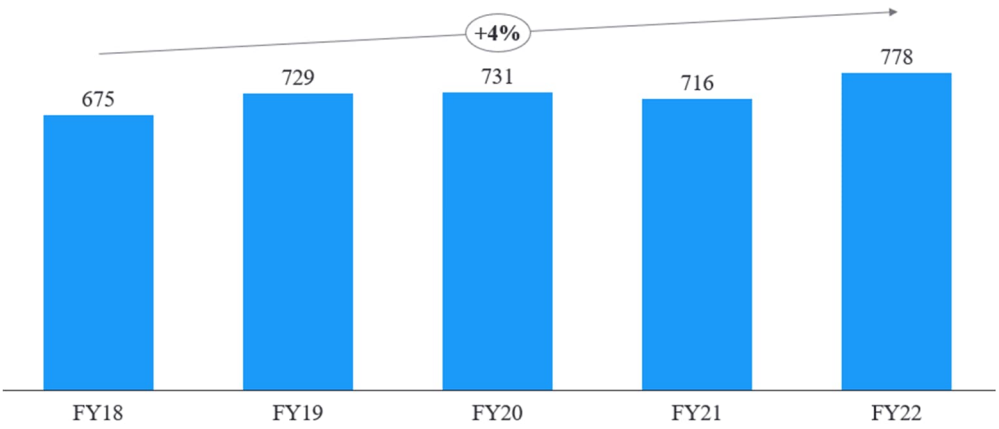
According to the National Electricity Plan by Central Electricity Authority (CEA) dated May 2023, India is expected to add thermal capacity of 25,580 MW between FY22-FY27 (~12% of current installed capacity), and it will be based on coal and lignite. Coal-based capacity of 2,121.5 MW is also considered for retirement due to aging and shortfall from regulatory requirements by 2032. By FY27, the country expects that coal-based power plants will constitute ~38% of total installed capacity.

Overview of India's coal energy industry

Coal production

According to the Ministry of Coal, coal production in India was 778 MT in 2021-22 which increased from 675 MT in 2017-18 at a growth rate of 4% during this time period. Out of this production in 2021-22, 80% of the production was done by Coal India Limited, 8% by SCCL and remaining was captive and others.

Production of coal in India (million tonnes), FY18-22



Source: Ministry of coal accessed July 2023

Future outlook for coal-based power plants

While the share of coal-based power generation has been steadily decreasing, the Indian power sector will still be dependent on coal for a significant portion of power requirement. This is due to variety of factors such as coal supply infrastructure, existence of current coal generation capacity and capabilities which drive the output of Indian economy and issues associated with alternative sources of power supply. The National Electricity Plan estimates that Coal + lignite-based power units would account for about 38% of installed capacity and a significant 59% of gross power generated in FY27.

Constraints with other sources of power

Alternative sources of power especially renewable sources, face intermittency issues due to 'temporal variability' and 'output uncertainty'. Solar and wind generation systems have high variability in output which makes them unsuitable to match varying demand patterns and decrease their reliability. Since the output is also dependent on weather conditions, these systems face scheduling challenges as real time output is likely to be different from predicted output.

The uncertainty and variability also create issues with respect to integration with mainstream grids as the shortfall due to these systems need to be met by increased generation from other sources such as thermal power plants. A large share of renewable energy sources would mean extensive operational and financial planning with respect to meeting variable demands.

There is also a demand-supply mismatch between the sources of renewable power generation units and the centers for power demand. Unlike thermal power plants, solar and wind generation units can only be set-up at specific locations with conducive geographical characteristics and it may not be feasible to set them up across the country. The potential for wind power generation is higher in the coastal states of India in the west and south and potential for solar power generation is concentrated in the western region. The power generated in these regions would require additional infrastructure investments for transmission and storage to rest of the country, hence increasing the cost of power.

Even in countries with other primary sources of power, thermal power stations still exist, to provide support during cyclical and ramping needs. Ministry of Power, along with CEA has been studying the feasibility of flexibilization of existing coal-fired power plants to achieve 40% technical minimal load which will continue to exist and support the renewable energy infrastructure and India's commitment towards green energy.

ASSESSMENT OF ENERGY TURBINE MARKET

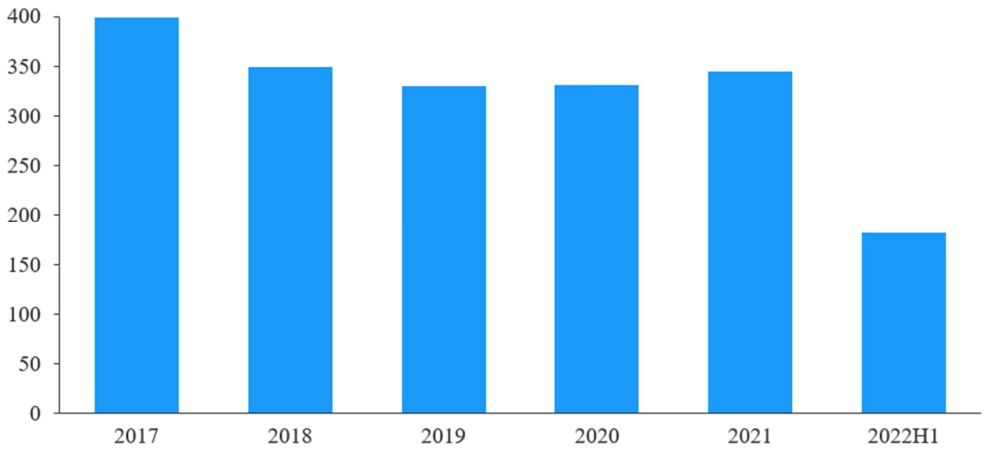
This report talks about the market for 2 types of energy turbines. These include turbines used for power generation and turbines used in industries for applications other than power generation.

Global power turbines market overview

A turbine is a mechanical device that converts kinetic energy into rotational energy by using steam, water, gas, etc.

Gas power turbines orders overview

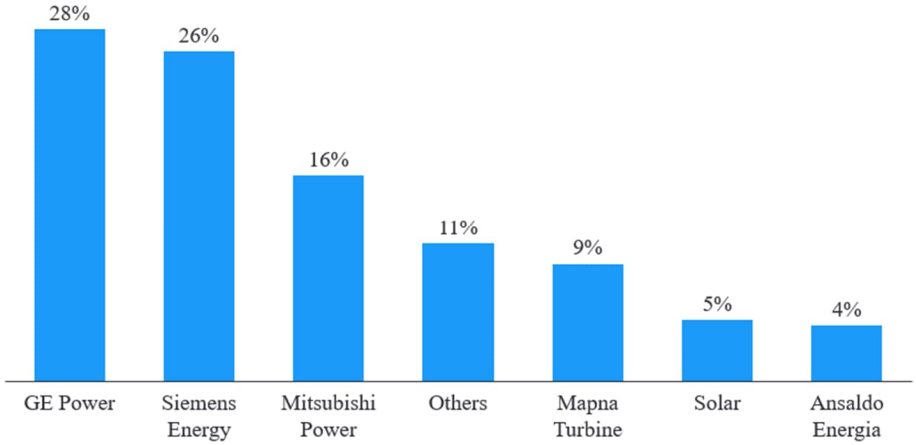
Gas power turbines ordered (2017-2022H1)



Source: McCoy Reports
Note: These orders of gas power turbines are only for simple cycle power plants

As per McCoy reports, during the 6M'22 period, the orders for gas turbines (GTs) were 183 units vs 172 units in 6M'21 for simple-cycle power plant. Additionally, there were 91 units ordered for combined cycle in 6M'22. The total number of orders in H1 2022 for gas turbines (across simple cycle & combined cycle) were 274 units. As per McCoy reports, total number of orders for gas turbines (across simple cycle and combined cycle) were 461 units in 2021. The gas turbine manufacturing market is highly concentrated with top 5 players contributing to more than 80% of the market (based on orders in 2022H1). Based on the market share as of orders in H12022, GE Power & Siemens Energy are two players with almost half of the market share.

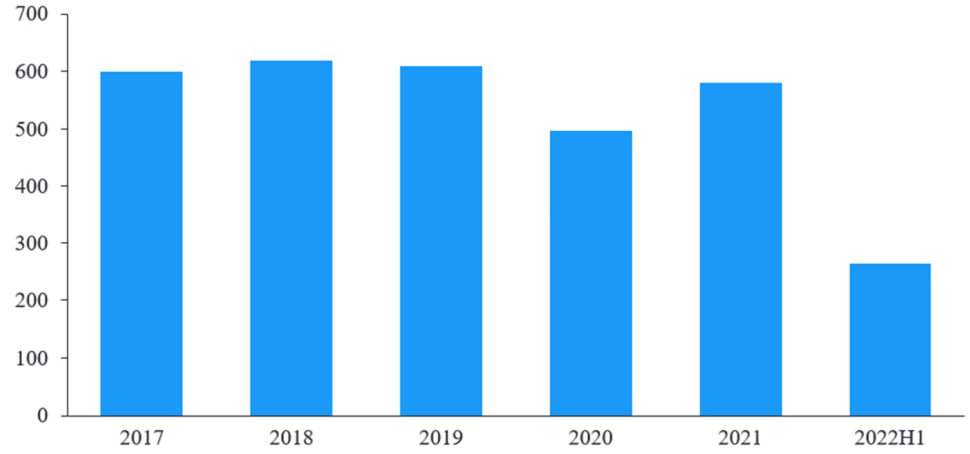
Market share for gas power turbines manufacturers based on orders in 2022H1



Source: McCoy Reports
Note: The market share is based on technological ownership & the number of units ordered in 2022H1.

Steam power turbines market overview

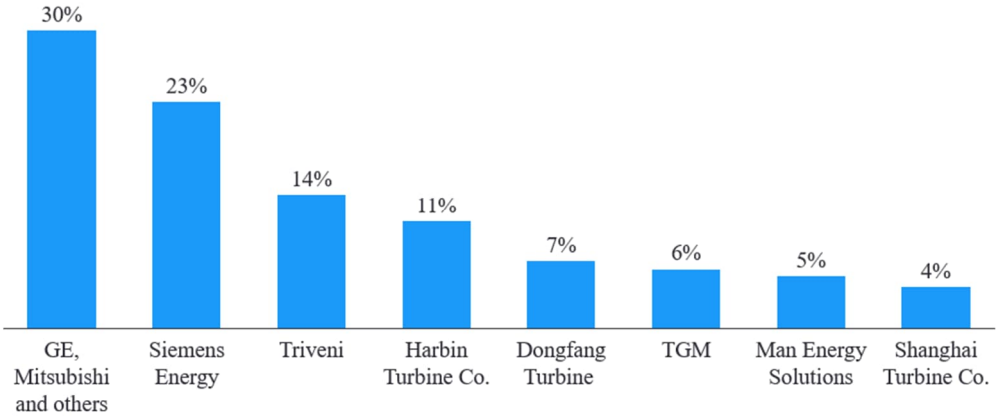
Steam power turbines ordered (2017-2022H1)



Source: McCoy Reports
Note: These orders of steam power turbines are only for simple cycle power plants

As per McCoy reports, during the 6M'22 period, the orders for steam turbines (STs) were 265 units vs 232 units in 6M'21 for simple-cycle power plant. Additionally, there were 58 units ordered for combined cycle in 6M'22. The total number of orders in H1 2022 for steam turbines (across simple cycle & combined cycle) were 323 units. As per McCoy reports, total number of orders for steam turbines (across simple cycle and combined cycle) were 610 units in 2021. Steam turbines include multiple fuel types such as fossil, biomass, nuclear, etc. The steam turbine manufacturing market is concentrated with top 5 players contributing to more than 60% of the market (based on orders in 2022H1). Based on the market share as of orders in H12022, Siemens Energy & Triveni Turbines Ltd. are two players with 37% of the market share.

Market share for steam power turbine manufacturers based on orders in 2022H1

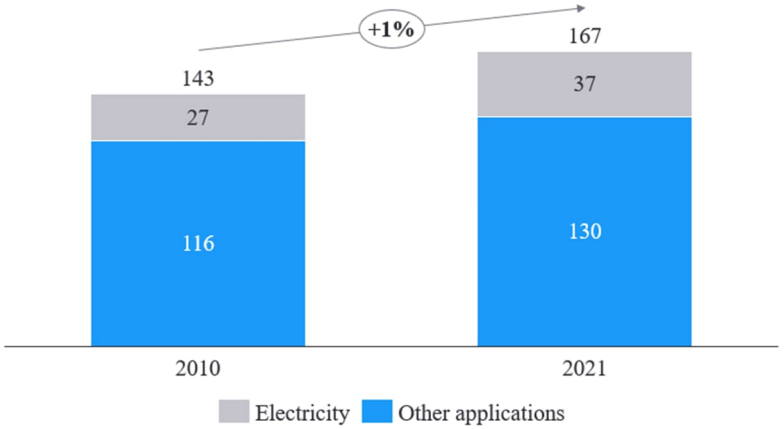


Source: McCoy Reports
Note: The market share is based on technological ownership & the number of units ordered in 2022H1.

Industrial turbines market and outlook

Global industrial energy consumption has increased from 143 GW in 2010 to 167 GW in 2021. Out of this, more than three-fourths of the market is consumed for non-power end use applications. By 2030, industrial energy consumption is expected to reach within the range of 172 GW (NZE scenario of IEA) to 178 GW (APS scenario of IEA) to 189 GW (STEPS scenario of IEA).

Global industrial energy consumption (GW), (2010-21)



Source: IEA World energy outlook

Industrial turbines are used in various industries such as oil & gas, chemicals, marine applications, cement, mining etc. Oil & gas is of the key industries with high demand for industrial turbines. There are various applications of industrial turbines in the Oil & Gas industry with pipeline compression being one of its prime use cases. Gas turbines help to compress the natural gas and to power the refrigeration system to cool the compressed gas so that it can be transported through pipelines to distribution centers.

Key turbine manufacturers

GE Power, Siemens Energy AG & Mitsubishi Power Ltd. have the largest number of orders (70% share as per orders in H12022) for gas turbines, whereas Siemens Energy & Triveni Turbines Ltd. have the largest number of orders (37% share as per orders in H12022) for steam turbines.

Azad Engineering Ltd. supplies components to 5 of the manufacturers of turbines mentioned below (General Electric, Siemens Energy AG, Mitsubishi Power Ltd., Ansaldo Energia S.P.A., Bharat Heavy Electricals Limited (BHEL), Triveni Turbines Ltd, Harbin Turbine Co. Ltd., Dongfang Electric Corporation, Shanghai Electric Power Generation Group, Baker Hughes, Solar Turbines).

Details of key turbine manufacturers

Players	Description	Energy related products	End-use Segments
General Electric	US based conglomerate that is present in diverse industries.	• Gas Turbine • Steam Turbine • Generators • Boilers	• Power generation • Renewable energy • Healthcare • Oil and gas • Industrial solutions
Siemens Energy AG	Germany based MNC that provides solutions and services across different industries.	• Energy Automation & Smart Grid • Turbine • Other power gen. equipment	• Power generation • Industry & manufacturing • Infrastructure & buildings • Healthcare • Digitalization and software solutions
Mitsubishi Power Ltd.	Japan based company with expertise in power generation, industrial equipment & infra solutions.	• Gas Turbine • Steam Turbine • Generators • Power plant solution • Boilers	• Thermal power plants • Renewable Energy • Integrated Energy solution • Environmental solutions

Ansaldo Energia S.P.A.	Italy based company recognized for its expertise in power generation equipment.	• Gas Turbine • Steam Turbine • Generators • Power Plant solution	• Thermal power generation • Industrial power generation • Renewable energy
Bharat Heavy Electricals Limited (BHEL)	Indian PSU that manufacturers power generation equipment.	• Gas Turbine • Steam Turbine • Generators • Boilers	• Aerospace • Defence • Electrical Equipment • Locomotive
Triveni Turbines Ltd.	India based Steam Turbine manufacturer	• Steam Turbine	• Textiles • Oil & Gas • Chemical • Power Generation
Harbin Turbine Co. Ltd.	China based enterprise that manufactures all types of turbines	• Gas Turbine • Steam Turbine • Nuclear Turbine • Fossil Turbine	• Power generation • Transmission, distribution • Nuclear • Oil and Gas
Dongfang Electric Corporation	China state-owned company that builds steam turbines	• Steam Turbine	• Power generation • Transmission, distribution • Oil and Gas
Shanghai Electric Power Generation Group	China based MNC that deals in power generation & electrical equipment	• Steam Turbine • Wind Turbines	• Power generation • Transmission, distribution • Electrical
Baker Hughes	US based company with diverse offerings across energy & industrial value chain	• Gas Turbine • Steam Turbine	• Oil and Gas • Industrial applications
Solar Turbines	US based company which supplies energy solutions for power generation & other applications	• Gas turbines	• Energy • Industrial • Renewable • Marine

Source: Company websites
Note: Product list & end-use segment list is non-exhaustive

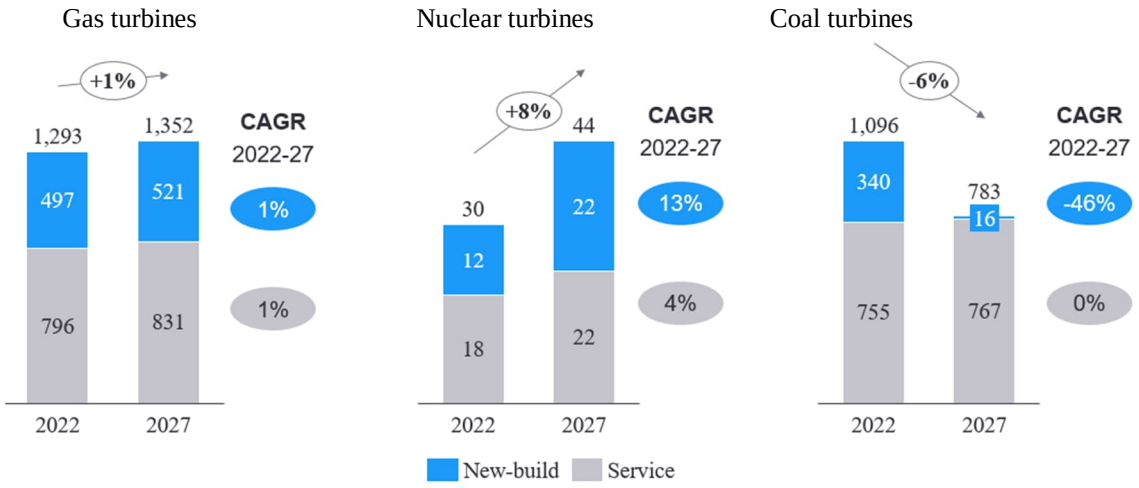
Outlook for new and serviceable turbines in power generation industry

According to Siemens Energy, gas services are an important part of the low emission society & despite problems over supply from Europe, it is still considered as a better alternative vs the other fossil fuels.

At COP27 the agreement on “low emission energy” was not defined in a formal manner that leaves a chance for natural gas production. Moreover, the technologically advanced gas turbines can burn hydrogen as well so the life of these will continue even in the new energy economy.

The market for turbines is driven by demand from turbines to be used in new power plants and serviceable turbines.

Outlook for new and serviceable turbines (number of turbines) (2022 – 27)



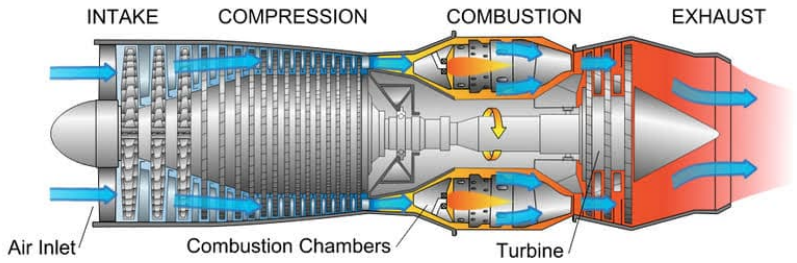
Source: IEA, Global energy monitor January 2023, Global energy monitor February 2023, World Nuclear Association

Key components of a turbine and its maintenance cycle

Key components of gas turbine

A gas turbine is an internal combustion engine used in power plants. It converts natural gas or other liquid fuels into mechanical energy, which in turn drives a generator to produce electrical energy transmitted through power lines. Major components of a gas turbine include:

Pictorial representation of a gas turbine



Source: Energy education website

1. ***Air Inlet***: It is an important component that makes huge amount of air to enter the turbine maintaining the pressure or flow, the filters used remove contaminants from the air. The air inlet is designed to ensure a steady air flow & maximize air compression.
2. ***Compressor***: Airfoils in this section perform the function to pull in large air volume, compresses the air to required pressure & pushes it to the combustion chamber at high speed. Usually axial-flow compressors are used due to their ability to maintain continuous air flow. These compressors consist of rotor blades/airfoils, drums and stator blades/airfoils which work in creating an 'adverse' pressure gradient to push gas to high static pressure from low across the compressor. Component critically is of high importance to prevent flow reversal and avoid 'stalling' of blades/airfoils which increases power required and decreases component life.
3. ***Combustion chamber***: Here the fuel is injected, post that ignition of fuel-air mixture is done using spark plugs located in the chamber. The job of flame stabilizers is to ensure that the flame stays in the combustion zone & is stopped from moving back in the compressor section.
4. ***Power turbine:*** The most vital component that converts the energy from high temperature & high-pressure gas into mechanical energy, which generates electricity. The gas flowing through

the turbine expands and exerts a force on the blades and makes them move. The moving blades draw more pressure in the combustion section & spin the generator to produce electricity. Cooling systems are mounted to maintain the temperature of the turbine.

5. ***Blades/Airfoils***: A turbine blade can be divided into 4 parts: airfoil, platform, shank & dovetail. They contain rows of hollow airfoils for cooling purposes. The compressor and turbine sections of a gas turbine use two types of blades:
    - ***Rotor blades/airfoils***: These blades are responsible to accelerate & compress the incoming air in the compressor & extract energy from gas flow in the turbine. They are shaped in aerodynamic manner to hold high centrifugal forces & run at high speeds.
    - ***Stator blades/airfoils (Guide vanes)***: They are used to compress the air near the rotor blades, optimize the angle of attack & reroute the airflow. These blades are important to the performance & efficiency of the turbine.

Other than combustion chamber and blades/airfoils, there are small parts in a turbine that require machining to have a precise finish.

Key components of steam turbine

Major components of a steam turbine include:

1. ***Casing***: It is the outer covering of turbine that is placed in a horizontal way, it prevents spillage of fluids from within the turbine. Its horizontal placement helps in easily accessing it for repairing.
2. ***Rotor***: It is the component of steam engine that moves and aids in converting the steam into energy. The rotor is made up of multiple cylinders that are together to form the movable rotating part of the turbine. Types of rotors: rigid, flexible & drum.
3. ***Blades/Airfoils***: These are very important part of a turbine; these convert the incoming steam into mechanical energy. Blades/Airfoils are of two types: movable & fixed, in some turbines these come together.
4. ***Diaphragms***: It is a stationary component of a steam turbine. The major use of a diaphragm is to improve turbine efficiency by regulating the steam flow to the blades.
5. ***Bearings***: These are very small components that are part of a turbine, they are used to reduce friction. They control friction between parts like rotors & shafts. Two types of bearings are used: Roller & Ball.
6. ***Governor System***: Governor is a control system that is deployed in the turbine to adjust its rotational speed with the use of variation in the water flow through the turbine.
7. ***Support System:*** It is made up of a lot of components to aid the performance of a steam turbine and help other components, it usually controls the stability of a turbine.

Turbine repair cycle

For maintaining the efficiency & the life of a turbine, timely repairs are an essential part. Today the market for the spare parts of turbines is dominated by few players given that the high temperatures & precision needs for turbine components.

Generally, all new turbine sales have a Long-Term Service Agreement (LTSA) that reduces the maintenance cost for the owner. Customers without service agreements either opt for transactional relationships with the OEM or seek services from independent providers, including those affiliated with gas turbine competitors. Gas turbines require repair every three to eight years and a major overhaul or rebuild every 10 to 16 years, with a typical lifespan exceeding 30 years. Steam turbines on the other hand require less maintenance than the gas turbines & have a longer operational life.

AEROSPACE AND DEFENCE INDUSTRY

PRESENCE OF AZAD ENGINEERING LTD IN THE AEROSPACE & DEFENCE INDUSTRY

Azad Engineering Ltd. provides components to the aviation sector such as engine airfoils and other precision, forged and machined components. Azad Engineering Ltd.'s aerospace and defence products are largely utilized in commercial and defence aircraft, spacecraft, and other defence systems to provide propulsion, actuation, hydraulics, and flight control. These goods are used in both new builds and by Maintenance, Repair, and Overhaul (MRO) service providers.

As engine products are life critical, these components are engineered to work under harsh situations and have a “zero parts per million” defects requirement. The company has supplied critical components for various aircraft platforms such as B737, B737 Max, B747, B777, B777X, A320, A350, A355, A350 XWB, Gulfstream G550 and is in discussions for supply of components for new engine platforms during the preparation of this industry report. The company has existing relationships with both Indian and global OEMs.

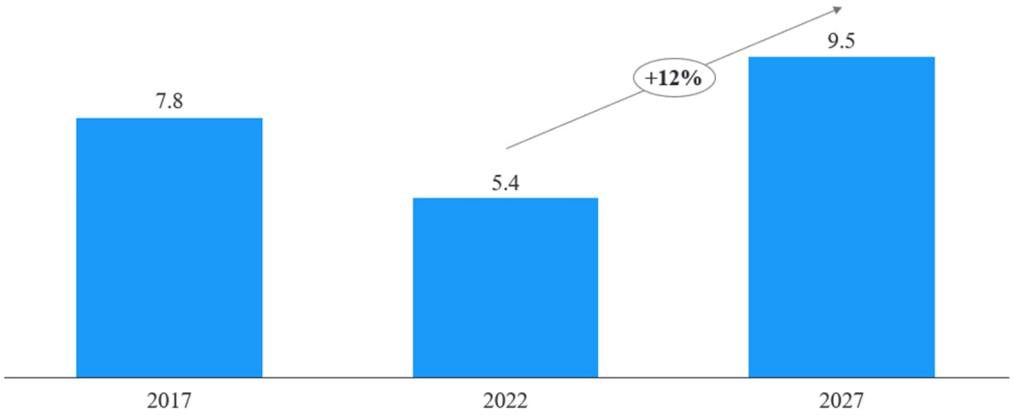
This section of the research examines the commercial and defensive aviation segments, as well as MRO, to provide an overview of the demand outlook and components used in the aerospace and defence sectors.

ASSESSMENT OF AEROSPACE INDUSTRY

Outlook for global passenger and cargo traffic growth

The commercial aircraft industry, which was facing significant headwinds post the pandemic, recovered in 2022 and 2023. The outlook for global air traffic is positive with Revenue Passenger Kilometer (RPK) expected to increase to 9.5 Bn by 2027, growing at a CAGR of 12%.

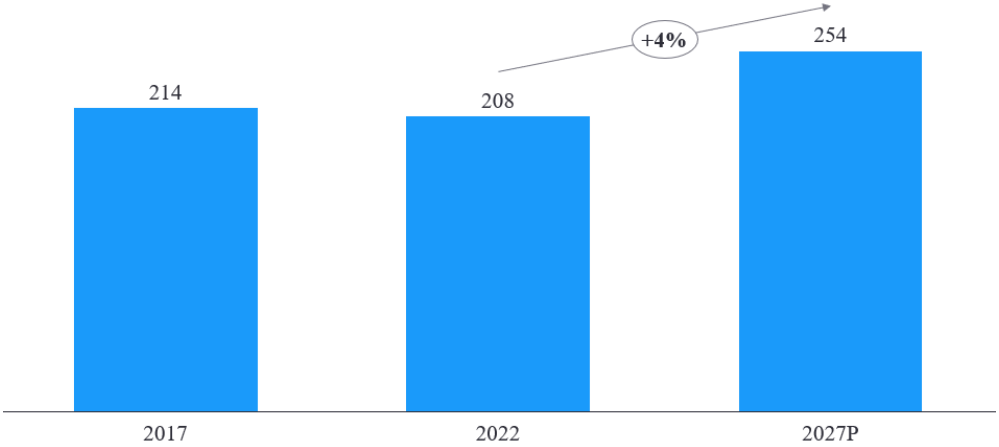
Global Revenue Passenger Kilometer (Bn) (2017-2027)



Source – IATA, World Air Traffic Forecast Boeing report 2022

Global air freight traffic has not changed much over the last few years. There was a drop of ~17% in 2020 due to COVID-19 pandemic, but there was a quick rebound in the next year.

Global air freight traffic (Bn-ton) (2017-2027)

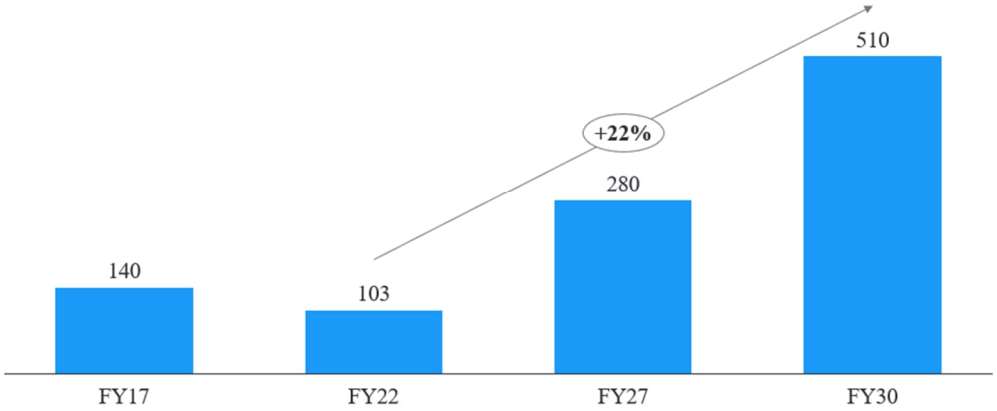


Source – World Bank Data- accessed July 2023, World Air Cargo Forecast – Boeing report 2022.

India passenger traffic trends and outlook

Before the COVID-19 pandemic, the Indian air traffic experienced substantial growth, with a CAGR of approximately 19% during the period FY17-FY19. The market dipped during the pandemic, however there was quick recovery post the pandemic, with the passengers handled across all Indian airports in FY23 reaching approximately 96% of the pre-pandemic levels. It is projected that the domestic air traffic will continue to increase, and by FY30, it is estimated to reach 350 million passengers. Similarly, the international passenger numbers are also expected to rise significantly, reaching 160 million by FY30.

Indian air traffic (millions) (FY17-FY30)

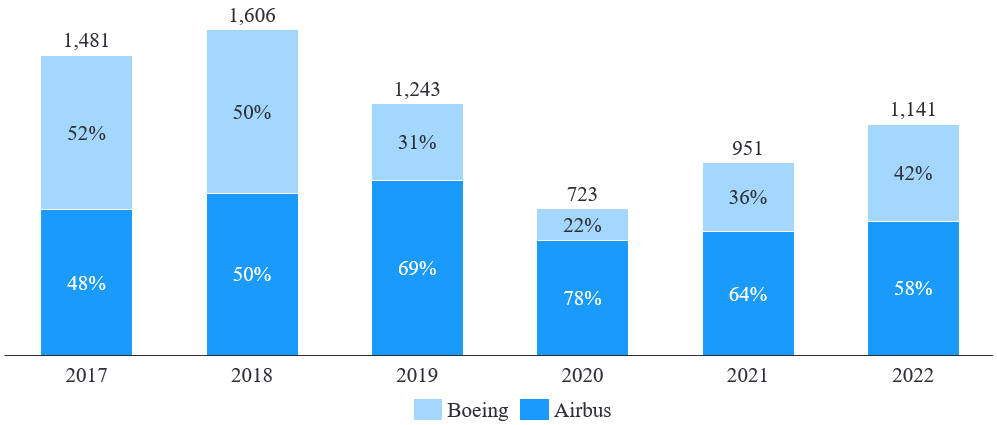


Source – World Bank Data, Economic Times – "India is flying high again: Domestic numbers touching pre-pandemic levels" dated May 2023

Global passenger aircraft order book

The commercial aircraft market is dominated by The Boeing Company and Airbus SE, which together had more than 90% of the global commercial aircraft market. A few other players like Pratt & Whitney, ATR, Bombardier, and Embraer also manufacture aircrafts, but they have a much smaller share. Newer players like China's COMAC (Commercial Aircraft Corporation of China) and Russia's Irkut Corporation have also emerged but are yet to make a mark.

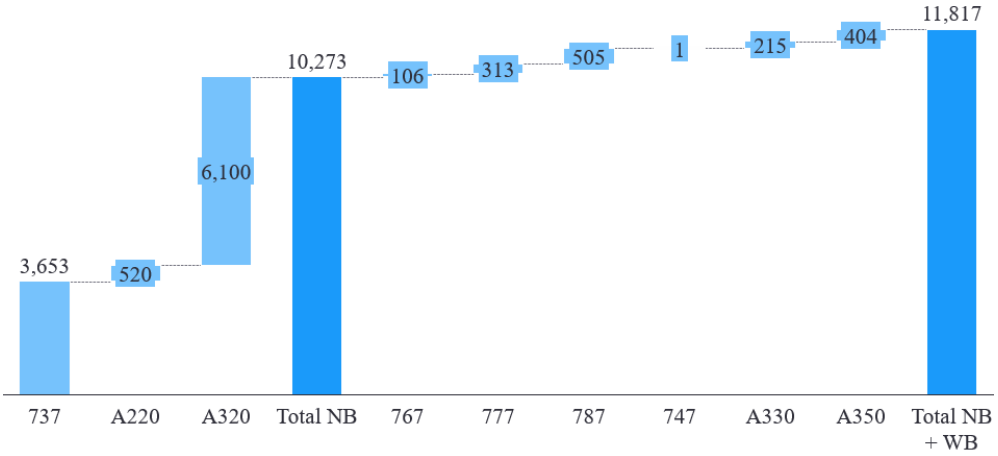
Split of commercial aircraft deliveries between Airbus SE & The Boeing Company (2017-2022)



Source – Airbus SE and The Boeing Company websites accessed August 2023

Airbus SE and The Boeing Company have an order backlog of ~12,000 units. Nearly 87% of these backlog orders were for narrow body aircrafts like Airbus A220, A320 and Boeing 737.

Airbus SE and The Boeing Company order book as of December 2022



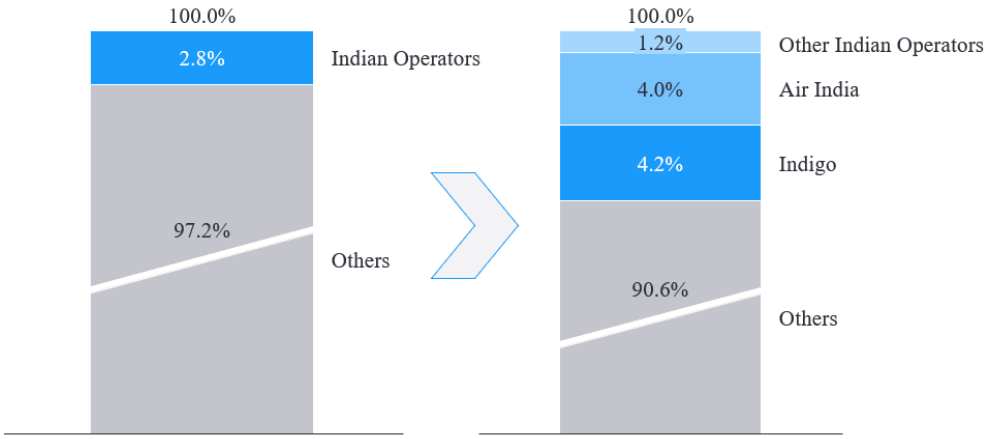
Source – Airbus SE and The Boeing Company Annual Reports 2022

India's share of the order book and expected trend

Global in-service passenger aircraft fleet size in 2023 is around 27,000 across narrow, wide, regional jet and turbo-prop segments. Of this narrow and wide body aircrafts account for about 22,000. India's share in these two segments stands at ~3%, with a fleet size of 630 (out of total 726 aircrafts). However, if the backlog orders are considered, Indian airline operators have around 1,100 planes on order with Airbus SE and The Boeing Company which translates to a share of ~9% of the global orderbook.

India's share of overall fleet currently in service

India's share of overall order backlog



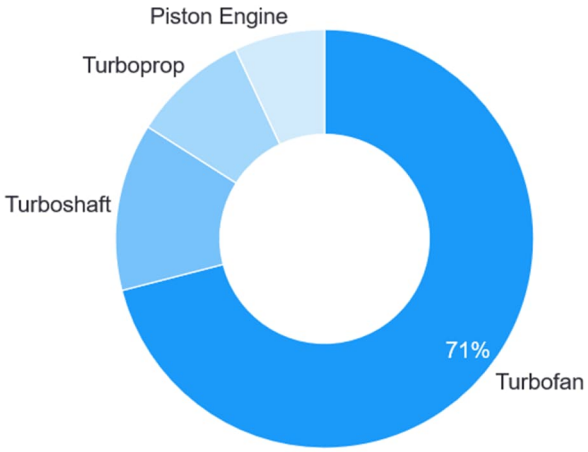
Source: Oliver Wyman's Global Fleet and MRO Market Forecast 2023-2033, Economic Times – "Indian airlines have more than 1,100 planes on order" dated Feb 2023
Note – The above shares are for NB and WB, which account for majority of Indian fleet

Different types of engines used in commercial aircrafts

The Turbofan engine stands as the dominant engine in commercial aircraft with a market share of 71%. It is followed by the Turboshaft and Turboprop engines, which hold smaller portions of the market.

Recent development in the aircraft engine is the emergence of a new turbofan engine. Developed by CFM International in 2008, LEAP engine is a type of turbofan engine and is one of the most efficient aircraft engines currently in operation. CFM International has a backlog over 10,000 LEAP engines. These engines power the NB aircrafts like Airbus A320neo, Boeing 737Max and the newly developed COMAC C919.

Market Share of Aircraft Engine by type (2021)



Source – Fortune Business Insights, 2021

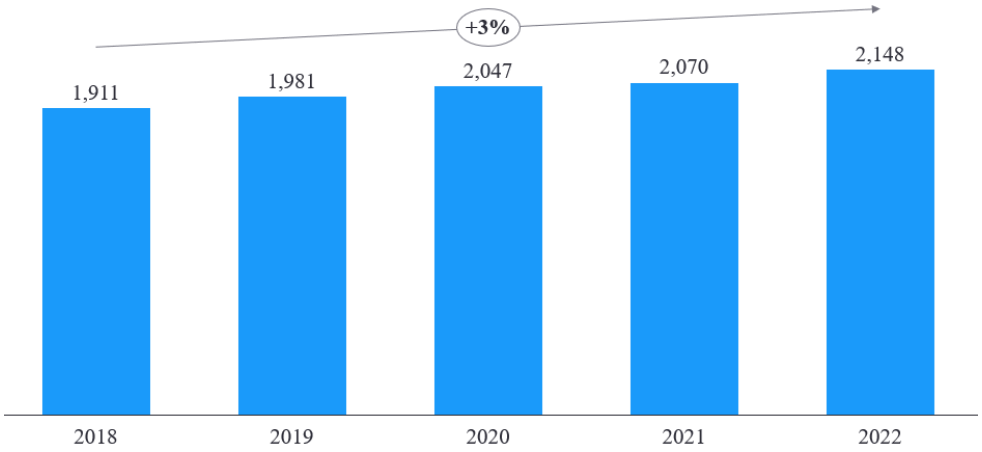
ASSESSMENT OF DEFENCE INDUSTRY

Global defence sector outlook

At US$ 2,148 Bn, the world spent about 2.1% of its GDP on military expenditure in 2022. The rise in global military expenditure was driven by the Russian - Ukraine conflict. As per SIPRI reports, the European region saw an increase of 13% in miliary spending due to the countries' spend on supporting Ukraine during the wartime with financial and military aid, modernizing own equipment to be 'war-ready' due to proximity to war zone, adding additional manpower and replenishing equipment provided to Ukraine. While Russia's military spend increased by over 9%, Ukraine's spending increased over

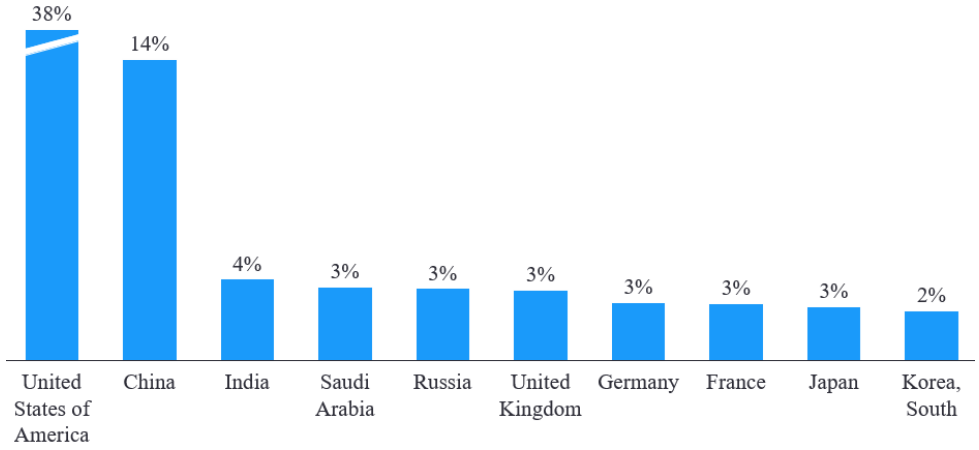
600% from its previous year and amounted to ~ US$ 44 Bn.

Global military expenditure (US$ Bn) (2018-22)



Source: SIPRI
Note: Includes SIPRI estimates of military spending for certain countries. All values at constant 2021 prices and exchange rates.

Top countries by value share of military expenditure in 2022



Source: SIPRI

- USA has the largest defence spending in the world and has been growing at a CAGR of 2% over the last 5 years. As of 2023, the defence budget was US$ 816.7 Bn under the 'New Defence Strategy'. The strategy calls for significant spending to improve capabilities on both the local and international fronts. The United States has made significant investments for boosting capabilities in the Indo-Pacific region to fight potential Chinese threats, as well as the US-European command region to resist Russian military aggressions and support Ukraine during the wartime conflict. The United States is also the world's top exporter of major weaponry, accounting for 40% of total global exports between 2018 and 2022.
- China is the world's second largest defence spender, with an expected US$ 298 billion in defence spending in 2022. This amounts to approximately 4.8% of overall government spending and a per capita expenditure of approximately US$202. Historically, China has pursued a policy of military-civil integration, which has aided the expansion of local manufacturing and technology. The country is highly 'self-reliant' in terms of armaments and defence requirements, with only a shortage of skills in sophisticated technology such as helicopters and engine development. During the 2016-2020 period, China had the lowest level

of imports among the 12 Indo-Pacific countries, with imports accounting for only 8% of total procurement.

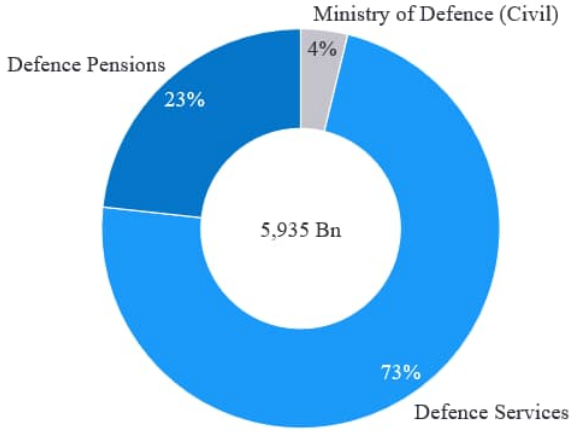
India's defence industry

India ranks third in the world in terms of defence expenditure. The country's need for extensive capabilities in defence sector arises primarily from having two neighboring countries Pakistan and China with nuclear capabilities and with whom India shares land boundary and has historically had border conflicts.

India's military expenditure as a share of GDP has been consistently around 2.5% over the last 5 years. India's per capita spending on defence is about US$58, which is the lowest among the top defence spending nations, but the per capita spending increased at a rate of 3.4% from 2018 to 2022. As per SIPRI estimates, Indian government allocates about 8.3% of its total spending towards military expenditure.

Indian Government's Union Budget of FY24 allocated INR 5,93,538 Cr towards Ministry of Defence (MoD). The MoD budget in India is split across defence services, MoD civil services and pensions. Defence services expenditure is the largest segment accounting for 73% allocation of the annual defence budget in FY24.

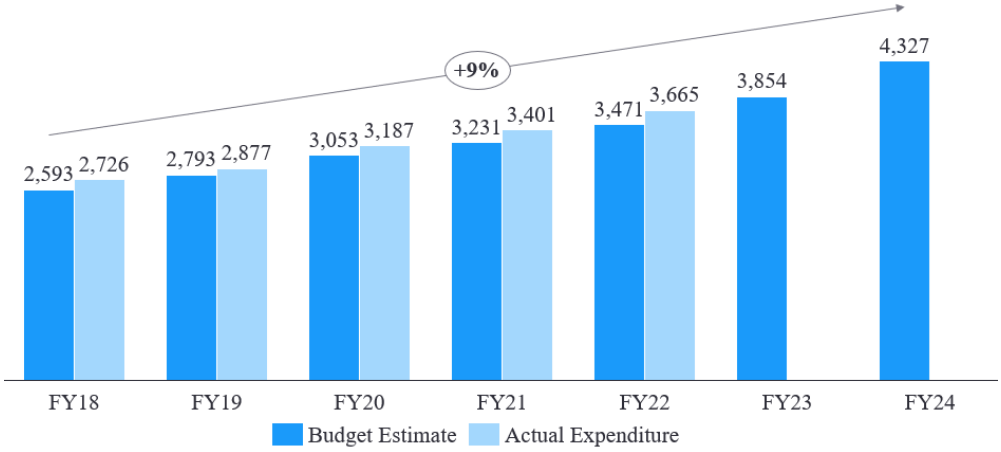
Allocation of Ministry of Defence budget in FY24



Source: Ministry of Finance, Union Budget
Note: Defence services includes both revenue and capital outlay expenditures

India has been increasing the allowance for defence services over the years and the actual spent has been consistently higher than the initial estimate of the budget over the last 5 years.

Defence services budgeted and actual expenditure over the years (INR Bn) (FY18-24)

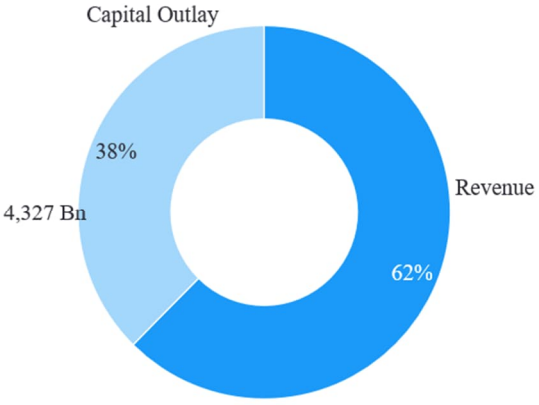


Source: Ministry of Finance, Union Budget
Note: Budget estimates mentioned for FY23 and FY24; includes both revenue and capital outlay expenditures

Defence services allocation is split into revenue and capital outlay in the budget. Capital outlay constitutes of the total capital expenditure by the defence ministry to procure arms, missiles, vehicles, equipment etc. and other capital expense such as buying land, construction expenses etc. It also includes expenditure for modernization and upgradation of equipment and technology to meet changing demands, upgrades in technology and to ensure the forces are ready for war at any notice. Defence purchases and upgrades happen in a planned and phased manner spearheaded by the Defence Acquisition Council.

Revenue head includes operational expenses such as salaries, transportation charges, Ex-Servicemen Contributory Health Scheme charges and all other non-capital expenditures.

Split of FY24 allocation by revenue and capital outlay (INR)



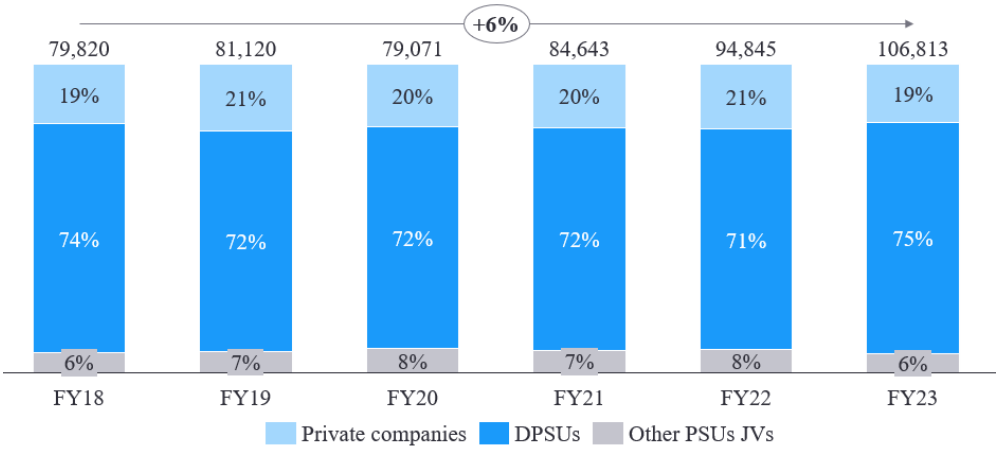
Source: Ministry of Finance, Union Budget
Note: Others include spend on Defence Ordnance Factories, Assistance for prototype development under make procedure, Investment in public enterprises and Inspection - Director General Quality Audit (DGQA)

Trends in defence production in India

Although India has a wide system of defence PSUs, ordnance factories and private players in defence manufacturing space, India is highly dependent on imports for its advanced military equipment. The country has consistently ranked among the top importers of major arms. According to SIPRI, India ranked first in the world in terms of major arms import during 2018-2022 period with a 11% share in total global imports.

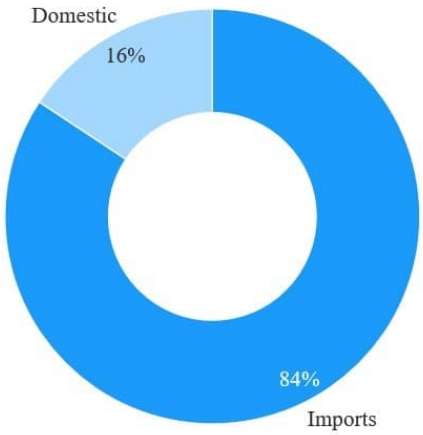
To boost local manufacturing and reduce dependence on imports, the Indian government recognized defence segment as a core sector for achieving 'Atma Nirbhar' in 2020. The scheme pushed for reforms across verticals and adequate funding to achieve 'self-reliance'. Post the launch of the scheme, defence production has grown at 12% between FY21 to FY23 and defence exports by 37% in the same period.

Trends in defence production in India (INR Cr) (FY18-23)



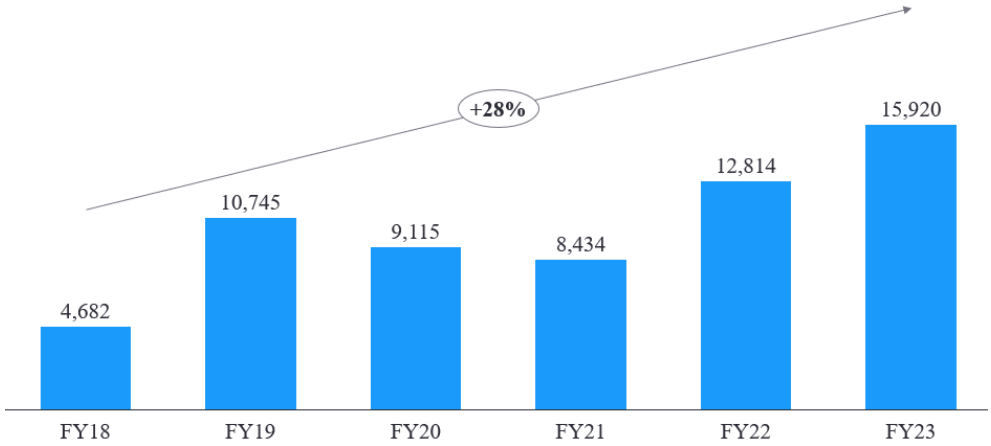
Source: Ministry of Defence, Dept. of Defence production dashboard accessed July 2023

Share of major conventional arms procured between 2016-2020 as per origin



Source: SIPRI
Note: Major arms as categorized by SIPRI include Aircrafts, armor, ships, missiles, air-defence systems etc. Arms produced completely in-house from design, development to manufacturing are considered domestic. Licensed production is included in imports.

Trends in value of Indian exports (INR Cr) (FY18-23)



Source: Press release from Ministry of Defence in PIB, dated 01 April 2023

The need for 'self-reliance' or 'Atma Nirbhar' in defence

India has historically relied on Russia for its military equipment and is heavily dependent on the country for upkeep and maintenance of these equipment. India has been steadily working towards boosting the domestic defence manufacturing industry and moving away from imports, to capitalize on the current opportunities in the defence manufacturing sector and to reduce the time taken for import procurement.

SIPRI report on 'Arms-production capabilities in the Indo-Pacific region' dated October 2022 notes that 84% of India's major arms procured between 2016 to 2020 are of foreign origin. Sixty-nine percent of the foreign origin arms were produced under license with Indian components. However, there is limited technology transfer between the licensed parties and the dependence on foreign technology continues. Of the major arms, import reliance is very high for armor (licensed production), aircrafts, missiles and air-defence systems while it is low for ships.

In terms of domestic capabilities, India is home to seven of the top 50 arms-producing and military services companies in the Indo-Pacific region.

Ranking of Indian companies among the top fifty arms producing companies in Indo-Pacific region

Company	Ranking	Arms sales as % of total sales
Hindustan Aeronautics Limited (HAL)	9	95%
Indian Ordnance Factories	12	98%
Bharat Electronics Limited	16	78%
Mazagon Dock Shipbuilders Limited	32	100%
Cochin Shipyard Ltd.	41	86%
Bharat Dynamics Ltd.	43	100%
Ashok Leyland	48	10%

Source: SIPRI
Note: Ranking based on value of arms sales for the year 2020 in US$ million

Summary of Defence Acquisition Procedure (DAP)

The Indian government released a draft Defence Acquisition Procedure (DAP) in 2020 aimed to increase 'self-reliance' by boosting domestic production and indigenization, promoting import substitution, cutting-down the gestation period and hastening up of defence procurement. The draft DAP has been accepted and is amended periodically to reflect India's evolving defence production needs and requirements.

Key measures under this policy include defining the 'Make III' category to promote import substitution, introduction of a new 'Buy (Global- Manufacture in India)' category to encourage entry of foreign manufacturers into India for manufacturing, maintenance and provision of spare parts and notification of 'Positive Indigenization lists' to encourage domestic development of equipment / technology and discourage imports.

Initiatives to promote Atma Nirbhar Bharat in the defence sector

For India to achieve self-reliance in the defence sector, 'Make in India' and 'Atma Nirbhar Bharat' schemes have pushed for initiatives across the value chain and have allocated resources to meet the target of US$ 5 Bn from exports by 2025 with a defence sector size of US$ 25 Bn as envisioned by the government.

As a result of the push for indigenization, domestic manufacturers were awarded procurement contracts worth INR 6,300 Cr in 2022 by the government.

Major contracts signed with indigenous manufacturers in 2022

Company	Contract details	Value of contract (INR Cr)
Bharat Electronics Limited (BEL)	Procurement of 42 D-29 EW Systems and Instrumented Electronic Warfare Range (IEWR) for Indian Air Force	3,102
BrahMos Aerospace Pvt. Ltd.	Procurement of 38 BrahMos missiles for two P-15B ships	1,723
Bharat Electronics Limited (BEL)	Procurement of 957 Commander Thermal image (Ti) cum day sight for T-90 Tanks	1,075
Goa Shipyard Limited (GSL)	Construction of Fast Patrol vessels (FPVs) for Indian Coast Guard	474

Source: Press release from Ministry of Defence in PIB, dated 17th Dec 2022

The 'Make in India', DAP and Atma Nirbhar policies together have promoted the participation of Indian conglomerates and private players in partnerships with global manufactures in the Indian defence manufacturing space.

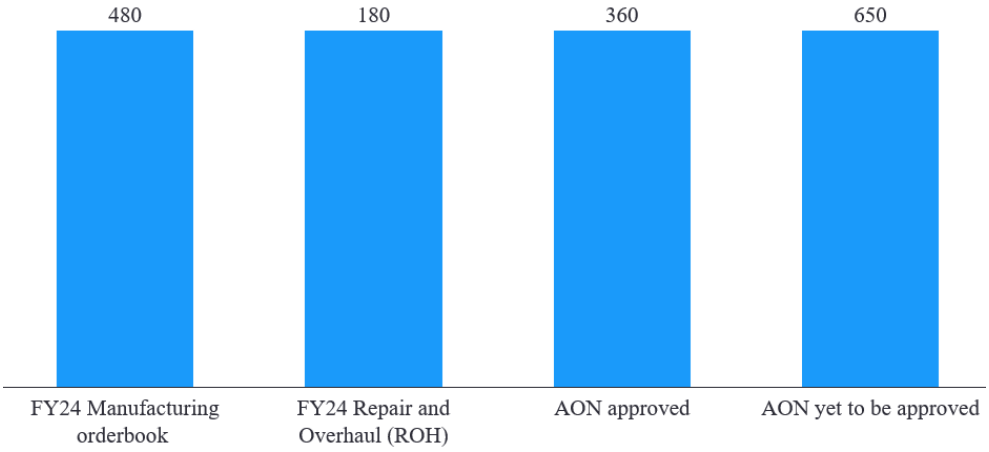
Among PSUs, the benefits of Atma Nirbhar scheme are reflected in the robust manufacturing orderbook of HAL, the largest defence PSU in India and its recent ability to sign an MOU with GE for manufacturing of GE F-414 engines in India.

Impact of 'Atma Nirbhar' on Hindustan Aeronautics Limited (HAL) orderbook

HAL, which is a customer of Azad Engineering Ltd., has shown substantial sales growth in recent years, with over 9% rise in FY23 over FY22. As a result of the push for indigenous production, the company anticipates 10% growth in FY24/FY25 and 13%-14% growth in the near future. At the end of FY23, Hindustan Aeronautics Limited (HAL) had an orderbook worth INR 818 Bn. Manufacturing orders included orders for Light Combat Aircraft (LCA) and LCA trainers, with a few deliveries beginning in FY24.

For FY24, Hindustan Aeronautics Limited (HAL) expects manufacturing orders worth INR 480 Bn comprising primarily of manufacturing of Advanced Light Helicopter (ALH) Dhruv, Light Utility Helicopters (LUH), RD33 and AL31FP engines. Repair and Overhaul (ROH) orders worth INR 170-180 Bn chiefly comprising of ROH for Su-30 and AL31FP engines are expected in FY24. In addition, orders worth INR 1,010 Bn are in the pipeline with Acceptance of necessity (AON) approved for 35% of them. The order pipeline includes manufacturing of LCHs, Hindustan Turbo Trainer (HTT) – 40s, LUHs and upgradation of Dornier aircrafts.

Hindustan Aeronautics Limited (HAL) orderbook and pipeline as of May 2023 (INR Bn)



Source: Hindustan Aeronautics Limited (HAL) Q4 FY '23 Earnings Conference Call Transcript, HAL analyst meet presentation, dated 17th May 2023

In terms of key projects in pipeline, Hindustan Aeronautics Limited (HAL) has signed Letter of Intent (LOI) with Indian Coast Guard for helicopters and Dornier Aircrafts and LOI with Argentinian Defence establishment for production of helicopters for their armed forces. As of June 2023, Hindustan Aeronautics Limited (HAL) has entered into an MOU with GE for production of military aircraft engines in India.

'Make in India' for aircraft and drone engines

Aircraft engine manufacturing is considered complex due to the need for specific technical requirements to provide stability to aircraft and handle the heat generated during operation while maintaining fuel efficiency. Even China with high technical expertise lack robust engine capabilities and depend on imports for these products. Indian drones and prominent aircrafts have also been highly dependent on foreign technology for their engines.

GE aerospace signed an MOU with Hindustan Aeronautics Limited (HAL) in June 2023, to produce GE's F-414 engines for Tejas Light Combat Aircraft Mk2 in India. GE Aerospace has applied for necessary authorizations with the US government to proceed with the MOU. The terms of the agreement include potential for joint production of these engines in India, thus boosting the defence manufacturing ecosystem in the country. This also opens global market opportunities for Indian manufacturers as GE's F-414 engines power military aircrafts in over eight nations including the USA and about 1,600 of them have been delivered globally. Producing this engine in India will open up opportunities for vendors such as Azad Engineering Ltd. if they can meet the quality, price and other requirements that may be specified.

Hindustan Aeronautics Limited (HAL) has also signed an agreement with Safran Helicopter Engines, which provided the engine technology for Hindustan Aeronautics Limited (HAL) developed helicopters, in July 2023 for the establishment of a joint venture to design, develop and produce engines for Indian Multi Role Helicopter (IMRH) & Deck Based Multi Role Helicopter (DBMRH). These agreements, when executed are likely to boost engine technology capabilities of Hindustan Aeronautics Limited (HAL) and provide higher degree of technology autonomy in the Indian manufacturing sector.

AEROSPACE AND DEFENCE COMPONENTS OVERVIEW

Different segments in the aerospace market

Aerospace market includes:

1. ***Commercial & general aircrafts:*** Commercial aircrafts are used for the purpose of

transportation of passengers & cargo for commercial reasons. This market is highly concentrated with duopoly of The Boeing Company & Airbus SE.

2. ***Military aircrafts:*** These are used for defence purposes. These aircrafts are fully equipped with equipment to support combat operations. These are specifically designed for different purposes. These are equipped with latest technologies, radar systems & weapon systems. These include combat & non-combat aircrafts.
    a. ***Combat aircrafts:*** These include aircrafts like fighters, bombers, attack aircraft, electronic warfare, maritime patrol, multirole etc.
    b. ***Non-combat aircrafts***: These include aircrafts like military transport aircraft, airborne early warning & control aircrafts.

Key components used in the aerospace & defence

An aircraft typically consists of three key components: Outer structure, engine, and operational systems.

1. ***Outer structure***: The outer structure of an aircraft consists of the following four main parts:
    a. ***Fuselage***: This is the main part of the aircraft, the long hollow tube that forms most of the aircraft. This is the part where cargo, cabin crew, passengers, & pilot are seated. It also includes the cockpit.
    b. ***Wings***: Airplanes have fixed wings, whereas helicopters have rotating wings, wings perform the important function of lift in the aircraft. Wings have two parts: flaps and ailerons, ailerons are used to control the rotation around the front-to-back axis of the aircraft, whereas flaps are used to provide lift & drag to the airplane.
    c. ***Empennage***: They work to guide the aircraft to reach its destination and includes the complete section of tail of the aircraft. The rudder helps steer the aircraft.
    d. ***Landing gear***: The landing gear is the part of the aircraft that aids landing, take-off & taxi for the aircraft. It is an integral part of the aircraft. Retractable gears are also present in some of the fast aircrafts. The landing gear absorbs the shock while pilot performs landing of the aircraft.
2. ***Engine***: Part of the propulsion that move the aircraft forward by exerting thrust. A jet engine includes the below mentioned parts:
    a. ***Fan***: The key responsibility of airfoils in this section is to suck in air which splits into two parts. The first part of the air passes through the engine core, whereas the second part completing skips the engine core and enters a duct (which is encompassing the core and back of the engine) to provide thrust to the jet engine.
    b. ***Compressor***: In the compressor section, airfoils squeeze the air entering into the engine core to increase its pressure. This results in a high potential energy of air and then pushed into the combustor. The compression ratio between inlet and outlet pressure determines the thrust and efficiency of the engine so the compressor components are highly critical to maintain the optimum compression ratio.
    c. ***Combustor***: The combustor, manufactured from ceramic materials can withstand the temperatures as high as 2,700 degrees Celsius. This is the location where fuel and air get mixed. This results in ignition of the engine. The fuel burns in tandem with the presence of oxygen in the pressurized air.
    d. ***Turbine***: Blades of a turbine move when air which is highly energized enter the turbine. The fan that is present in the front of compressor moves via the movement of the turbine shaft. The turbine moves the air through the engine, and it is the force with which the

turbine moves the air which provides the aircraft with the required thrust. Hence component criticality is of prime importance.

e. ***Nozzle***: It is responsible to push the plane in a particular direction.

3. ***Operational Systems***: Systems that are required in an aircraft for its proper functioning. Some of the important systems within the aircraft are listed:

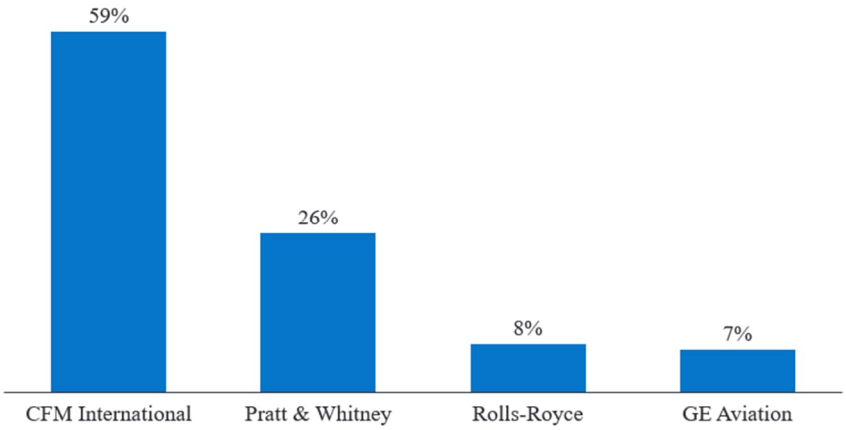
   a. Avionics Technology
   b. Engine control systems
   c. Flight control systems
   d. Pneumatic systems
   e. Hydraulic systems
   f. Rotary wings systems
   g. Fuel System
   h. Environmental control system

Aircraft engine and other part manufacturers

Aircraft engine manufacturers and their share

CFM International (JV of GE Aerospace and Safran S.A.) is the market leader with 59% share followed by Pratt & Whitney with 26% share, as per 2021 engine deliveries.

Aircraft engine manufacturers market share (%) based on 2021 deliveries



Source: Commercial Engines by Flight Global
Note: Data is for 2021 deliveries

Passenger aircraft engines in service by manufacturers (2022)

Manufacturers	Number of Engines
GE Aerospace & its JVs	40,900
Pratt & Whitney	12,730
Rolls-Royce	12,700

Source: GE 2023 Investor Conference Report, Rolls Royce annual report, Pratt & Whitney Website accessed July 2023
Note – GE Aerospace and its JV include GE, CFM International and Engine Alliance

Other key manufacturers of aerospace components

Apart from the engine manufacturers in the aerospace ecosystem, it also includes following players:

1. ***Original Equipment Manufacturers***: Manufacturers like The Boeing Company, Airbus SE that design, build & assemble the complete aircrafts.
2. ***Avionics & Electronics Suppliers***: Companies like Honeywell International Inc. that specialize

in building avionics & electronic subsystems.

3. ***Other subsystems***: Components and parts manufactured by vendors such Eaton Corporation Plc which provide power management solutions, hydraulic systems and more to the OEMs.

List of key manufacturers in aerospace & defence segment

The commercial aircraft market is dominated by The Boeing Company and Airbus SE, which together had over 90% market share of the global commercial aircraft market. Lockheed Martin Corp. is a key supplier for aircraft manufacturer to the US Defence. Hindustan Aeronautics Limited (HAL) is the sole player that designs & manufactures aircrafts in the Indian aircraft market.

Azad Engineering Ltd. supplies components to 6 manufacturers in the aerospace & defence segment mentioned below (The Boeing Company, Airbus SE, Collins Aerospace, Eaton Corporation Plc, GE Aerospace, HAL, Honeywell International Inc., Lockheed Martin Corp., Safran S.A.).

Details of key manufacturers

Players	Description	Player type	Products (aircraft related)
The Boeing Company	US based MNC that builds, designs & manufactures aircraft	OEM	• Commercial Aircrafts • Defence, Space & Security
Airbus SE	European company that is involved in designing & manufacturing of aircrafts	OEM	• Commercial Aircraft • Defence & Space
Collins Aerospace	American firm that is involved in designing & manufacturing components for aircraft	Component/ Sub-system manufacturer	• Aerostructures • Avionics • Mechanical Systems • Power & Control
Eaton Corporation Plc	American Irish conglomerate with focus on power management	Component/ Sub-system manufacturer	• Fluid Conveyance Systems • Fuel Systems • Motion Control Systems
GE Aerospace	US based MNC operating in multiple industries	Engine manufacturer	• Aircraft Engines
HAL	Indian PSU aerospace & defence company that develops, designs & manufactures aircrafts	OEM	• Defence Aircrafts • Helicopters • UAVs
Honeywell International Inc.	USA based large multinational conglomerate with presence across different industries	Component/ Sub-system manufacturer	• Engine & Power System • Mechanical Systems • Electronics Systems
Lockheed Martin Corp.	USA based aircraft manufacturer and a leading supplier to the US Defence	OEM	• Aircrafts • Radar • Sensors • Weapon systems
Safran S.A.	French MNC that develops, designs & manufactures aircraft engines	Engine manufacturer	• Aircraft Engines

Source: Company websites
Note: List of products is non-exhaustive

OILFIELD INDUSTRY

PRESENCE OF AZAD ENGINEERING LTD. IN THE OILFIELD INDUSTRY

Azad Engineering Ltd. supplies components to the oilfield industry such as drill bits, slips which are

used in the drilling equipment and are part of the exploration and production phase. The company has supplied components to one of the global manufacturers of drilling equipment.

This section of the report covers the assessment of oilfield industry and an overview of the different equipment used in the oilfield industry.

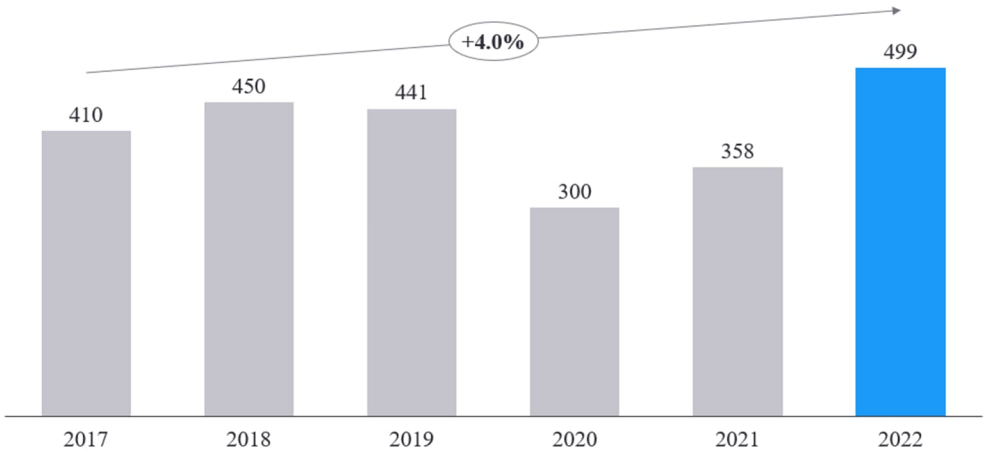
ASSESSMENT OF OILFIELD INDUSTRY

Global exploration and production (E&P) spending

The global spending on upstream capex has been growing at 4% historically and currently stands at 499 Bn (2022). Although the spending witnessed a significant fall in 2020 during COVID but has now bounced back above pre COVID levels. One of factors responsible for this increased spending is also the rising costs along with the increase in E&P activity.

As per worldoil estimates, India, Asia, and Australia are expected to lead the growth in 2023 as spending in these regions remained relatively consistent even during the pandemic. Along with these countries, The MENA region is also expected to witness accelerated growth.

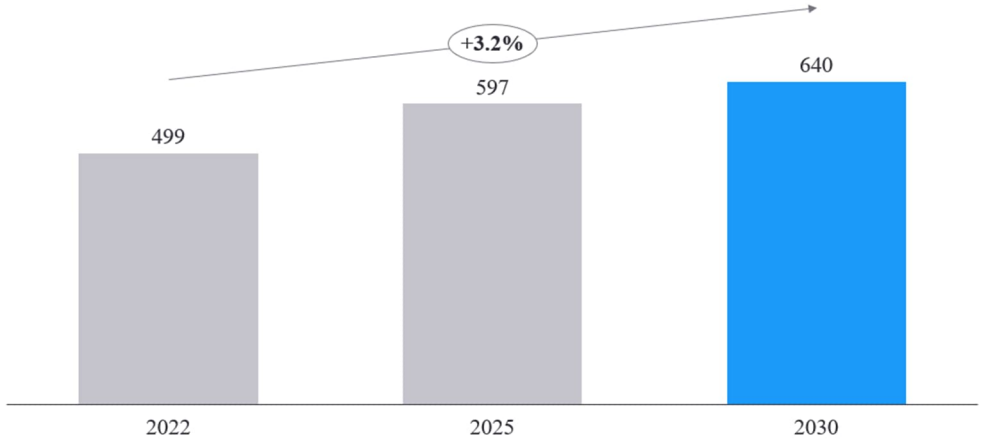
Global O&G upstream capex (US$ Bn), (2017-2022)



Source – IEF, S&P Global Upstream Oil and Gas Investment Outlook, dated February 2023

As per IEF and S&P estimates, the global O&G upstream spending would reach 640 Bn by 2030. Along with the rising costs, the other key drivers for this spending are demand and production. Since historically production growth lagged the demand growth, this further creates a need for increase in E&P to ensure stable supply.

Global O&G upstream capex forecast (US$ Bn), (2022-2030)

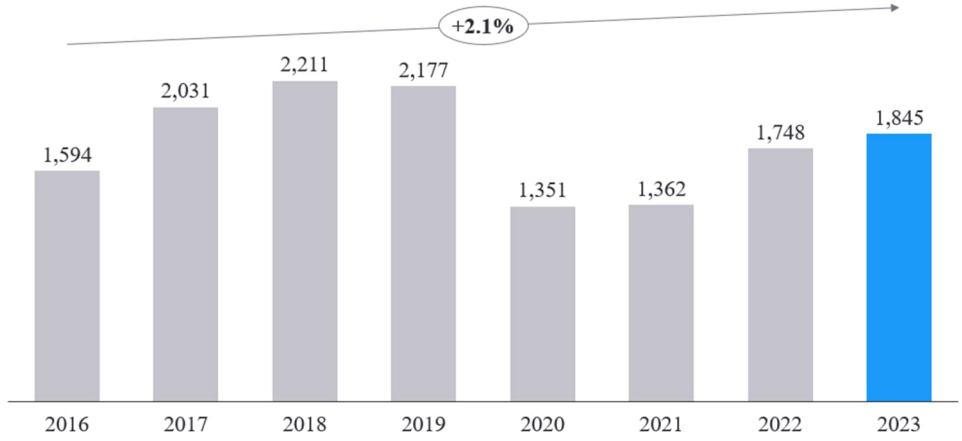


Source – IEF, S&P Global S&P Global Upstream Oil and Gas Investment Outlook, dated February 2023

Global rigs

The global average rig count (including both land and offshore rigs) has grown at about 2% and currently stands at 1,845 (2022). Following the trend in upstream capex, the rig count also witnessed a decline in 2020 but is now recovering.

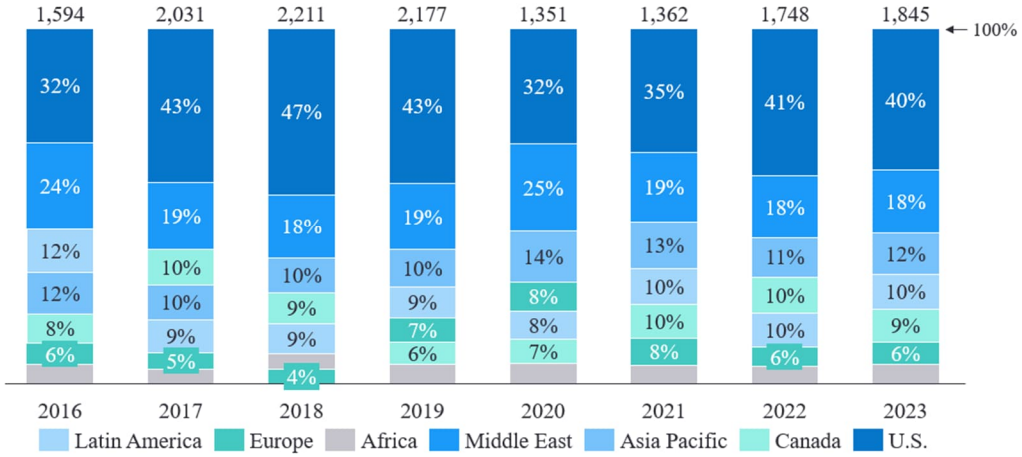
Global rigs (units), (2016-2023)



Source – Baker Hughes rig count, dated July 2023

US leads the average rig count making up for about 40% of the global average rig count, followed by Middle East.

Global rigs share by country (units), (2017-2022)



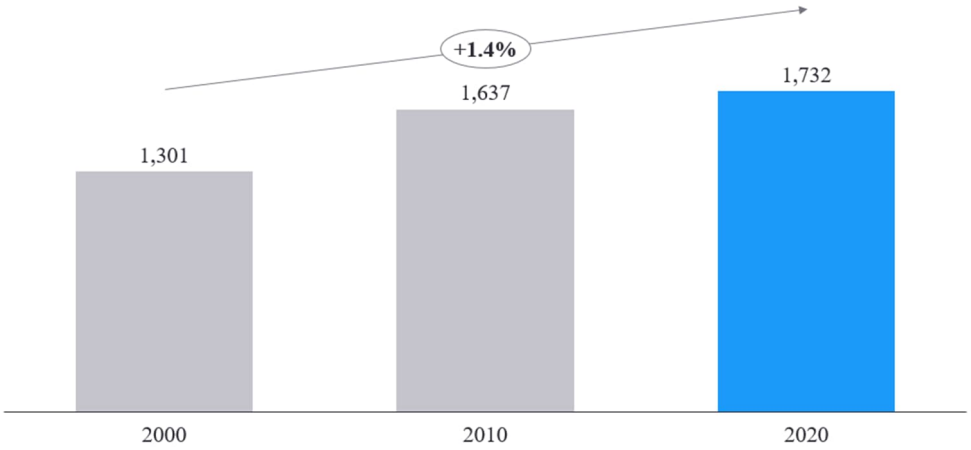
Source - Baker Hughes rig count, dated July 2023

Global crude oil reserves, production, and consumption

Global oil reserves

The global oil reserves have grown at about 1% annually in the last decade and was 1,734 thousand million barrels in 2020.

Global oil reserves (thousand million barrels), (2000-2020)



Source – Energy institute statistical review of world energy, dated June 2023

Global oil production

The global oil production has remained stagnant, witnessing an annual growth of just 0.3% in last 5 years and currently stands at 93,848 thousand barrels daily (2022). Because of the major production cuts by OPEC during COVID to curb the falling oil prices, production also witnessed a decline in 2020 but is now back to pre-COVID level following the demand.

Global oil production (thousand barrels daily), (2016-2022)

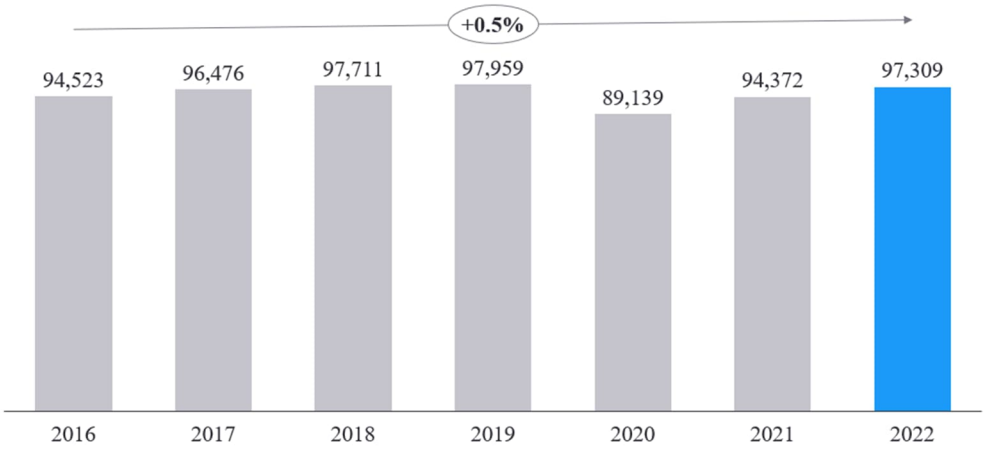
Source – Energy institute statistical review of world energy, dated June 2023

Middle East contributes to about a third to global oil production with North America at second spot accounting 27%. The share of North America has increased slightly since 2016.

Global oil consumption

There was a daily oil consumption of 97,309 thousand barrels globally in 2022 with a compounded annual growth of 0.5% between 2016-22.

Global oil consumption (Thousand barrels daily), (2016-2022)



Source – Energy institute statistical review of world energy, dated June 2023

Indian rigs

Oil rigs, both onshore and offshore regions, are critical to exploration, extraction & production of crude oil.

Indian oil rigs (FY18–FY22)

Oil rigs	2017-18	2018-19	2019-20	2020-21	2021-22
Onshore	112	131	118	105	103
Offshore	47	49	45	44	37
Total	159	180	163	149	140

Source: Snapshot of India's Oil and Gas data dated December 2022

Indian crude oil reserves, production, and consumption

Crude oil reserves

As of FY22, India has around 650 million metric tons of crude oil reserves. With the ever-increasing demand, these reserves are of great importance as reduce India's reliance on imports.

Indian crude oil reserves (FY18 - FY22)

Indian crude oil reserves	2017-18	2018-19	2019-20	2020-21	2021-22
Crude oil reserves (in MMT)	594	619	608	592	651

Source: Snapshot of India's Oil and Gas data dated December 2022

Indian crude oil production & consumption

In FY22 the production of crude oil in India stood at 29.6 Metric Tons, it is lower than the FY21 production by approximately 3%. The primary reason is the decline in productivity of older fields, and some events like shutdowns.

Indian crude oil production - FY18 - FY22

Indian crude oil production	2017-18	2018-19	2019-20	2020-21	2021-22
Crude oil production (in MMT)	35.6	34.2	32.2	30.4	29.6

Source: Snapshot of India's Oil and Gas data dated December 2022

India's crude oil has increased in line with economic growth

Indian crude oil consumption - FY18-FY22

Indian crude oil consumption	2017-18	2018-19	2019-20	2020-21	2021-22
Crude oil consumption (in MMT)	252	257	254	222	241

Source: Snapshot of India's Oil and Gas data dated December 2022

DRILLING EQUIPMENT OVERVIEW

Azad Engineering Ltd. supplies drill bits to the oilfield service and equipment players. Drill bits are part of rotary system of the drilling rig. Additionally, the company also supplies downhole drilling tools such as reamers.

The key components for drilling rig and the downhole drilling tools include:

Drilling Rig

The platform where the drilling work happens is called a drilling rig. It contains the parts that are needed for drilling purpose. The various components include:

1. ***Power System***: This system is responsible to provide power for running the rig. Usually, the power is generated via combustion generators.
2. ***Hoisting System***: This system is used to elevate, descent and hang the drill string and provide support in their insertion into the well. It is the part that does main drilling work.
3. ***Well control & monitoring system***: It is used to prevent the unrestrained & destructive release of high-pressure fluids like oil, gas, or salt water from the formations at subsurface. In the event of an abrupt pressure shift in the well causing formation fluids to surge upwards, the Blowout Preventer (BOP) is promptly activated to seal off the well, preventing blowouts.
4. ***Rotary system***: It causes the drill bit to rotate over the wellbore. The rotary system has multiple components including drill bit.
5. ***Circulating system***: This system is used to support the movement of drill fluid or mud through the drill string. It comprises of multiple components which enable the drilling fluid to effectively accomplish its core functions.

Downhole Drilling Tools

These are used for well drilling, completion & intervention. These tools help in maintaining the level of well & ensure a steady flow from a reservoir. The downhole drilling tools include reamers, elevators, tongs etc. The main reason for utilizing downhole tools is to perform workover tasks and well completion process. These tools also enable the assessment of reservoir properties like rock, sand, and liquids by retrieving samples to the well's surface for analysis.

Key manufacturers of drilling equipment

There are some key players in the drilling equipment market globally including Schlumberger, Ltd., Baker Hughes, Haliburton, NOV Inc., RPC Inc. etc.

Azad Engineering Ltd. supplies components to one of the manufacturers of drilling equipment mentioned below (Schlumberger Limited, Baker Hughes, Halliburton, NOV Inc., RPC Inc.).

Details of key manufacturers

Players	Description	HQs	Products/ Services (O&G)
Schlumberger Limited	Oilfield company providing technology, services & solutions. It is the largest oilfield player	US	• Reservoir characterization • Well construction • Production • Intervention • Drilling services
Baker Hughes	Global energy tech company that is focused on providing services, equipment & digital solutions to O&G	US	• Onshore composite pipes • Reservoir tech services • Drilling • Production • Integrated well services • Processing
Halliburton	Multinational oil and gas company that provides tech & solutions for exploration, drilling & production of oil	US, UAE	• Well construction • Integrated well construction • Drilling & completion • Well cementing • Well construction hardware
NOV Inc.	National Oilwell Varco is a provider of equipment, components & services for the global O&G industry	US	• Drilling • Onshore, offshore prod. • Well construction & completion • Intervention
RPC Inc.	Range of specialized equipment, services, & tech. for exploration, drilling, completion, & prod. activities	US	• Downhole tools • Pressure pumping • Snubbing • Well control

Source: Company websites
Note: List of products is non-exhaustive

MARKET FOR COMPONENTS IN ENERGY, A&D AND OILFIELD INDUSTRY

ENERGY TURBINE COMPONENTS

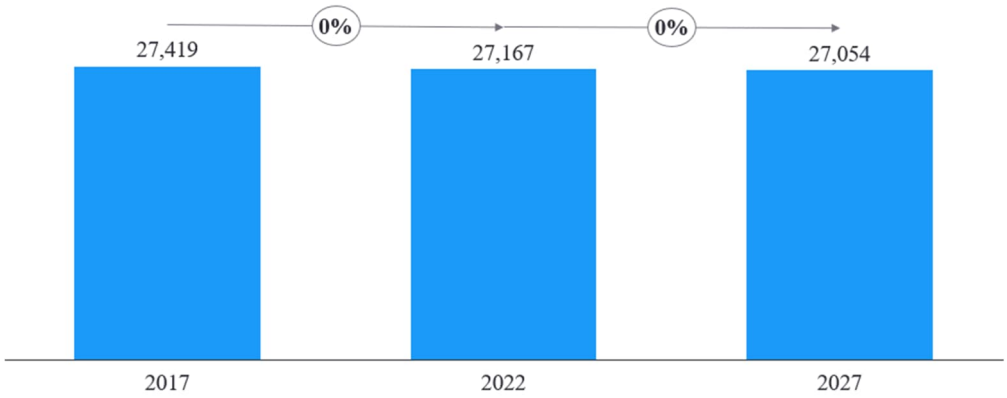
MARKET REVIEW AND OUTLOOK

This report talks about the market for 2 types of energy turbines. These include turbines used for power generation and turbines used in industries for applications other than power generation.

Overall power turbine components market and outlook

The overall global market for components of a turbine used for power generation in 2022 is INR 27,167 Cr & is expected to be INR 27,054 Cr by 2027.

Overall power turbine components market (INR Cr) (2017-22)



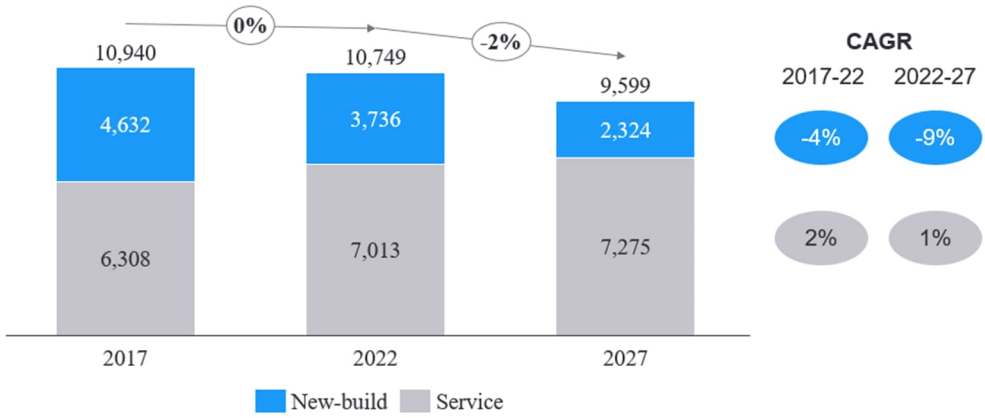
Source: IEA World Energy outlook dated October 2022, Global energy monitor January 2023, Global energy monitor February 2023, World Nuclear Association accessed July 2023, IAEA reports
Note: 1. Overall turbine components market includes blades market for coal, nuclear and gas turbines. Additionally, it includes non-blades market for gas turbines and diaphragm market for nuclear turbines.
2. The market forecast for power turbine (coal and gas) components is based on the STEPS scenario of IEA.

Turbine blades market can be divided into two types of market basis the market that they cater to –

1. ***New-build market*:** Constitutes the market for turbine blades from contracts for the construction of new power plants and those currently under development.
2. ***Service market*:** Turbines have a limited operational lifespan depending on the fuel type for the power generation and other operational factors. At the end of the operational period or in the case of unforeseen breakdown these blades need to be replaced which generates demand for blade manufacturers.

The overall global market for blades of a turbine used for power generation in 2022 was INR 10,749 Cr & is expected to be INR 9,599 Cr by 2027.

Overall power turbine blades market (INR Cr) (2017-22)



Source: IEA World Energy outlook dated October 2022, Global energy monitor January 2023, Global energy monitor February 2023, World Nuclear Association accessed July 2023, IAEA reports
Note: 1. Overall turbine blades market includes market for coal, nuclear and gas turbines.
2. The market forecast for power turbine (coal and gas) components is based on the STEPS scenario of IEA.

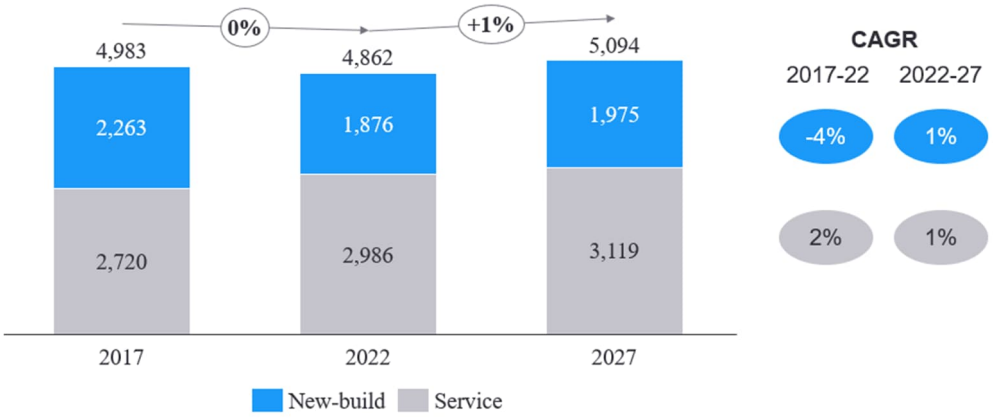
Global gas power turbine blades market

The demand of gas turbine is dependent on the demand for natural gas power plants. The International Energy Agency predicts a 2.5% growth in global natural gas demand for the next decade which is driven by multiple factors such as:

1. Demand of turbines led by growth of gas-based power generation in countries that have access to natural gas or have set up LNG facilities to source gas through contracts.
2. ***Switch to Natural Gas*** - Countries across the world are opting for natural gas as a more environment friendly option for power generation to reduce their impact and achieve net-zero emissions by 2050.

The global gas turbine blades market in 2022 was INR 4,862 Cr & is expected to go up to INR 5,094 Cr by 2027. Service market for gas turbines account for ~60% in 2022 as well as 2027.

Global gas power turbine blades market (INR Cr) (2017-27)



Source: IEA World Energy outlook dated October 2022, Global energy monitor February 2023.
Note: 1. The market forecast for gas power turbine components is based on the STEPS scenario of IEA.

New gas power turbine blades market is directly linked to the growth of use of gas power, and these are linked with the sale of turbines as sold by the OEMs. The replacement is determined by the age of gas turbines, maintenance cycle lengths & overall new technology push.

Natural gas is also seen as a bridging fuel that supports integration of intermittent renewable energy sources. Hence there are turbines designed to utilize wide variety of fuels such as renewable gases, hydrogen blends and the likes. New gas turbines are being modified to burn hydrogen as a fuel, and this will push the life of these turbines as their use will continue even in the new energy economy with high share of renewable energy.

Global nuclear power turbine blades market

Global nuclear power turbine blades market is estimated to be roughly INR 364 Cr in 2022 and is projected to reach INR 536 Cr by 2027 at a CAGR of 8% between 2022-27. Both the new-build and service-related market for nuclear turbines blades is expected to increase by 2027 driven by growing nuclear power generation capacity and hence, reactors globally.

The growth in the nuclear turbine blades market is directly associated to the growth of the overall nuclear power industry. Some of the key drivers for the nuclear power industry are –

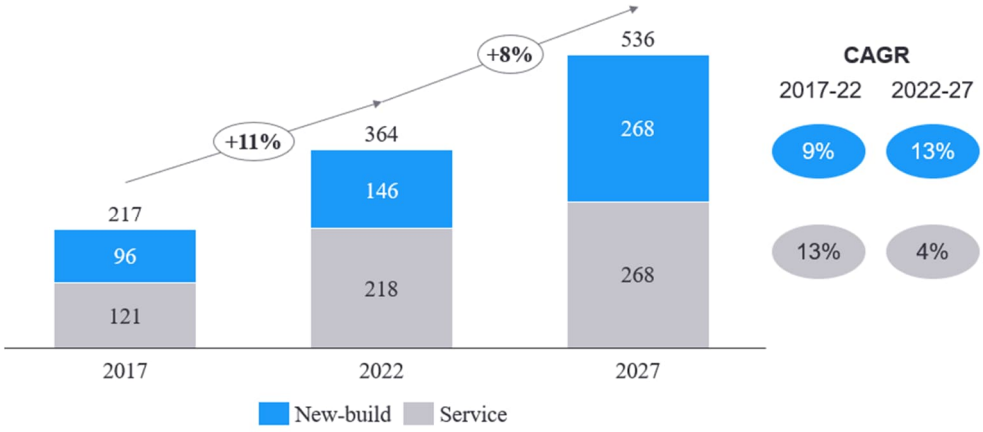
1. ***Focus on clean energy*** – Countries across the globe are focusing on controlling their effect on global warming with a higher focus on alternate energy sources like renewables and nuclear power.
2. ***Expected adoption of SMR technology by developing nations*** – Developing economies across

the world are showing an interest in SMR technology due to cost advantages. About 80 SMR technologies are currently being developed and the volume of orders from these reactors are expected to increase due to lower set-up time and use of standardized components.

New-build market: Over the years, there has been an increase in the number of new nuclear power plants with an expectation of future growth driven by the number of power plants which are currently under construction and set to begin operations in the next five years.

Maintenance market: Typically, reactor turbines have an operational lifespan ranging from 25 to 30 years. But there is a maintenance market targeting reactors of this age bracket.

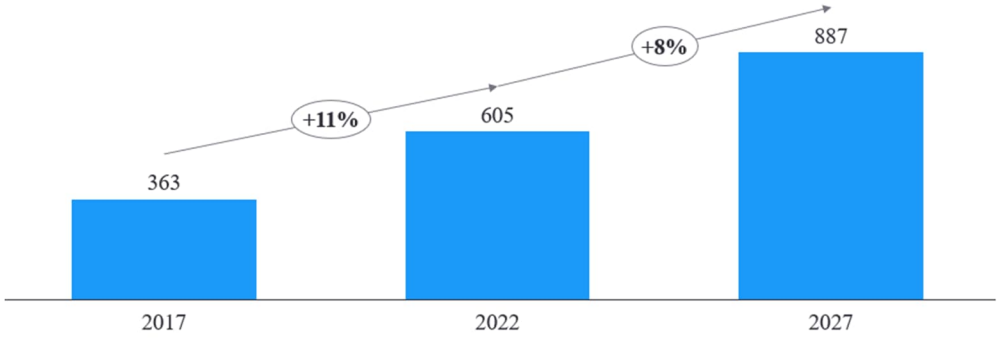
Global nuclear power turbine blades market (INR Cr) (2017-27)



Source – World Nuclear Association accessed July 2023, IAEA reports.

The overall market for diaphragm used in nuclear power plant turbines is INR 605 Cr in 2022 & is expected to be INR 887 Cr in 2027 with an estimated CAGR of 8% in 2022-27.

Global nuclear power turbine diaphragm market (INR Cr) (2017-2027)

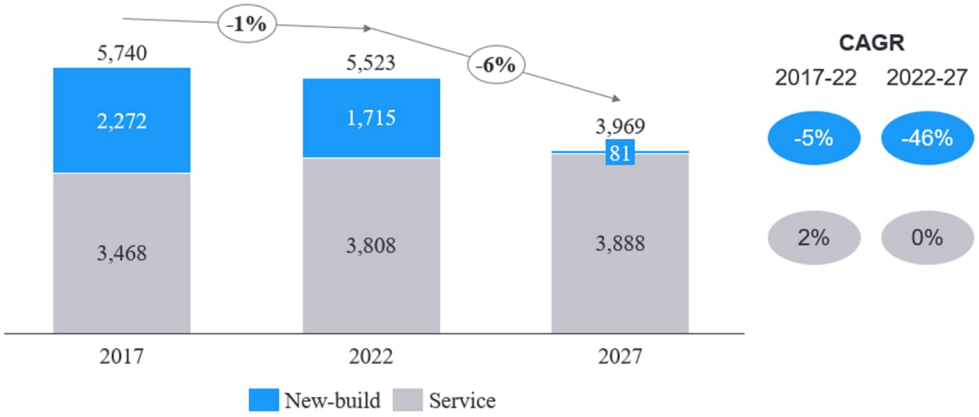


Source: World Nuclear Association accessed July 2023, IAEA reports

Global coal power turbine blades market

The global coal power turbine blades market in 2022 was INR 5,523 Cr & is expected to be INR 3,969 Cr by 2027. Service market for coal power turbines is expected to account for majority of the market by 2027.

Global coal power turbine blade market (INR Cr) (2017-27)



Source: IEA World Energy outlook dated October 2022, Global energy monitor January 2023.
Note: 1. The market forecast for coal power turbine components is based on the STEPS scenario of IEA.

The overall global coal power turbine market, including new blades and blades used in servicing existing turbines, has witnessed a small decline over the years as new capacity additions of coal power generation plants has been reducing. This trend is expected to continue resulting in decline of market for blades for turbines for new coal plants. However, the market of blades for servicing turbines is expected to stay flat.

Newer materials require manufacturers and their vendors to make improvements in manufacturing processes and equipment to continue to remain in the market. One of the key trends in the steam turbine blades market is the ongoing pursuit of weight reduction of the turbine components. Lighter turbine blades offer several advantages, such improved turbine efficiency, reduced material costs, and relatively easier handling during maintenance and installation.

Advanced materials such as nickel based super alloys and new manufacturing processes are being explored by the manufactures to achieve this goal. While these new materials provide better temperature resistance (ability to maintain their mechanical properties at elevated temperatures of up to 1400 degree) and strength, their high cost remains a key challenge for a wide adoption.

Ceramic blades are also lighter and also eliminate the requirement for cooling system. However, these blades besides being more expensive and also brittle lengthening the period for the shift to happen.

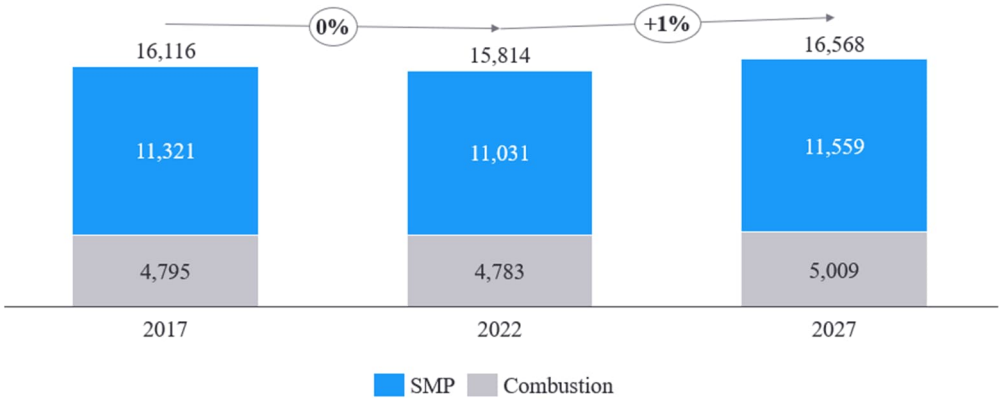
As per IEA, unabated coal accounted for over 30% of total electricity generated. It also catered to over 50% of the additional global demand for electricity in 2021. Energy crisis due to Russia-Ukraine war postponed the phase down of coal-fired power plants in many countries and they temporarily reopened decommissioned coal fired plants in order to reduce natural gas consumption and to meet energy demand. Although temporary, this trend has boosted to the coal fired plant generation and the demand for spares.

Advanced economies across the world are planning to reduce coal-based power generation (a reduction of about 60%), but the overall usage of coal to meet energy demand will increases by 3% due to developing countries by 2030. However, it is expected that in the long term, coal-based power generation will reduce with higher usage of renewable sources of energy.

Power turbine components (non-blades) market & outlook

Apart from power turbine blades, the other relevant components of a turbine include Special Machined Parts (SMP) & Combustion chamber. The overall market for non-blade components for gas power turbines is INR 15,814 Cr in 2022 & is expected to be INR 16,568 Cr in 2027 with an estimated CAGR of 1% in 2022-27.

Global gas power turbine components (non-blades) market (INR Cr) (2017-2027)

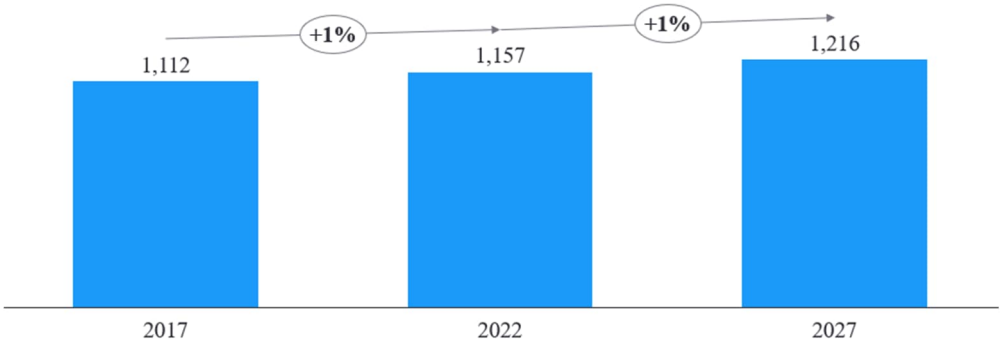


Source: IEA World Energy outlook dated October 2022, Global energy monitor February 2023.
Note: 1. The market is relevant to gas turbines only.
2. The market forecast for gas power turbine components is based on the STEPS scenario of IEA.

Industrial gas turbine blades market & outlook

The overall market for blades for industrial gas turbines is INR 1,157 Cr in 2022 & is expected to be INR 1,216 Cr in 2027 with an estimated CAGR of 1% in 2022-27.

Global industrial gas turbine blades market (INR Cr) (2017-2027)



Source: IEA World Energy outlook dated October 2022
Note: The market forecast for industrial gas turbine components is based on the STEPS scenario of IEA.

COMPETITION LANDSCAPE FOR ENERGY TURBINE COMPONENTS

Industry structure

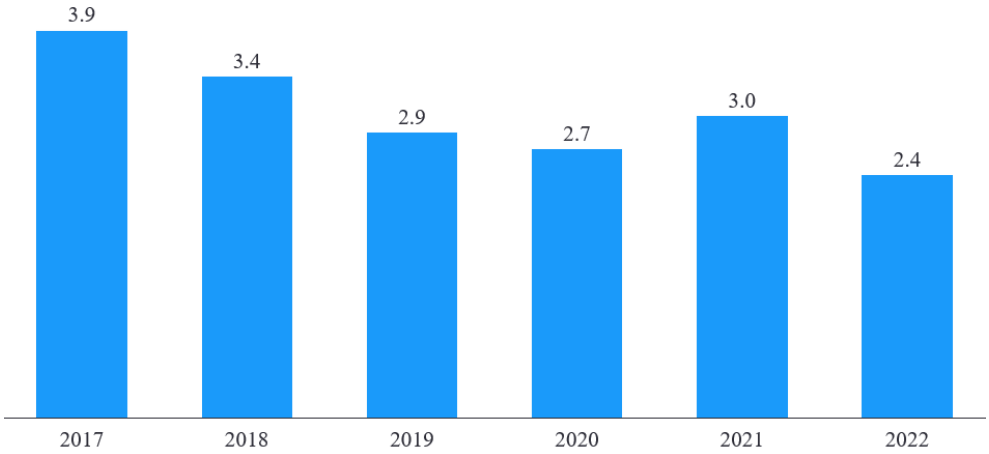
The turbine and its component manufacturing industry has a two-tiered structure where there are large players (OEMs) which are involved in research and development, design, manufacturing, and assembly of turbines. Then there are downstream manufacturing companies who have the capability of supplying a few critical components to the OEMs.

Global and Indian trade

Overall global exports

The global exports of turbine parts have fallen in the past few years along the share of fossil fuel-based power generation. In 2022, its global exports stood at US$ 2.4 Bn, which has reduced by ~38% since 2017.

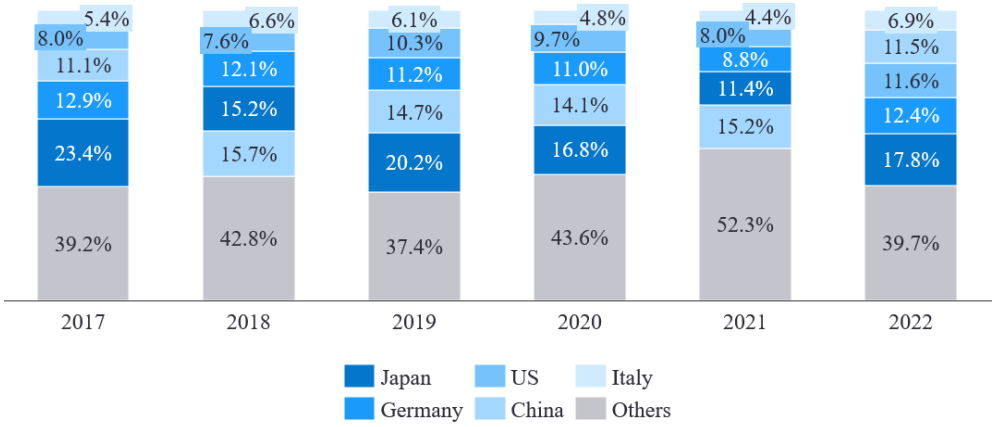
Global exports of turbine parts (US$ Bn) (2017-22)



Source – ITC trade map
Note –HS Code 84069 refers to "Parts of turbines" (As per Ministry of Corporate Affairs, MCA) Global data is being analyzed using CY data instead of FY data.

Japan, Germany, and US have been a major exporters of turbine parts and contribute more than half of the global exports while India's share of global exports in turbine parts stood at ~4% in 2022.

Top 5 countries exporting turbine parts (US$ Bn) (2017-22)

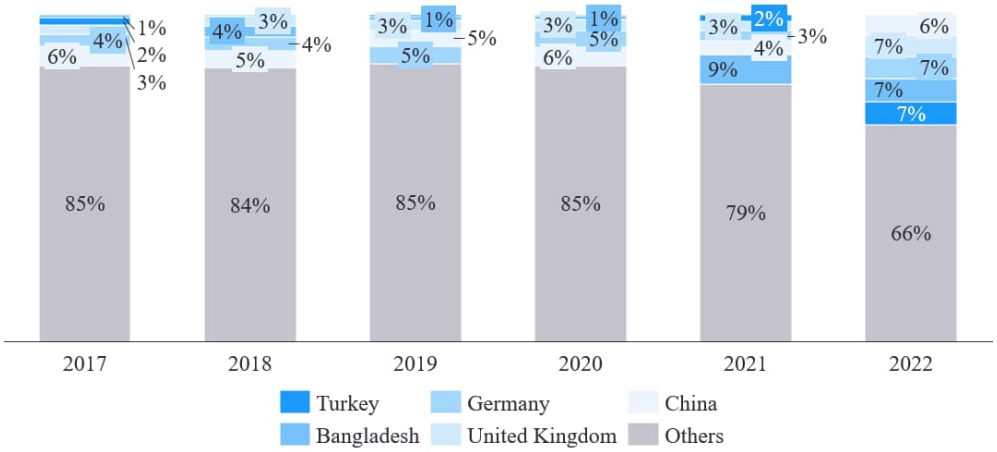


Source – ITC trade map
Note - HS Code 84069 refers to "Parts of turbines" (As per Ministry of Corporate Affairs, MCA) Global data is being analyzed using CY data instead of FY data.

Global trade by importing countries

Turkey, China, Germany, UK, and Bangladesh have been a significant importers of turbine parts accounting for a third of global imports in 2022. India share of imports by value has hovered around 3-5% of the total imports in the last 5 years.

Top 5 nations importing turbine parts (US$ Bn) (2017-22)

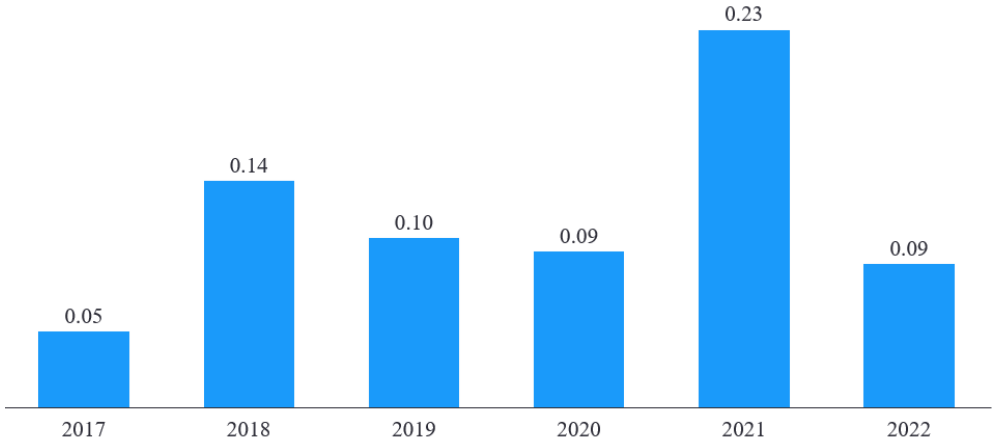


Source – ITC trade map
Note –HS Code 84069 refers to "Parts of turbines" (As per Ministry of Corporate Affairs, MCA). Global data is being analyzed using CY data instead of FY data.

Exports from India

India's export of turbine components was around US$ 90 Mn in 2022. While this was 60% lower than in 2021, it is in line with the amount exported in the previous years (2017-2020). The higher value of exports in 2021 was probably due product mix. USA and Japan continued to be the top destinations for Indian turbines in 2022.

Turbine parts exports from India (US$ Bn) (2017-22)



Source – ITC trade map
Note – HS Code 84069 refers to "Parts of turbines" (As per Ministry of Corporate Affairs, MCA). For the purpose of comparing with global trade, we have used calendar year for India trade data.

Value chain for the turbine manufacturing market

Turbine manufacturing value chain can be broadly divided into three parts:

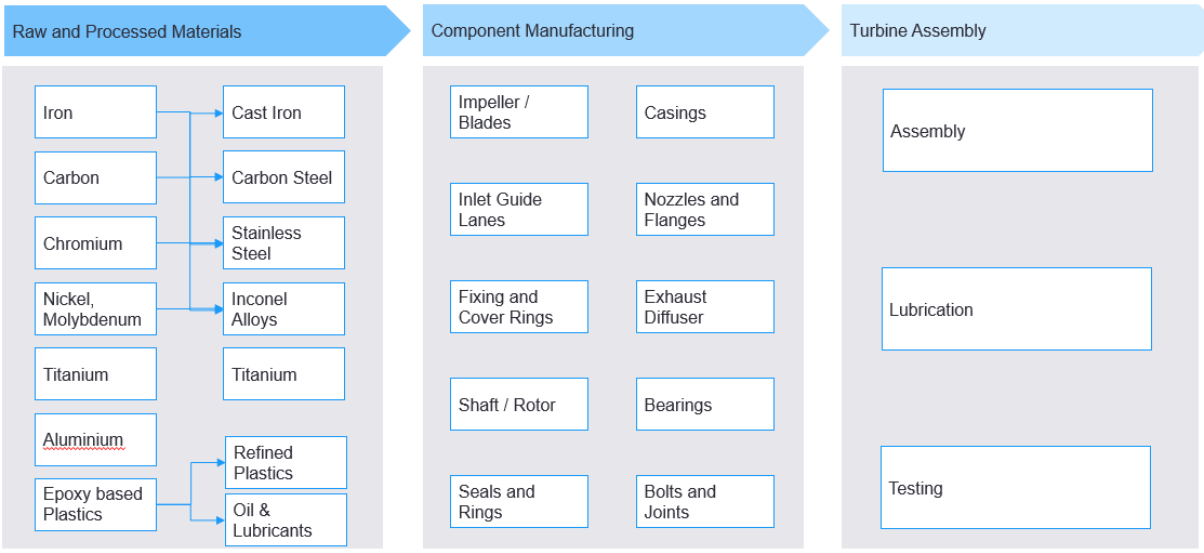
1. Suppliers of raw and processed materials
2. Component manufacturers
3. Turbine assembly

Companies operating within the turbine assembly segment of the value chain play a crucial role in delivering the end product to customers, namely power plants. In addition to assembling the turbines, these companies have expertise in design, research, and development, as well as manufacturing. But

they also outsource part of their manufacturing processes to machining and manufacturing firms, which provide the necessary turbine components based on specific requirements.

Both, downstream manufacturing players and turbine manufacturers have their respective supply chains through which they acquire raw materials and processed materials from various sources.

Turbine manufacturing Industry Value-Chain



Source: Global Value Chain and Manufacturing Analysis on Power Plant Turbines, NREL
Note: Examples in the raw and processed materials, components and turbine assembly are not exhaustive

Key players manufacturing turbine components

There are several players in the BTG (Boiler, Turbine and Generator) equipment space, catering to the needs of the power plants in the country. Several private companies have entered this space by partnering with domestic companies. Many of these companies / JVs have either developed an integrated facility capable of manufacturing a number of components that goes into a turbine, or they assemble a turbine by outsourcing parts like blades, rotor casing, and other components.

Some of the prominent players operating in the domestic BTG equipment industry are - L&T MHI Power Turbine Generators Pvt. Ltd., Triveni Turbines Ltd., and others. Some of these manufactures blade inhouse, while others only design and outsource the manufacturing part.

Prominent domestic and global BTG equipment players which hold the capability of manufacturing turbine blades include –

Azad Engineering Ltd.:

Azad Engineering Ltd. started its core manufacturing in 2008 and is a player in the energy turbine and aerospace & defence components market. It is also a manufacturer of oil & gas components. In energy turbine sector, the company produces rotors and blades for gas turbines and moving and guide blades for variety of steam turbines. The company has high-precision manufacturing ability and caters to prominent OEMs in the energy sector. The company's manufacturing infrastructure comprises four facilities in India, at Hyderabad with a total manufacturing area of ~20,000 sq. meters.

Details of other players

The details about other key players manufacturing turbine components are mentioned below.

Details of key players manufacturing turbine components

Players	Key products	Key services	Manufacturing locations	Markets served
L&T MHI Power Turbine Generators Pvt. Ltd.	• Steam turbines • Generators	• Engineering consulting • Equipment maintenance • Technical support	India	Domestic (India) & export
Triveni Turbines Ltd.	• Steam turbines	• Installation • Maintenance support • Complete plant service across plant island & balance of plant	India	Domestic (India) & export
SIFCO Industries Inc.	• Steam turbines • Gas turbines • Discs, shafts & gears • Blades and vanes	• Turbine repair & maintenance service • Digital plant support solutions	USA, Italy	Domestic (USA / Italy) & export
Pietro Rosa TBM	• Airfoils for jet engine, gas turbine & steam turbine • Engine mounts • A-frame	• Engineering and design services	USA, Italy	Domestic (USA / Italy) & export

Source: Company websites
*Note: SIFCO Industries Inc. acquired Italy-based C*Blade S.p.a., which also has capabilities in steam and gas turbines and aerospace parts in 2015*

Operational benchmarking of key players

Value chain presence

As mentioned in the previous section, players operating in the assembly segment of the value chain have the manufacturing expertise along with the designing and R&D capability. Part of their manufacturing work is outsourced to smaller companies who hold the manufacturing capability and can provide critical components, as per specific design and requirement.

Value chain presence of key players

	Component Manufacturer	Final turbine assembly
Azad Engineering Ltd.	✓	✗
L&T MHI Power Turbine Generators Pvt. Ltd. (OEM)	✓	✓
Triveni Turbines Ltd. (OEM)	✓	✓
SIFCO Industries Inc.	✓	✗
Pietro Rosa TBM	✓	✗

Source – Company websites

Segmental presence of various players

Most players are focused on coal and gas power plants, with many specializing in both steam and gas turbines. However, some players focus exclusively on one of these technologies. These companies manufacture various components such as turbine blades, fasteners, nozzles, and other crucial parts.

Segmental presence of various players

Company name	Sectors served	Specialization in turbine type	Components manufactured
Azad Engineering Ltd.	Coal, Gas, Nuclear	Gas + Steam Turbines	Blades, fasteners, other hardware
L&T MHI Power Turbine Generators Pvt. Ltd.	Coal and Gas	Steam Turbine	Blade, Stator/Rotor Coil

Triveni Turbines Ltd.	IPP, CPP	Steam Turbine	Casings, rotors, blades, labyrinth packing, oil seal holders
SIFCO Industries Inc.	Coal and Gas	Gas + Steam Turbines	Turbine Blades, Vanes, Shafts
Pietro Rosa TBM	Coal and Gas	Gas + Steam Turbines	Airfoils

Source – Company websites
Note: IPP and CPP refers to Independent Power Producer and Captive Power Plant, respectively.

Financial benchmarking of key players

Revenue comparison of key players

Azad engineering Ltd. is one of the fastest growing manufacturers amongst the competitors listed below.

Revenue comparison of competitors 2020-2024 H1 *(INR Cr.), CAGR (2020-23)*

Company	2020	2021	2022	2023	2024 H1	CAGR
Triveni Turbines Ltd.	832	722	882	1,290	792	15.7%
SIFCO Industries Inc.	936	820	691	-	-	-14.0%
L&T MHI Power Turbine Generators Pvt. Ltd.	841	762	625	361	-	-24.6%
Pietro Rosa TBM	-	435	538	-	-	-
Azad Engineering Ltd.	124	125	199	262	170	28.4%
C*Blade S.p.a.	-	141	136	-	-	-

Source – Financials reports published in MCA, Company annual reports, SEC filings, Italian business register.
Note: 1. For Indian Players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
2. For Foreign Players, figures are converted using latest conversion rates
*3. For SIFCO Industries Inc. & C*Blade S.p.a., financials are for year ending Sept & for Pietro Rosa TBM, financials are for year ending Dec.*
4. CAGR for SIFCO Industries Inc.is for 2020 – 22 due to lack of 2023 financial data.
5. Revenue for SIFCO Industries Inc. between Oct 22 – Jun 23 is INR 514 Cr.

Comparison of EBITDA margin of key players

All Indian players are found to have a positive EBITDA margin. Azad Engineering Ltd.'s EBITDA margin stood at ~31% in FY23 which is one of the highest margins compared to the competitors listed below.

EBITDA margin comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Triveni Turbines Ltd.	20.5%	23.1%	21.8%	21.4%	21.9%
SIFCO Industries Inc.	10.0%	-0.3%	-10.4%	-	-
L&T MHI Power Turbine Generators Pvt. Ltd.	21.6%	16.4%	17.5%	13.3%	-
Pietro Rosa TBM	-	0.1%	2.4%	-	-
Azad Engineering Ltd.	34.7%	24.4%	33.7%	31.4%	37.3%
C*Blade S.p.a.	-	7.8%	-4.1%	-	-

Source – Financials reports published in MCA, Company annual reports, SEC filings, Italian business register.
Note: 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
*2. For SIFCO Industries Inc. and C*Blade S.p.a., financials are for year ending Sept and for Pietro Rosa TBM, financials are for year ending Dec.*
3. EBITDA margin for SIFCO Industries Inc. between Oct 22 – Jun 23 is -7.0%

Comparison of PAT margin of key players

Azad Engineering Ltd. and Triveni Turbines Ltd. have had consistently positive net profit margins.

PAT margin comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Triveni Turbines Ltd.	13.5%	16.8%	8.2%	14.9%	15.8%
SIFCO Industries Inc.	8.1%	-0.7%	-11.5%	-	-
L&T MHI Power Turbine Generators Pvt. Ltd.	5.8%	4.7%	1.6%	-14.7%	-
Pietro Rosa TBM	-	-2.7%	-0.7%	-	-
Azad Engineering Ltd.	17.1%	9.2%	14.8%	3.2%	15.9%
C*Blade S.p.a.	-	1.9%	-10.4%	-	

Source – Financials reports published in MCA, Company annual reports, SEC filings Italian business register.
Note: 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
*2. For SIFCO Industries Inc. and C*Blade S.p.a., financials are for year ending Sept and for Pietro Rosa TBM, financials are for year ending Dec.*
3. PAT margin for SIFCO Industries Inc. between Oct 22 – Jun 23 is -9.0%

Comparison of ROCE of key players

Return on Capital Employed for Azad Engineering Ltd. and Triveni Turbines Ltd. was 20-21% in 2022.

ROCE comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Triveni Turbines Ltd.	27.4%	22.6%	19.8%	33.0%	18.0%
SIFCO Industries Inc.	12.5%	-1.8%	-14.0%	-	-
L&T MHI Power Turbine Generators Pvt. Ltd.	11.8%	10.6%	6.4%	0.1%	-
Azad Engineering Ltd.	29.4%	15.0%	21.0%	14.9%	11.6%

Source – Financials reports published in MCA, Company annual reports, SEC filings.
Note: 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
*2. For SIFCO Industries Inc. and C*Blade S.p.a., financials are for year ending Sept and for Pietro Rosa TBM, financials are for year ending Dec.*
3. ROCE for SIFCO Industries Inc. between Oct 22 – Jun 23 is -7.7%

Comparison of P/E ratio of key players

P/E ratio for Triveni Turbines was 24.2x as on Mar 2022.

P/E ratio comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Triveni Turbines Ltd.	14.9	32.1	24.2	55.9	-
SIFCO Industries Inc.	2.3	-	-	-	-

Source – Financials reports published in MCA, Company annual reports, SEC filings, BSE India, Nasdaq
Note: 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
*2. For SIFCO Industries Inc. and C*Blade S.p.a., financials are for year ending Sept and for Pietro Rosa TBM, financials are for year ending Dec.*
3. Closing price of last trading day of relevant month is considered for calculation of P/E ratio
4. P/E ratio of 2024 H1 is not included as annualized earnings are not available
5. P/E ratio for SIFCO Industries (2021, 2022) is negative due to negative earnings.

Comparison of P/B ratio of key players

P/B ratio of Triveni turbines was 7.6x as on Mar 2022.

P/B ratio comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Triveni Turbines Ltd.	3.4	5.2	7.6	14.1	15.7
SIFCO Industries Inc.	0.5	1.0	0.4	-	-

Source – Financials reports published in MCA, Company annual reports, SEC filings, BSE India, Nasdaq
Note: 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
*2. For SIFCO Industries Inc. and C*Blade S.p.a., financials are for year ending Sept and for Pietro Rosa TBM, financials are for year ending Dec.*
3. Closing price of last trading day of relevant month is considered for calculation of P/B ratio
4. P/B ratio for SIFCO Industries Inc. as on Jun 2023 is 0.4x.

Key success factors in the industry

Key success factors in the industry include –

1. ***Quality of products*** – As the products go into super critical and expensive end use applications, the products are of the highest quality and quality assurance are critical with "zero parts per million" defects requirement. Superior manufacturing demands a unique blend of expertise, innovation, quality, and advanced safety controls in the industry which cannot be obtained by only installing CNC machines.
2. ***Pricing*** - Outsourcing by OEMs is primarily driven by the potential for cost saving; Indian players are 20-30% cheaper compared to European players.
3. ***Adherence to delivery timelines*** - OEMs face the risk of penalties from end customers for delay in adhering to service and order timelines; they in turn require vendors to deliver on schedule and quality.
4. ***Geographic Location*** – Geo-political risks associated with supplier locations are closely monitored by the OEMs. Locations with low geopolitical risk are preferred for developing a supplier base, and India is increasingly being considered a strategic procurement destination by OEMs.
5. ***Scale of Operations*** - OEMs prefer to work with suppliers capable of scaling over time, aiming for consolidation in the supplier base with a reasonable share diverted towards each supplier.

Additionally, the industry has a significant entry barrier due to a lengthy qualification process for the energy components due to criticality of components. The vendors must go through separate qualification process for each component that they supply. The qualification process for a new vendor is stringent and includes multiple steps mentioned below –

1. Identification and understanding the vendor.
2. Assessment and audit of the technical capabilities for the vendor
3. RFQ and negotiations
4. Vendor registration
5. Evaluation and test of the product qualifications
6. Final contract and negotiations
7. PO for product supply

This entire process is time intensive and often takes more than 15 months to qualify as a supplier during which the vendor is evaluated by the OEM. This is in addition to the time taken for set-up of manufacturing infrastructure and facilities.

Once a contract is awarded by an OEM to a supplier for a critical component, the OEM and the supplier typically spend significant amount of time and capital on design, manufacturing, first article inspection (FAI), testing & certifications for product specific equipment such as tooling. Any new supplier will need to undergo the same process. OEMs are reluctant to switch suppliers as there are high switching costs unless the current suppliers are unable to meet the requirements on quality, cost, or delivery.

Comparison of Indian, Chinese, and other global players

Chinese and Indian players possess a competitive advantage due to the lower labor costs in these countries when compared to OECD countries. The attractiveness of China has reduced due to growing geopolitical tensions and also rising labour costs. Products that have significant IP may also be at risk as the US restricts such IP from being transferred.

AEROSPACE AND DEFENCE COMPONENTS

MARKET REVIEW AND OUTLOOK

Key customers in aerospace and defence

Based on the analysis of market share of US based commercial aircraft & engine manufacturer, The Boeing Company & GE Aerospace are the largest players that emerge out of the segment. Amongst suppliers, Eaton Corporation Plc is supplier of high-pressure main engine fuel pumps and related components to engine manufacturers such as GE Aerospace. Similarly, Honeywell International Inc.is a key supplier to The Boeing Company, Honeywell International Inc. is also expanding its capacity to cater to the growing demand from players like The Boeing Company, due to ongoing fleet expansion worldwide. In the Indian aircraft market, Hindustan Aeronautics Limited (HAL) is the sole player that designs & manufactures aircrafts, hence it is considered as a key customer in the addressable market.

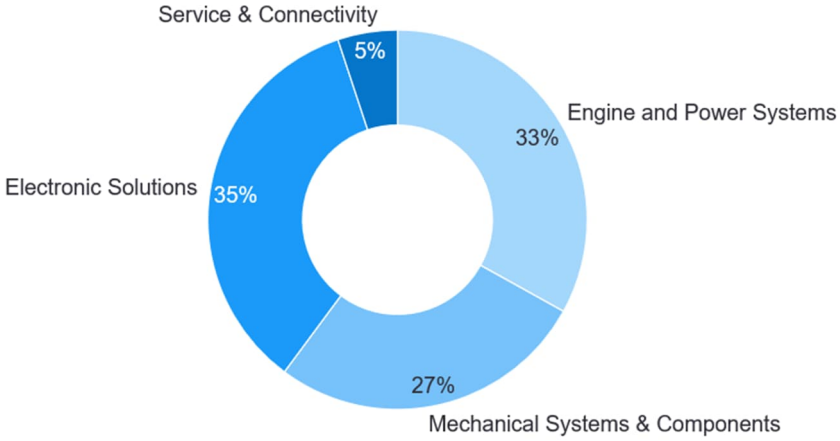
Honeywell International Inc.:

Overall revenue for Honeywell International Inc. (2018-22)

In US$ Bn	2018	2019	2020	2021	2022
Overall aerospace	15.5	14.1	11.5	11.0	11.8

Source: Annual report

Segment revenue for Honeywell International Inc. (2022) – (%)



Source: Investor Presentation for Honeywell International Inc. 2022

Relevant offering: Relevant offering for Honeywell International Inc. is Electronic Solutions (ES), Engine and Power Systems (EPS) & Mechanical Systems & Components (MCS) and Service & Connectivity. Service & Connectivity is excluded since it includes data analytics-based service.

GE Aerospace:

Revenue by segment for GE Aerospace (2018-22)

In US$ Bn	2018	2019	2020	2021	2022
Overall aerospace	30.5	32.8	22.0	21.3	26.0
Commercial engines & services	22.7	24.2	13.0	14.3	18.6
Military	4.1	4.3	4.5	4.1	4.4
Systems & others	3.7	4.2	4.5	2.8	2.9

Source: Company annual report

Relevant offering: Commercial engines & services is relevant offering. Defence business has higher entry barriers and is largely outsourced to US vendors due to confidentiality challenges.

Eaton Corporation Plc:

Revenue by segment for Eaton Corporation Plc (2018-22)

In US$ Bn	2018	2019	2020	2021	2022
Overall aerospace	2.3	2.5	2.2	2.6	3.0

Source: Company annual report

Relevant offering: For Eaton Corporation Plc, defence may not be considered as a relevant offering with major focus on commercial.

The Boeing Company:

Revenue by segment for The Boeing Company (2018-22)

In US$ Bn	2018	2019	2020	2021	2022
Overall aerospace	100.9	76.9	58	62.3	66.5
Commercial airplanes	57.5	32.3	16.2	19.5	25.8
Defence, space & security	26.3	26.1	26.3	26.5	23.1
Global services	17.1	18.5	15.5	16.3	17.6

Source: Company annual report

Relevant offering: Commercial Airplanes & Global Services are relevant offerings. First gaining the market of Global services & later moving to Commercial Airplanes. Defence market may not be addressable for upcoming 5-6 years.

Hindustan Aeronautics Limited (HAL):

Revenue by segment for HAL (FY19-23)

In US$ Bn	FY19	FY20	FY21	FY22	FY23
Overall	2.46	2.65	2.80	3.00	3.37
Manufacturing	1.05	1.06	1.07	0.92	0.61
ROH & Spares	1.22	1.46	1.56	1.94	2.39
Development & Others	0.14	0.11	0.14	0.12	0.34
Exports	0.05	0.03	0.03	0.02	0.03

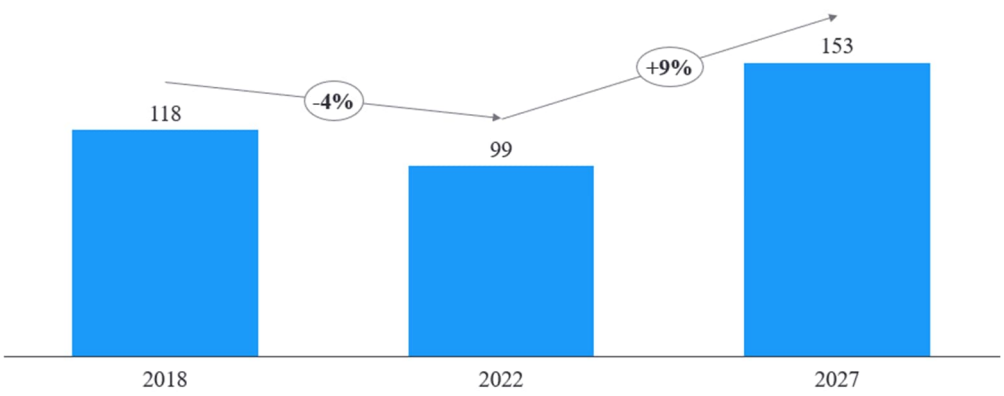
Source: Company annual report

Relevant offering: Manufacturing, ROH & Spares & Exports are relevant offerings which Azad Engineering Ltd. can address.

Overall market size for the components for the above customers

The addressable market for aerospace and defence is INR 99k Cr in 2022 & is expected to go up to INR 153k Cr by 2027.

Addressable market for aerospace & defence components (in INR'000 Cr) (2018-27)



Source: Company annual reports
Note: The market includes the market for five key players: Eaton Corporation Plc, The Boeing Company, Honeywell International Inc., GE Aerospace & HAL

GE Aerospace is the player with the largest addressable market size, followed by The Boeing Company & Honeywell International Inc.

In a typical aircraft multiple components require machining to attain the required precise measurements that are defined by the design of the aircraft. By using machining one can produce complex dimensions & shapes. Some of the parts of an aircraft that need machining include:

1. Engine
2. Avionics
3. Sensors
4. Seating
5. Connectors
6. Airframe

Forging involves process of putting pressure over metal by using some external force such as hammer. There are multiple components of an aircraft that require forging. Some of these components are:

1. Engine discs
2. Components of a wing
3. Undercarriage components
4. Air fuselage.

It has been observed that in the last few years air travel has increased significantly, with projections of it going further up. The market for aerospace components is contingent on several factors:

1. ***Increasing demand for commercial aircrafts****:* The demand for commercial aircrafts is increasing, driven by higher demand from countries like India.
2. ***Rise in defence spending****:* Globally the defence spending is expected to go up. With ongoing modernization of defence equipment, the demand of more advanced & powerful military aircrafts is expected to go up.
3. ***Technological advancements****:* Global trends such as higher fuel efficiency, next generation engines and materials is creating avenues for research & development opportunities for component suppliers.

While there are drivers that push the demand for the aerospace components some of the risk factors are:

1. ***Supply-chain disruptions***: The aerospace industry is dependent on suppliers from a number of countries to meet its component and material requirements. Disruption in availability of a raw material or intermediate material can disrupt the supply chain impacting the business of component manufacturers.
2. ***Usage of advanced materials****:* Continuous push for lighter aircrafts and engines with greater fuel efficiency have resulted technological advancements where either newer material are being used or newer manufacturing techniques are being adopted.
3. ***Increasing competition & high development costs****:* Aircraft manufacturing is largely a duopoly limiting the bargaining power of the suppliers lower. Also, the development costs are very high in the aerospace industry given the stringent quality checks & the certifications that are required to qualify as a supplier.

COMPETITION LANDSCAPE FOR A&D COMPONENTS MARKET

Industry structure

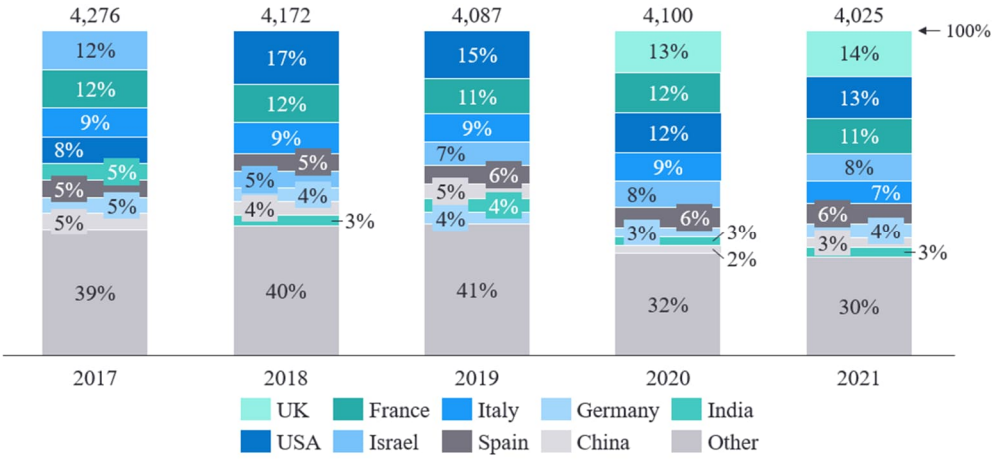
The Aerospace and defence component industry is fragmented and there are a many small and medium sized players catering to Tier 1 manufacturers who further supply to OEMs like Airbus SE and The Boeing Company. The OEMs are smaller in number and the value chain funnel from Tier 2 to Tier 1 to OEM becomes even more narrow.

Global and Indian trade

Overall global exports

The total exports have remained flat around US$ 4 Bn mark. UK, France, and USA occupy the top spots in exports and make up for over a third of global exports. India contributes to about 3% of the total exports. Below is the export share breakup of countries for HS code: 88039 which refers to "parts of aircraft and spacecraft, n.e.s.".

Overall global exports at HS code 88039 (US$ Mn), (2017-21)

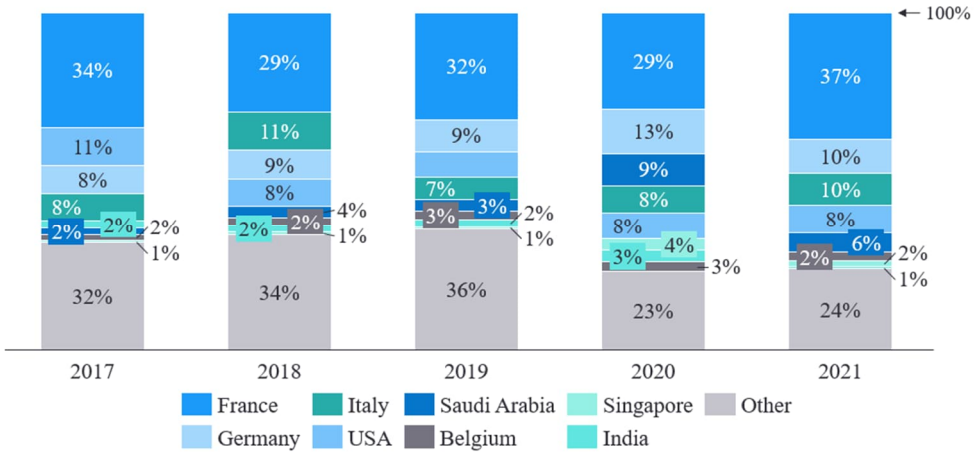


Source: ITC trade map
Note: The import data is specific for the HS code 88039 which refers to "parts of aircraft and spacecraft, n.e.s.". Global data is being analyzed using CY data instead of FY data.

Overall global imports

France makes up for over a third of global imports with Germany and Italy making up for 10% each. The primary reason for this is that major assembly lines for aerospace (such as Airbus SE, Thales Group, Safran S.A., Dassault Aviation S.A. etc.) are located in France. Below is the import share breakup of countries for HS code: 88039.

Overall global imports at HS code 88039 (US$ Mn), (2017-21)

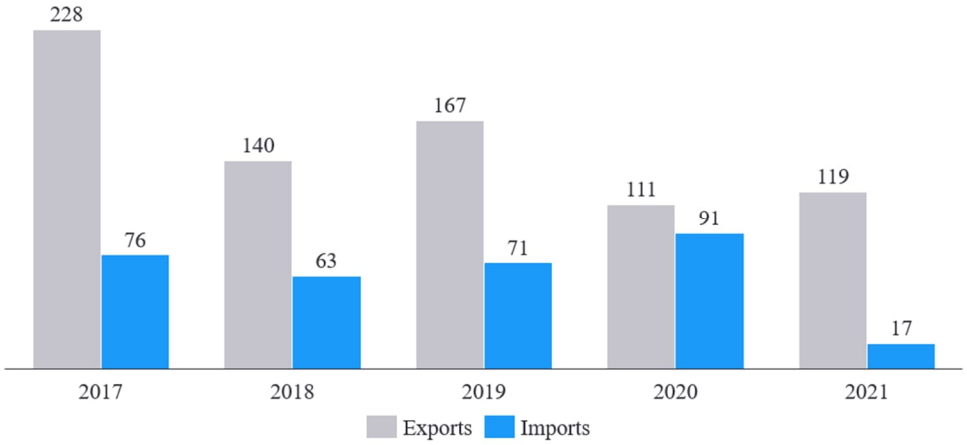


Source: ITC trade map
Note: The import data is specific for the HS code 88039 which refers to "parts of aircraft and spacecraft, n.e.s.". Global data is being analyzed using CY data instead of FY data.

India's exports and imports

Exports declined in 2018 due to decline in export of high value products. Post that exports declined in 2020 due to decline in orders of The Boeing Company & Airbus SE driven by decline in demand due to the pandemic. However, the imports have witnessed a marginal increase. As per Union Defence Ministry, India's defence exports reached 13,399 INR Cr in FY23 which is the highest ever for the country. Below are the imports and exports from India for HS code: 88039.

India's exports and imports at HS code 88039 (US$ Mn), (2017-21)

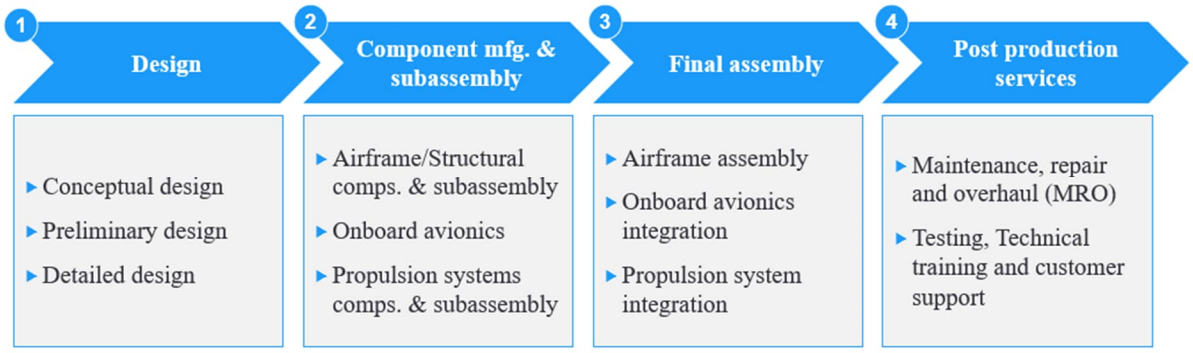


Source: ITC trade map
Note: The import data is specific for the HS code 88039 which refers to "parts of aircraft and spacecraft, n.e.s.". For the purpose of comparing with global trade, we have used calendar year for India trade data.

Value chain for the A&D components market

The value chain for manufacturing of A&D components has four key steps. Starting from the design, then component manufacturing and subassembly of systems, then final assembly of the particular part and then postproduction services. The final aircraft assembly is only done by OEMs like The Boeing Company and Airbus SE and a tier 1 player does assembly of the particular part (propulsions system, lavatories etc.). On the other hand, a tier 2 supplier primarily supplies subassemblies and components (e.g., blades, fasteners, engine parts etc.) which are then integrated into the final assemblies (propulsions system, lavatories etc.).

A&D manufacturing value chain



Source: Research gate
Note: This excludes final aircraft assembly which is done by OEMs (such as The Boeing Company, Airbus SE) only.

Key players manufacturing A&D components

Azad Engineering Ltd.:

Azad Engineering Ltd. started its core manufacturing in 2008 and is a manufacturer in the aerospace & defence and energy turbine components. It is also a manufacturer of oilfield drilling equipment. The company manufactures high precision components for A&D industry.

Details of other players

The details about other key players manufacturing A&D components are mentioned below.

Details of key players manufacturing A&D components

Players	Key products	Key services	Manufacturing locations	Markets served
Dynamatic Technologies Ltd.	• Wing & Rear Fuselage • Ailerons & wing flaps • Airframe structures	• Designing & manufacturing • Precision machining • Aerospace fabrication	India	Domestic (India) & export
Maini Precision Products Ltd.	• Aerospace engine parts • Aerospace structures • Aerospace systems • Clean powertrain	• Designing & testing • End to end machining & casting processes • Export packaging & warehousing	India, UK	Domestic (India) & export
MTAR Technologies Ltd.	• Nuclear assemblies • Space vehicle engines • Clean energy units	• CNC machining • Quality, testing & control • Assembly services	India	Domestic (India) & export
Paras Defence & Space Technologies Ltd.	• Defence & space optics • Aerospace communication systems • Avionic suites	• Heavy engineering & precision manufacturing • Embedded software development • System engineering design	India	Domestic (India) & export
International Aerospace Manufacturing Pvt. Ltd.	• Aeroengine compressor • Gas turbine parts • Compressor casings, housings, rings & other parts	• Machining • Metal spray, blasting & painting • Advanced manufacturing using AI	India	Domestic (India) & export

Mecachrome SAS	• Aerostructures • Subassemblies for helicopters, fighter planes, jets & aircrafts • Assemblies for aircraft engines • Engine drive shaft mechanism for helicopters	• Machining • Sheet metal working • Assembly of work packages • Digitalization using AI to improve the cost of lifecycle of products for customers	France	Domestic (France) & export
Jamco Corporation	• Aircraft components • Jet engine parts • Aircraft interiors	• Design, assembly & supply • Maintenance, repair & overhaul (MRO)	Japan	Domestic (Japan) & export
Wuxi Turbine Blade Co., Ltd. (WTB)	• Compressor blades • Disks and shafts • Structural parts	• Machining & forging • Non-destructive testing • Special processes	China	-
Aero Engine Corporation of China (AECC)	• Aerospace engine parts • Turbofan engines • Turboprop engines • Turboshaft engines	• Design, assembly, integration & supply • Testing • Maintenance	China	Domestic (China) & export
Shanghai Prime Machinery Company Ltd.	• Fasteners • Bolts & rods • Special parts • Nuts & screws, socket cap screws	• Design & manufacturing • Surface plating	China	Domestic (China)

Source: Company websites
Note: Information for markets served by Wuxi Turbine Blade Co., Ltd. (WTB) is not available

Operational benchmarking of key players

Value chain presence of players

Almost all of the players are present in the component manufacturing and sub-assembly whereas only large players have integrated and provide design and final assembly as well.

Value chain presence of players

	Production			Post production services
	Design	Component manufacturing	Assembly	
Azad Engineering Ltd.		✓	✓	
Dynamatic Technologies Ltd.	✓	✓	✓	✓
Maini Precision Products Ltd.	✓	✓	✓	✓
MTAR Technologies Ltd.	✓	✓	✓	
Paras Defence & Space Technologies Ltd.	✓	✓	✓	
Aero Engine Corporation of China (AECC)	✓	✓	✓	✓
International Aerospace Manufacturing Pvt. Ltd.		✓	✓	
Jamco Corporation	✓	✓	✓	✓
Mecachrome SAS		✓	✓	✓
Shanghai Prime Machinery Company Ltd.	✓	✓		
Wuxi Turbine Blade Co., Ltd. (WTB)		✓		

Source: Company websites
Note: 1. Post-production services typically include maintenance repair and overhaul (MRO). Testing is a critical part of production process and hence is not included within post-production services. 2. This excludes final aircraft assembly which is done by OEMs (such as The Boeing Company, Airbus SE) only.

Segmental presence of players

While most players only focus on machined components, a few players offer forgings and casting

services as well. Within machined engine parts, the most common offering are blades. Other parts include landing gear, wire harnesses systems and other assemblies.

Segmental presence of players

	Aero structures	Machined engine parts	Other machined parts	Others
Azad Engineering Ltd.		✓	✓	✓
Dynamatic Technologies Ltd.	✓		✓	
Maini Precision Products Ltd.	✓	✓	✓	✓
MTAR Technologies Ltd.	✓	✓	✓	✓
Paras Defence & Space Technologies Ltd.	✓		✓	✓
Aero Engine Corporation of China (AECC)		✓		
International Aerospace Manufacturing Pvt. Ltd.		✓		
Jamco Corporation		✓		✓
Mecachrome SAS	✓	✓	✓	
Shanghai Prime Machinery Company Ltd.			✓	
Wuxi Turbine Blade Co., Ltd. (WTB)	✓	✓	✓	✓

Source: Company websites
Note: Other machined parts include machined components such as flanges, bushings etc. Other parts include landing gear, wire harnesses systems & other assemblies.

Financial benchmarking of key players

Revenue comparison of the key players

Presently global players are operating at much larger scale but have been stagnant in terms of growth.

Revenue comparison of competitors 2020-2024 H1 (INR Cr), CAGR (2020-23)

Company	2020	2021	2022	2023	2024 H1	CAGR
Jamco Corporation	5,401	2,953	2,306	2,786	-	-19.8%
Dynamatic Technologies Ltd.	1,334	1,124	1,262	1,326	742	-0.2%
Maini Precision Products Ltd.	584	437	627	841	-	12.9%
MTAR Technologies Ltd.	218	248	331	593	324	39.6%
Azad Engineering Ltd.	124	125	199	262	170	28.4%
Paras Defence & Space Technologies Ltd.	149	145	186	231	112	15.7%
International Aerospace Manufacturing Pvt. Ltd.	162	108	151	192	-	5.9%

Source – Financials reports published in MCA, SEC filings, Company annual reports.
Note – 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
2. Revenues for international players are converted to INR as per latest exchange rate.
3. A&D segment share in overall revenue: Dynamatic Technologies Ltd ~ 34% (2021), Maini Precision Products Ltd. ~10% (2021), International Aerospace Manufacturing Pvt. Ltd., Jamco Corporation ~100%,
4. Revenue for Jamco Corporation between Apr-Jun 2023 is INR 862 Cr.

Comparison of EBITDA margin of the key players

Azad Engineering Ltd. has the highest EBITDA margin (31% in 2023) across the compared companies in India and globally.

EBITDA margin comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Jamco Corporation	5.1%	-16.8%	-3.9%	8.1%	-
Dynamatic Technologies Ltd.	15.2%	13.8%	14.1%	14.4%	14.0%
Maini Precision Products Ltd.	6.8%	3.0%	6.7%	22.3%	-
MTAR Technologies Ltd.	28.6%	34.1%	31.2%	29.2%	23.3%
Azad Engineering Ltd.	34.7%	24.4%	33.7%	31.4%	37.3%
Paras Defence & Space Technologies Ltd.	27.7%	30.9%	29.5%	28.1%	25.3%
International Aerospace Manufacturing Pvt. Ltd.	15.4%	14.2%	14.2%	16.5%	-

Source – Financials reports published in MCA, SEC filings, Company annual reports.
Note – 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23

Comparison of PAT margin of the key players

Indian companies have a diversified portfolio of customers and have been consistently profitable.

PAT margin comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Jamco Corporation	0.7%	-27.1%	-10.4%	4.7%	-
Dynamatic Technologies Ltd.	2.9%	-1.9%	1.2%	3.2%	7.2%
Maini Precision Products Ltd.	-3.9%	-10.7%	-2.9%	12.9%	-
MTAR Technologies Ltd.	14.4%	18.6%	18.4%	17.4%	12.6%
Azad Engineering Ltd.	17.1%	9.2%	14.8%	3.2%	15.9%
Paras Defence & Space Technologies Ltd.	13.2%	10.9%	14.6%	15.6%	13.0%
International Aerospace Manufacturing Pvt. Ltd.	2.9%	0.7%	4.8%	7.5%	-

Source – Financials reports published in MCA, SEC filings, Company annual reports.
Note – 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
2. PAT margin for Jamco Corporation between Apr-Jun 2023 is 2.7%.

Comparison of ROCE of the key players

Most Indian companies have ROCE's in excess of 10%.

ROCE comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Jamco Corporation	4.2%	-36.5%	-16.3%	7.3%	-
Dynamatic Technologies Ltd.	13.2%	8.7%	12.2%	13.2%	7.4%
Maini Precision Products Ltd.	0.1%	-7.8%	-0.1%	48.4%	-
MTAR Technologies Ltd.	21.6%	14.5%	15.8%	21.4%	8.3%
Azad Engineering Ltd.	29.4%	15.0%	21.0%	14.9%	11.6%
Paras Defence & Space Technologies Ltd.	13.5%	13.6%	11.1%	12.2%	4.8%
International Aerospace Manufacturing Pvt. Ltd.	8.9%	3.1%	10.2%	18.3%	-

Source – Financials reports published in MCA, SEC filings, Company annual reports.
Note – 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
2. ROCE for Jamco Corporation between Apr-Jun 2023 is 1.0%

Comparison of P/E ratio of the key players

Dynamatic Technologies Ltd., MTAR Technologies Ltd. and Paras Defence & Space Technologies Ltd. have a P/E ratio of more than 40x in 2023.

P/E ratio comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Jamco Corporation	34.3	-	-	18.5	-
Dynamatic Technologies Ltd.	7.9	-	87.5	40.9	-
MTAR Technologies Ltd.	-	60.3	88.3	47.0	-
Paras Defence & Space Technologies Ltd.	-	-	80.4	50.8	-

Source – Financials reports published in MCA, SEC filings, Company annual reports, BSE India, Google Finance
Note – 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
2. Closing price of last trading day of relevant month is considered for calculation of P/E ratio
3. P/E ratio of 2024 H1 is not included as annualized earnings are not available
4. P/E ratio for Jamco Corporation (2021, 2022) and Dynamatic Technologies Ltd (2021) is negative due to negative earnings.

Comparison of P/B ratio of the key players

Dynamatic Technologies Ltd and Paras Defence & Space Technologies Ltd. have a P/B ratio of 3-4x in 2023 with P/B ratio of MTAR Technologies Ltd. at 7.8x in 2023.

P/B ratio comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Jamco Corporation	0.7	1.7	1.9	3.0	-
Dynamatic Technologies Ltd.	0.8	1.6	3.6	3.2	4.7

MTAR Technologies Ltd.	-	5.8	10.3	7.8	11.8
Paras Defence & Space Technologies Ltd.	-	-	5.8	4.4	6.3

Source – Financials reports published in MCA, SEC filings, Company annual reports, BSE India, Google Finance
Note – 1. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
2. Closing price of last trading day of relevant month is considered for calculation of P/B ratio
3. P/B ratio for Jamco Corporation as on Jun 2023 is 3.0.

Key success factors in the industry

The key success factors in the aerospace and defence components industry not only require access to resources but also continual attention to improve operational efficiency:

1. ***Operational effectiveness***
    a. Highly skilled labour is required but optimal labor costs are also needed as suppliers have lower bargaining powers vis-à-vis the OEMs.
    b. OEM seek to maximize their margins and are constantly looking for cost effective suppliers which gives Indian vendors who are able pass the stringent qualification process an edge.
    c. Specialization in one product or common process confers an edge to the supplier as they tend to get higher volumes.
2. ***Execution capability***
    a. Control over supply chain is critical in this industry since the tolerance for error is non-existent.
    b. Ability to ramp to meet the production schedules is a key requirement for the OEMs and Tier1 players. They prefer supplier who can provide this consistently.
    c. Rapid responses to request for quotes and proposals is also a key demand from customers.
3. ***Access to resources***
    a. These products are of high quality and used in life critical components such as engine of an aircraft. Hence, the margin for error in these components is nil.
    b. Access to skilled labor with experience in manufacturing components with small tolerances is a key requirement. Plant locations which have access to such talent have an advantage.
    c. Vendors are required to participate during the product development stage and vendors who can commit capital and resources have a higher right to win when the product is launched, and demand picks up.

The industry has a significant entry barrier due to a lengthy qualification process for the A&D components due to criticality of their usage. The qualification process for a new vendor is stringent and includes multiple steps mentioned below.

1. Identification and understanding the vendor.
2. Assessment and audit of the technical capabilities for the vendor
3. RFQ and negotiations
4. Vendor registration
5. Evaluation and test of the product qualifications
6. Final contract and negotiations
7. PO for product supply

This entire process is time intensive and often takes more than 15 months to qualify as a supplier during which the vendor is evaluated by the OEM. The vendors also need to institute quality and tracking procedures for all products that are supplied which demands a higher order quality control.

Once a contract is awarded by an OEM to a supplier for a critical component, the OEM and the supplier

typically spend significant amount of time and capital on design, manufacturing, first article inspection, testing & certifications for product specific equipment such as tooling. Any new supplier will need to undergo the same process. OEMs are reluctant to switch suppliers as there are high switching costs unless the current suppliers are unable to meet the requirements on quality, cost, or delivery.

Comparison of Indian, Chinese, and other global players

Players that are well integrated into the value chain have an edge in their execution capability as witnessed for Chinese and other global players. Few Indian players have also developed similar capability. Global players who have scale are able to effectively utilize labour resources to achieve better operational effectiveness, gaining an advantage.

DRILLING EQUIPMENT

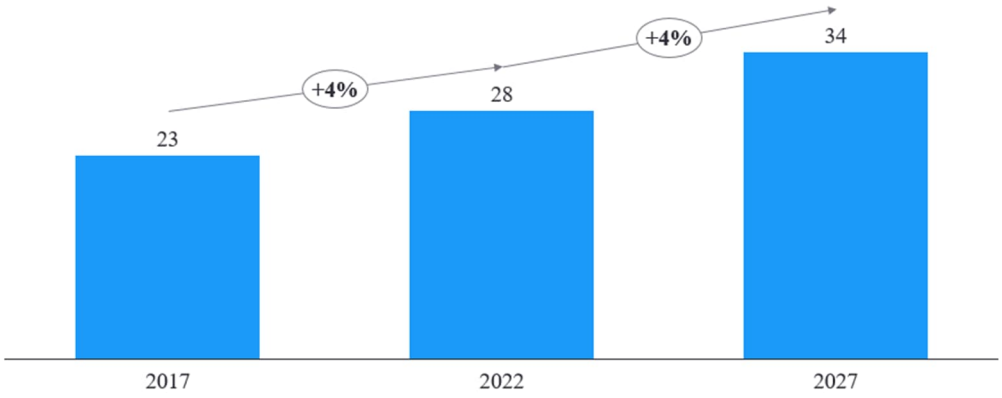
MARKET REVIEW AND OUTLOOK

The global oil and gas drilling tools market caters to the needs of the oil and gas industry by supplying specialized equipment essential for drilling during exploration, production, and resource extraction. This market plays a vital role in facilitating efficient and effective drilling operations in both onshore and offshore environments. Azad Engineering Ltd. manufacturers components of drilling rigs (such as drill bits) and downhole drilling tools (such as reamers).

Overall drill bits market and outlook

The overall market for drill bits in 2022 is INR 28k Cr which is expected to reach INR 34k Cr by 2027 with an estimated compounded annual growth of 4% between 2022 – 27. This growth is largely driven by the growth in exploration and production (E&P) spending globally.

Drill bits market (INR'000 Cr) (2017-27)

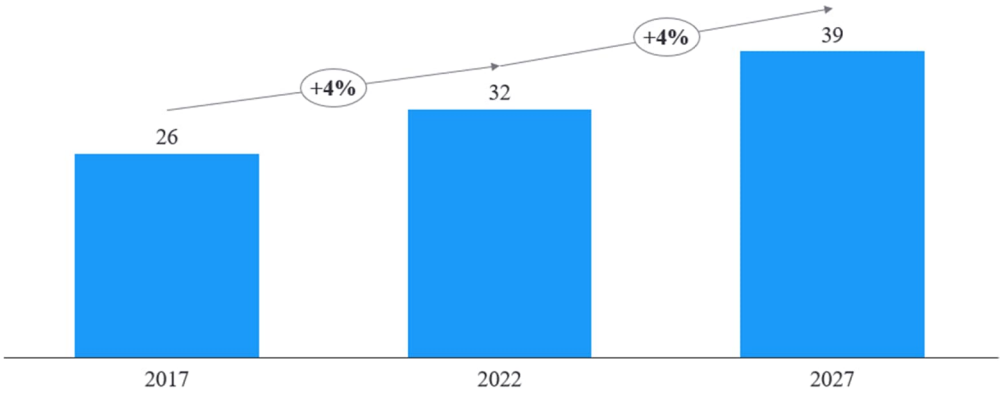


Source: IEF, S&P Global Upstream Oil and Gas Investment Outlook, dated February 2023, Schlumberger, Ltd. corporate overview
Note: This includes overall drill bits market which is supplied by large OFSE players such as Schlumberger, Ltd., Baker Hughes etc. and doesn't specifically take into account the outsourcing share in this market.

Overall downhole drilling tools market and outlook

The overall market for downhole drilling tools includes market for products such as reamers. This market was estimated to be INR 32k Cr in 2022 & is expected to reach INR 39k Cr by 2027 with an estimated compounded annual growth of 4% between 2022 – 27. Similar to drill bits market, this growth is also largely driven by the growth in exploration and production (E&P) spending globally.

Downhole drilling tools market (INR'000 Cr) (2017-27)



Source: IEF, S&P Global Upstream Oil and Gas Investment Outlook, dated February 2023, Schlumberger, Ltd. corporate overview
Note: This includes overall downhole drilling tools which is supplied by large OFSE players such as Schlumberger, Ltd., Baker Hughes etc. and doesn't specifically take into account the outsourcing share in this market.

The major driving factors behind the increasing demand of drilling equipment are:

1. ***Technological advancements in drilling*:** Drilling techniques and technologies are becoming more advanced resulting in greater efficiency and safety allowing exploration of areas that were too expensive earlier such as deep water and ultra-deep water.
2. ***Offshore E&P activities*:** Area under offshore drilling has expanded adding to the demand of advanced drilling equipment.
3. ***New infrastructure & pipeline development activities*:** Due to changes in the political landscape, multiple new pipelines are being developed & further new infrastructure is being built which are creating demand for equipment using in piping gas and oil.
4. ***Increased funding by players in upstream sector*:** The investment in upstream sector is increasing at global level as the demand for energy continues to increase.

The major risks to the demand of drilling equipment are:

1. ***Technological and operational risks*:** Technological advancements can result in obsolescence of some equipment which will require vendors to keep abreast of new technologies.
2. ***Demand fluctuations:*** Changes in global energy consumption, push for adoption of renewable energy sources, and energy efficiency trends can impact the demand for oil and gas.

COMPETITION LANDSCAPE FOR DRILLING EQUIPMENT

Industry overview

The Oil field service and equipment (OFSE) market in complex and has several value chains that vary across the geographies. The companies follow various business models and are present across few or all parts of value chains. While some players manufacture components, some are involved in drilling and production, and some do both. Several players like Baker Hughes takes up contracting jobs as well.

The market is dominated by several large integrated players like Schlumberger, Ltd., NOV Inc., Halliburton, Pioneer energy services, Superior energy services Inc., GE oil and gas, C&J energy services Ltd., Expro group holding N.V., Baker Hughes etc. These players primary engage in drilling activities along with manufacturing of the drilling and equipment and hence aren't direct competitors to machining companies. On a technological level, there is low differentiation among the OFSE players

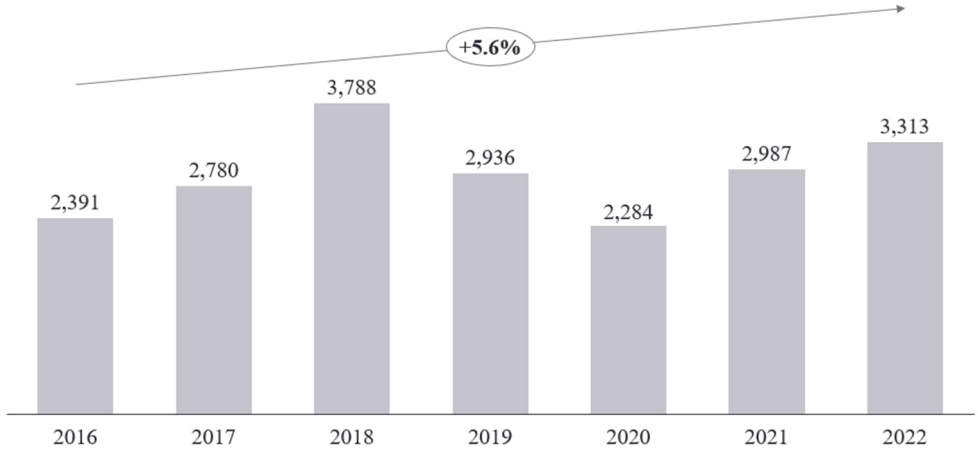
and hence there have been rise of new players in the space.

Global and Indian trade

Global exports and imports

The global exports at HS code 843041, which refers to "Self-propelled boring or sinking machinery for boring earth or extracting minerals or ores", have been growing at about 6% from 2016 to 2022. After witnessing the lowest exports in 2020 since 2016, the exports are witnessing an increase and currently stands at 3.3 US$ Bn.

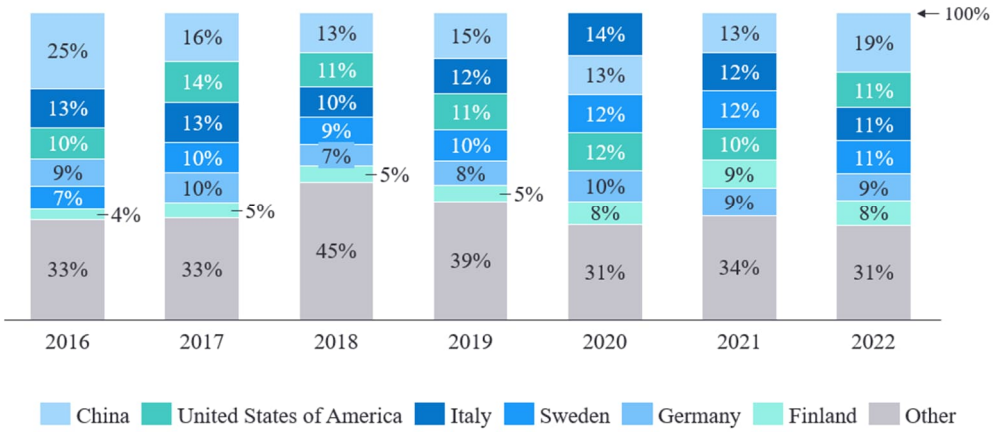
Global exports at HS code 843041 (US$ Mn), (2016-22)



Source: ITC trade map
Note: The import data is specific for the HS code 843041 which refers to "Self-propelled boring or sinking machinery for boring earth or extracting minerals or ores"

China contributed the largest share in global exports for drilling equipment and accounted for 19% of total exports in 2022. China, USA, and Italy together constituted for about a third of total exports by value.

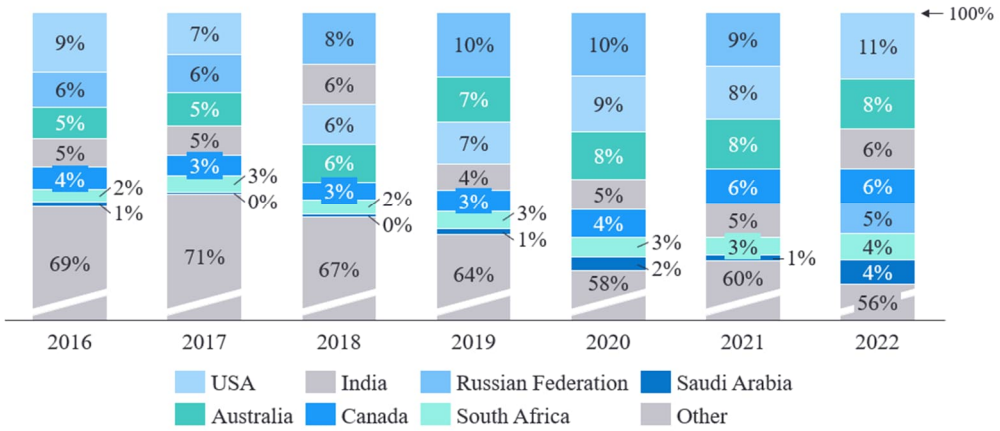
Global exports by country at HS code 843041 (US$ Mn), (2016-22)



Source: ITC trade map
Note: The import data is specific for the HS code 843041 which refers to "Self-propelled boring or sinking machinery for boring earth or extracting minerals or ores"

USA, Australia, and India were the three largest importers of drilling equipment in 2022 making up for about 25% of the total imports.

Global imports by country at HS code 843041 (US$ Mn), (2016-22)

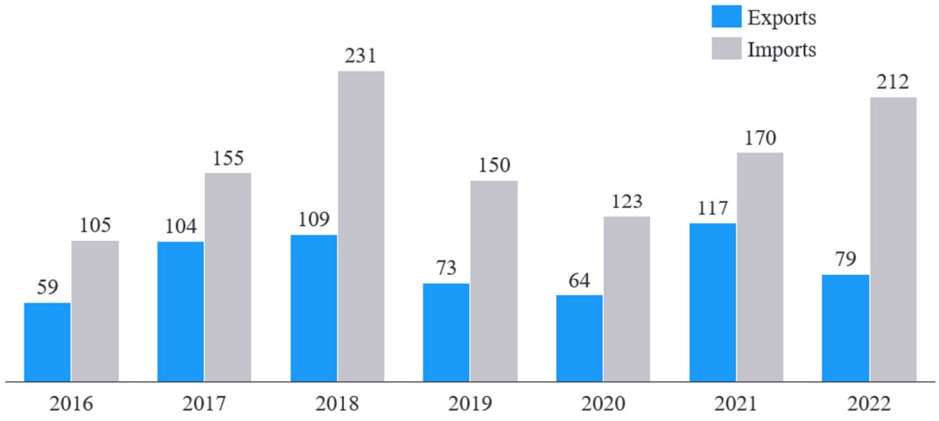


Source: ITC trade map
Note: The import data is specific for the HS code 843041 which refers to "Self-propelled boring or sinking machinery for boring earth or extracting minerals or ores"

Indian exports and imports

India is a net importer of drilling tools with over 70% of the imports coming from China. The total imports have followed a similar trend to global exports and currently stands at 212 US$ Mn in 2022. The exports have fluctuated around 100 Mn US$ since 2017 and currently stands at 79 USD Mn.

India's exports and imports at HS code 843041 (US$ Mn), (2016-22)

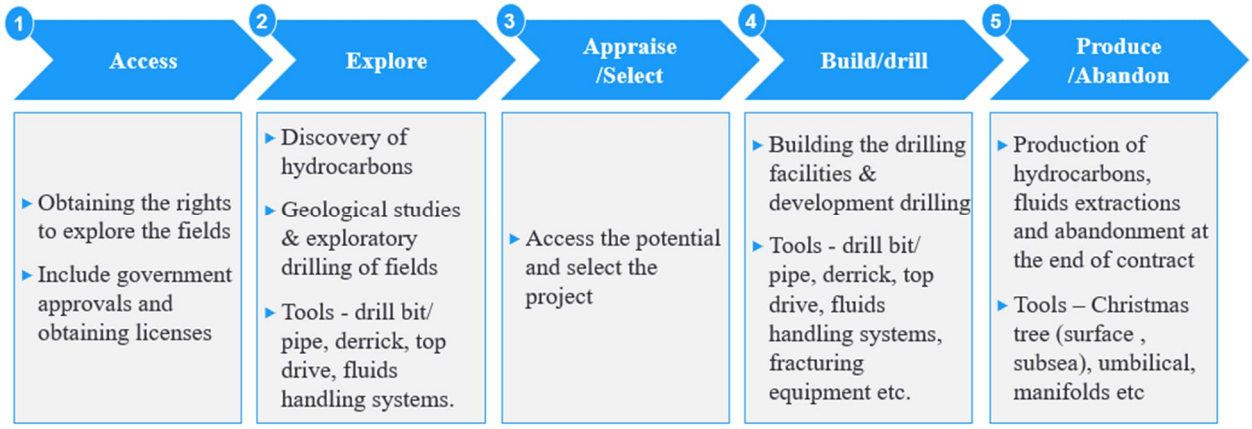


Source: ITC trade map
Note: The import data is specific for the HS code 843041 which refers to "Self-propelled boring or sinking machinery for boring earth or extracting minerals or ores"

Value chain

The value chain for E&P starts from obtaining a license for exploration followed selection, drilling, production of hydrocarbons and finally abandonment at the end of contract. The tools are primarily used in exploration for exploratory drilling, in development drilling and in production.

Value chain for exploration and production (E&P)



Source: E&M combustion article, accessed August 2023

Key players machining for drilling equipment

Azad Engineering Ltd.:

Azad Engineering Ltd. started its core manufacturing in 2008 and is a player in the energy turbine, aerospace & oilfield drilling equipment market. Within oilfield drilling components, the company supplies drill bits, reamers, slips amongst others.

Details of other players

The details about other key players machining for the oilfield drilling equipment are mentioned below.

Details of key players machining for drilling equipment

Players	Key products	Key services	Manufacturing locations	Markets served
United Drilling Tools Ltd.	• Wireline winch • Gas lift equipment • Downhole tools • Connectors	• Bottom hole assembly and drilling solutions	India	Domestic (India) & export
Drilling Tools International Corp.	• Desanders • Valves • Roller reamers	• Directional & premium tools rental services • Downhole inspection services • Wellbore optimization	USA	Domestic (USA) & export
Schoeller-Bleckmann Oilfield Equipment AG	• Reamers • Hole openers • Non-magnetic drill collars • Circulations & completion equipment	• Repair & maintenance services	Germany, Austria, USA	USA & Europe

Source: Company websites

Operational benchmarking of key players

Value chain presence of players

Almost all key players provide individual components, systems, and services across the segment. Players such as Azad Engineering Ltd. focus more on machining of components than end-user service.

Value chain presence of players

	Components	Systems	Services
Schoeller-Bleckmann Oilfield Equipment AG	✓	✓	✓
Drilling Tools International Corp.	✓	✓	✓
Azad Engineering Ltd.	✓		
United Drilling Tools Ltd.	✓	✓	✓

Source: Company websites

Segmental presence of players

International players such as Schoeller-Bleckmann Oilfield Equipment AG and Drilling Tools are present across drilling and completion segments while Indian players are generally present only in two segments. The largest India player United Drilling Tools Ltd. provides products in drilling and completion but does not operate in the flow control segment.

Segmental presence of players

	Drilling tools	Circulation / flow control tools	Completion tools
Schoeller-Bleckmann Oilfield Equipment AG	✓	✓	✓
Drilling Tools Intl. Corp.	✓	✓	✓
Azad Engineering Ltd.	✓		
United Drilling Tools Ltd.	✓		✓

Source: Company websites

Financial benchmarking of key players

Revenue comparison of the key players

Indian enterprises are far smaller when compared to global players such as Schoeller-Bleckmann Oilfield Equipment AG.

Revenue comparison of competitors 2020-2024 H1 (INR Cr), CAGR (2020-23)

Company	2020	2021	2022	2023	2024 H1	CAGR
Schoeller-Bleckmann Oilfield Equipment AG	2,706	2,791	4,709	-	-	31.9%
Azad Engineering Ltd.	124	125	199	262	170	28.4%
United Drilling Tools Ltd.	115	147	176	120	50	1.6%

Source – Financials reports published in MCA, SEC filings, Company annual reports.
Note: 1. Drilling Tools International Corp. is not considered due to lack of periodic revenue data
2. CAGR between 2020 – 22 is considered for Schoeller-Bleckmann Oilfield Equipment AG due to lack of 2023 financial data,
3. For Azad Engineering Ltd., the total company financials are considered not the oil and gas segmental financials
4. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
5. For Schoeller-Bleckmann Oilfield Equipment AG, financials are for year ending Dec
6. For Foreign Players, figures are converted using latest conversion rates
7. Revenue for Schoeller-Bleckmann Oilfield Equipment AG between Jan – Jun 23 is INR 2,740 Cr.

Comparison of EBITDA margin of the key players

United Drilling Tools Ltd. had a high EBITDA margin of 42.8% compared to 33.7% for Azad Engineering Ltd. and 25.3% for Schoeller-Bleckmann Oilfield Equipment AG in 2022.

EBITDA margin comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Schoeller-Bleckmann Oilfield Equipment AG	5.5%	19.6%	25.3%	-	-
Azad Engineering Ltd.	34.7%	24.4%	33.7%	31.4%	37.3%
United Drilling Tools Ltd.	48.8%	29.1%	42.8%	16.4%	18.9%

Source – Financials reports published in MCA, SEC filings, Company annual reports.
Note: 1. Drilling Tools International Corp. not considered due to lack of periodic revenue data
2. For Azad Engineering Ltd., the total company financials are considered not the oil and gas segmental financials
3. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
4. For Schoeller-Bleckmann Oilfield Equipment AG, financials are for year ending Dec.
5. EBITDA margin for Schoeller-Bleckmann Oilfield Equipment AG between Jan – Jun 23 is 24.2%.

Comparison of PAT margin of the key players

In 2022, Schoeller-Bleckmann Oilfield Equipment AG & Azad Engineering had PAT margin of ~14%.

PAT margin comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Schoeller-Bleckmann Oilfield Equipment AG	-7.3%	6.8%	14.4%	-	-
Azad Engineering Ltd.	17.1%	9.2%	14.8%	3.2%	15.9%
United Drilling Tools Ltd.	39.4%	22.3%	28.4%	8.5%	8.9%

Source – Financials reports published in MCA, SEC filings, Company annual reports.
Note: 1. Drilling Tools International Corp. not considered due to lack of periodic revenue data.
2. For Azad Engineering Ltd., the total company financials are considered not the oil and gas segmental financials,
3. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23
4. For Schoeller-Bleckmann Oilfield Equipment AG, financials are for year ending Dec
5. PAT margin for Schoeller-Bleckmann Oilfield Equipment AG between Jan – Jun 23 is 14.2%.

Comparison of ROCE of the key players

United Drilling Tools Ltd. had the highest ROCEs compared to others whose ROCE ranges between 15-20% in 2022.

ROCE comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Schoeller-Bleckmann Oilfield Equipment AG	-4.8%	4.9%	16.2%	-	-
Azad Engineering Ltd.	29.4%	15.0%	21.0%	14.9%	11.6%
United Drilling Tools Ltd.	31.4%	20.1%	29.5%	6.2%	2.7%

Source – Financials reports published in MCA, SEC filings, Company annual reports.
Note: 1. Drilling Tools International Corp. not considered due to lack of periodic revenue data.
2. For Azad Engineering Ltd., the total company financials are considered not the oil and gas segmental financials,
3. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23,
4. For Schoeller-Bleckmann Oilfield Equipment AG, financials are for year ending Dec
5. ROCE for Schoeller-Bleckmann Oilfield Equipment AG between Jan – Jun 23 is 9.7%.

Comparison of P/E ratio of the key players

Schoeller-Bleckmann Oilfield Equipment AG has 12.2x P/E ratio as on Dec 2022.

P/E ratio comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Schoeller-Bleckmann Oilfield Equipment AG	-	23.1	12.2	-	-
United Drilling Tools Ltd.	4.7	16.3	20.0	38.4	-

Source – Financials reports published in MCA, SEC filings, Company annual reports, BSE India, Wiener Börse AG
Note: 1. Drilling Tools International Corp. not considered due to lack of periodic revenue data.
2. For Azad Engineering Ltd., the total company financials are considered not the oil and gas segmental financials,
3. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23,
4. Closing price of last trading day of relevant month is considered for calculation of P/E ratio,
5. For Schoeller-Bleckmann Oilfield Equipment AG, financials are for year ending Dec
6. P/E ratio for Schoeller-Bleckmann Oilfield Equipment AG (2020 is negative due to negative earnings
7. P/E ratio of 2024 H1 is not included as annualized earnings are not available.

Comparison of P/B ratio of the key players

United Drilling Tools Ltd. has a P/B ratio of 0.2x as on Mar 2023.

P/B ratio comparison of competitors 2020-2024 H1

Company	2020	2021	2022	2023	2024 H1
Schoeller-Bleckmann Oilfield Equipment AG	1.7	1.4	2.2	-	-
United Drilling Tools Ltd.	0.1	0.3	0.4	0.2	0.2

Source – Financials reports published in MCA, SEC filings, Company annual reports, BSE India, Wiener Börse AG
Note: 1. Drilling Tools International Corp. not considered due to lack of periodic revenue data.
2. For Azad Engineering Ltd., the total company financials are considered not the oil and gas segmental financials,
3. For Indian players, financials are for FY20-FY23 and H1 2024 financials are for Apr – Sept,23,
4. Closing price of last trading day of relevant month is considered for calculation of P/B ratio,
5. For Schoeller-Bleckmann Oilfield Equipment AG, financials are for year ending Dec.
6. P/B ratio for Schoeller-Bleckmann Oilfield Equipment AG as on Jun 23 is 1.9x.